CIMMYT Report On WHEAT IMPROVEMENT 1978

CIMMYT

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CIMMYT Report On WHEAT IMPROVEMENT

1978

A Report on the Wheat Improvement Program
of the International Maize and Wheat Improvement Center
El Batan, Mexico

CENTRO INTERNACIONAL DE MEJORAMIENTO DE MAIZ Y TRIGO
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Introduction

World wheat production for the year ending in mid-1978 dropped to 382 million tonnes (metric tons) from the record mid-1977 level of 415 million tonnes (USDA World Agricultural Situation, 18 December 1978).

Most of the reduction occurred in the grain exporting nations—Argentina, Australia, Canada and the United States. A drop in production of approximately 11 million tonnes also occurred in the Centrally Planned Countries, with the Soviet Union and the People's Republic of China each registering a decrease of approximately five million tonnes. On the other hand, India and Turkey harvested record crops and both countries have built large reserve stocks. Turkey, during the past two years, also has established itself as a sizable wheat exporter into African and Southern European markets. India, during 1978 for the first time since independence, also exported 700,000 tonnes of wheat to several neighboring countries including the USSR, Vietnam, Sri Lanka and Afghanistan, while at the same time building a large reserve stock. Pakistan, on the other hand, experienced a sharp drop in production during 1978 resulting primarily from a severe widespread epidemic of leaf rust. This experience clearly indicates the need for efficient continuous monitoring of the rust populations in farmers' fields by plant pathologists and must culminate in a decision to timely multiply and distribute new varieties whenever needed, in order to provide adequate protection against the changes in races of the populations of the rust pathogens.

Despite the reduction in world wheat production during 1978, total world agricultural output increased by about 2.5 per cent, largely because of sizable increases in production of rice and coarse grains. Worldwide grain reserves stood at about 16 per cent of annual consumption, compared to 11.5 per cent during the serious shortages of the 1972–73 to 1974–75 period. India, for the first time in its history, has built a large reserve stock of grains, largely wheat from domestic production, now estimated to be about 16 million tonnes. Such reserve stocks will provide considerable protection against a bad harvest which could result from a poor monsoon. Moreover, during the past year, about 1.5 million tonnes of grain from reserve stocks have been distributed to unemployed or underemployed who are engaged in government "food for work" programs, which are designed for the dual purpose of relieving poverty and hunger while, at the same time, improving the infrastructure of the rural economy. The success of the "food for work" program during its first year in operation will likely lead to the expansion of this program in the years ahead.

As cereal production rapidly expands in developing countries such as Turkey and India, other new problems arise, for example the need for more adequate storage facilities. The urgency and methods of coping with the need for expanded storage capacity vary with climate. On the Anatolian Plateau in Turkey, where the atmosphere is dry during summer, and temperatures are sufficiently high that insect and fungal activity can take place, wheat can be safely stored on the ground in long piles or mounds for two or more years, at low cost, under a protective layer of heavy gauge plastic which is covered with soil. In India however, where high humidity and high temperatures coincide during the summer monsoon season, losses from insects and fungi are high unless the grain is stored in good permanent grain warehouses. Currently, perhaps nearly half of the large grain stock in India is inadequately protected under temporary improvised plastic storage. As food production is increased in the developing nations, capital investment in adequate storage facilities must be made if losses from insects, fungi and rodents are to be maintained at a tolerable level.

Although wheat production has increased dramatically over the past decade in a number of developing countries e.g. India, the People's Republic of China, Turkey, Pakistan and Tunisia, nonetheless, collectively the developing nations still import from 30–35 million tonnes of wheat grain and wheat flour annually. This continuing high import of wheat by developing countries results from a combination of rapid population growth and an increase in per capita consumption of wheat.

The technology for greatly increasing wheat production is now available for most areas of the developing nations where wheat has been one of the important crops. Continued rapid increases in yield and production however will result only with the expanded use of fertilizer, better control of weeds, more widespread use of improved agronomic practices which improve the utilization of moisture, keeping diseases under control and provided that economic policies are maintained (or established) that stimulate the adoption of the high yield technology.

Because of the increasing drain on foreign exchange resulting from wheat imports, a considerable number of developing countries where wheat has not been an important crop, have initiated wheat research programs within the last few years. Among the newer wheat research and production plans, the Bangladesh program has been uniquely successful. In 1978 production rose to 340,000 tonnes and expansion is targeted for 500,000 and 800,000 tonnes in 1979 and 1980, respectively.

As world population grows and the demand for wheat increases, scientists must simultaneously attempt to stabilize yields—reduce year to year variation—through minimizing losses from diseases and insects, while at the same time, strive to develop higher yielding varieties and more efficient and better agronomic practices (e.g. better moisture utilization, better fertilization practices and improved weed control). It is generally accepted that there are now well adapted, high yielding commercial varieties available for use in most wheat growing areas of the developing nations. The genetic yield potential of these varieties on most farms is currently only being utilized to a level of 30–60 per cent. Consequently, CIMMYT scientists believe that much of the breeding emphasis in the near future must be focused on reducing the danger of losses from epidemic diseases, especially from the rusts, but also from *Septorias,* mildew and barley yellow dwarf virus which sometimes become epidemic, while at the same time encouraging the more widespread adoption of agronomic practices which will utilize more of the genetic yield potential in present commercial varieties.

Stable resistance to the three rusts remains the first objective of the wheat scientists. Rust has been a threat to the wheat crop for thousands of years and many devastating epidemics have occurred. Constant mutation of the rust pathogens, as well as their hybridization on the alternate host, provides new threats to the wheat varieties, including the varieties previously considered resistant to the existing races of rust. The breeders and pathologists jointly must therefore give first attention to the development of new varieties which combine different and more stable sources of resistance to the three rusts, and also provide for timely replacement of today's commercial varieties when they become susceptible.

The pathologists must continuously monitor the races of the rust pathogens on farms throughout their region. At the first sign of the appearance of new races capable of seriously attacking the principal commercial varieties, they and the breeders, must promptly identify high yielding agronomically acceptable lines in the breeding program, release and multiply them, and see that they are widely distributed to farmers before an epidemic develops and disaster results.

Unfortunately, almost without exception in the developing nations, the seed multiplication and distribution organizations are both inefficient and bureaucratic. This results in a long delay between the time when a new variety is released until it becomes widely available for growing on farms. During this period the crop is vulnerable to attack whenever ecological conditions favor the pathogen. Such was the case that resulted in the severe leaf rust epidemic in Pakistan in 1978 and necessitated the importation of two million tonnes of grain.

The use of multiline varieties, described elsewhere in this report, offers one excellent option for slowing down the build-up of a rust epidemic and thereby permits the crop to mature without damage. The writer and his Mexican colleagues developed two tall strawed multiline wheat varieties and demonstrated their potential usefulness in the control of rust more than 20 years ago. Unfortunately, elaboration of these multilines coincided with the development and release of the higher yielding dwarf wheat varieties, and as a consequence, the multiline varieties were not released. During the 1960's and early 1970's most of the breeding research emphasis at CIMMYT was concentrated on correcting the defects in the early dwarf varieties e.g. broadening disease resistance, improving straw strength and milling and baking properties, etc. Within the last six years, a modest research effort has been made to develop iso-lines of the 8156 varieties Kalyansona and Siete Cerros that are potential candidates for use in multiline varieties being developed by a number of national wheat programs.

Meanwhile Drs. K.F. Frey and J. A. Browning at Iowa State University have developed, and for the last seven years successfully used, commercial multiline varieties of oats in the U.S.A. Their work has shown clearly the feasibility of this approach to controlling airborne diseases in self pollinated crop species. Why has this approach not been used commercially in wheat up to the present time?

During 1978, India became the first country to release multiline varieties of semidwarf wheats. Three different multiline varieties based on the high yielding broadly adapted semidwarf variety Kalyansona are now being distributed to farmers in the regions where the parent variety Kalyansona has been popular for the past 10 years, but which in recent years has become increasingly more susceptible to leaf rust. It is hoped that these events will usher in a new era in protecting self pollinated crop species from the onslaught of epidemics of rusts and other airborne diseases.

The use of multiline varieties also offers an excellent way of circumventing ineffective seed multiplication and distribution programs in developing countries where these organizations are usually ineffective. For example, each of the 10 isolines that are to be used in a multiline variety can be multiplied individually to a level of four tonnes and mixed mechanically to form 40 tonnes of seed of multiline variety. The seed then can be divided into 8,000 five kilogram samples and distributed to farmers by extension agents in the area where the parent variety was well accepted by farmers and performed satisfactorily. The multiline variety can be reconstituted employing other isolines whenever necessary as indicated by changes in the rust race population.

Today, as I read through and write the introduction to this annual report, which is the last that I will issue while I am director of the CIMMYT wheat program, I cannot help but reflect on the great progress that has been made in developing an effective cooperative system of international testing of genetic materials in wheat, barley and triticale. Three decades ago, there was no international testing. Today, there is a worldwide international fraternity of collaborating wheat scientists who cooperate with each other for mutual benefits as well as for collective benefits. In this report our staff has assembled a summary of the recent cooperative efforts and results in research and production programs of hundreds of scientists from many countries. In 1978, our international nurseries of bread wheat, durum wheat, barley and triticale were shipped to 108 countries. These nurseries put new germ plasm on display and generate testing data to guide the worldwide wheat network in further breeding.

Training of young scientists from developing countries is one of the most important aspects of the CIMMYT program. Fifty-eight young wheat scientists from developing countries were brought to Mexico in 1978 to work one cropping season with CIMMYT staff. They are now back in their home countries where they serve in their national programs and as part of the world network. Sixty visiting scientists came to CIMMYT to learn more about our program, help in varietal selection and explore new techniques for crop improvement.

Stabilizing yield by reducing crop losses from diseases, insects and viruses is of primary importance in the short and medium term research objectives.

However, in the long term, our research objective must also be to increase as far as possible, the maximum genetic yield potential of future varieties. Concurrently, the CIMMYT research program must develop agronomic information that will make it possible to economically exploit a higher level of the genetic grain yield potential occurring in both present and future varieties. The semidwarf and double dwarf wheats distributed from Mexico in the 1960's raised the yield potential in the research station for wheat varieties of 140–150 days maturity from 4 t/ha to the 7–8 t/ha range. Since that time the yield potential has gradually increased to the range of 8–9 t/ha, but in general a yield plateau has existed for a decade.

Although many of the benefits of the so-called "green revolution" in the developing countries are still to come from the more widespread application and more intensive use of the materials and methods now available, we are nonetheless, already asking ourselves where and how can we add another dimension to the present revolution in small grain crop production. It is obvious that it is becoming more and more difficult to increase further the genetic yield potential in newer varieties as we approach the maximum genetic yield potential (whatever that may be) under an ideal environment. Our efforts in the past have been handicapped by the large amount of breeding program effort that has, by necessity, been devoted to maintaining disease resistance in the commercial varieties. To continue to increase the maximum genetic yield potential further will require employing the use of more diverse germ plasm and also the use of different breeding methods. Although it is obvious that we must continue to expend most of our research effort and budget on the crops that feed the world today, we must also explore other new approaches in a modest way.

CIMMYT, for the past decade, has recognized the increasing difficulty that is being encountered in trying to increase the maximum genetic yield potential of wheat varieties under an ideal environment. We believed it was unwise to wait until we could no longer further increase the genetic yield levels of wheat before we, in another way, explored other possible alternatives to increasing small grain yields.

A major step in this direction is being made by the development of the new man-made crop triticale. The new species was created by producing a "sterile mule" like plant by hybridizing wheat and rye and manipulating the chromosome numbers with chemicals to induce fertility. The new form possesses all of the genetic mechanism of the two species, wheat and rye, in a single species. The genetic potential of this species in increasing food production and improving nutritional quality is indeed promising.

Triticale is not intended at present to replace wheat as a commercial crop, except under very special conditions where it already greatly outyields wheat. On very acid soils, such as the highly leached laterites of Brazil, Kenya, Ethiopia, Tanzania and the outer ranges of the Himalayas in northern India, Pakistan and Nepal, and also the acid soils in the mountains of Michoacan in Mexico, triticale will frequently yield twice as much as the best wheat. At present, in the best irrigated areas in Sonora, Mexico—the home of the Mexican dwarf wheats—triticale yields as much as the best wheat varieties. In the same area 10 years ago, it yielded only 50 per cent as much as the best wheat. We are now convinced that triticale will become an important new cereal crop in some areas of the world within the next decades.

As part of CIMMYT's overall effort to be of assistance to national wheat, triticale and barley research and production programs, our Mexico based wheat staff travelled to more than 60 countries in 1978 to observe the international wheat trials, to talk with farmers, to consult with policy makers and research scientists and to visit former trainees.

Highlights of these cooperative activities appear in the following pages.

Norman E. Borlaug

Bread Wheat

INTRODUCTION

The philosophy of the CIMMYT Wheat Program is the development of germ plasm for distribution around the world. Because this germ plasm possesses high yield potential, daylength insensitivity and acceptable rust resistance it has had widespread acceptance in most spring wheat producing areas.

The total area of high yielding varieties (HYV) in the lesser developed countries (LDC) has increased steadily in the past 10 years. In the USDA Foreign Agricultural Economic Report (1978), "Development and Spread of High Yielding Varieties of Wheat and Rice in the Less Developed Nations" Dalrymple reported that HYV occupied about 5,000,000 hectares in 1967-68 in the LDC's. This increased to approximately 19,000,000 hectares in 1972-73 and by 1976-77 to at least 29,000,000 hectares. The major portion of this area is seeded to semidwarf CIMMYT germ plasm either through direct release of CIMMYT derived varieties or the reselection and interbreeding of CIMMYT germ plasm by national programs.

During this period of time, there has been a rapid increase in the use of semidwarf HYV in the Indian sub-continent, grown mainly under irrigation. In the future, a major impact of the HYV in the LDC's will come from rainfed production in the regions of North and West Africa, Near East, South America and, the sub-continent. The rapid increase that occurred in the late sixties and early seventies in the sub-continent is now being repeated in these rainfed areas.

In the future, CIMMYT must provide variable high yielding germ plasm with wide adaptation combined with broader disease resistance. This will be achieved by a continued active participation of the CIMMYT base wheat program with the national and expanding CIMMYT regional programs.

With these objectives in mind, the CIMMYT Wheat Program made over 8,000 crosses in 1978 and evaluated more than 40,000 segregating lines at each of two Mexican sites (Cd. Obregon at 40 m and Toluca at 2,649 m altitude respectively) in alternate winter and summer cycles. At Cd. Obregon, along with the segregating materials, more than 1700 advanced lines were yield evaluated to select high yielding germ plasm for the International Bread Wheat Screening Nursery (IBWSN). From this material, 465 lines were selected to make up the 12th IBWSN which was distributed to 200 locations throughout the world.

The 15th International Spring Wheat Yield Trial (ISWYN) was selected from 119 cultivars and selections from the major spring wheat regions of the world grown and evaluated at Cd. Obregon. The ISWYN is composed of 49 of the best entries from this planting and it was sent to 120 locations throughout the world. A total of 1700 F_2 bulk populations were classified for exploitation under irrigation, or rainfed conditions, spring x winter crosses, crosses for aluminum toxicity resistance, and Siete Cerros type for multiline selection. These F_2 bulk populations were sent to 350 selected sites throughout the world where these special germ plasm groups can be more fully exploited.

More than 200 advanced lines selected for resistance to *Helminthosporium sativum* were sent to 50 sites. In addition, the 105 components for Siete Cerros multiline composites were made available to 30 cooperators in the world.

The distribution of these international nurseries has resulted in the selection and release of many cultivars world wide. The cultivars released from CIMMYT germ plasm during 1978 are listed in table 1.

DEVELOPMENT OF GERM PLASM

To produce high yielding, widely adapted germ plasm, the CIMMYT Wheat Program incorporates the following characteristics—high yield potential under many environmental conditions, semidwarf growth type, broad based disease resistance and also daylength and/or temperature insensitivity.

INCORPORATION OF GENETIC VARIABILITY UTILIZING MEXICAN SITES.

To accomplish these objectives segregating populations are selected and evaluated at two locations viz., Cd. Obregon and Toluca. At Cd. Obregon in Sonora, the environmental conditions are excellent for the selection for leaf rust resistance and high yielding agronomic types.

By contrast, Toluca is characterized by high rainfall and humid conditions under cool temperatures which are conductive for selection for resistance to stripe rust, scab, *Fusarium nivale, Septoria* spp and brown necrosis. At both locations, selection for stem rust resistance is accomplished by artificial inoculation.

Additional locations in Mexico that are used for leaf and stem rust evaluations are: Los Mochis, Sinaloa; Refugio and Roque, Guanajuato; Rio Bravo, Tamaulipas; and El Batan, Mexico.

Special nurseries of advanced line material are grown at Patzcuaro, Michoacan for the evaluation of resistance to *Septoria tritici.*

Selection for resistance to *Helminthosporium sativum* is done at Poza Rica, Veracruz.

The elite yield trials are also evaluated at Mexicali, Baja California and at Hermosillo, Sonora and Celaya, Guanajuato.

INCORPORATION OF GENETIC DIVERSITY FOR DISEASE RESISTANCE AND AGRONOMIC CHARACTERISTICS THROUGH INTERNATIONAL TESTING

Since 1964 the ISWYN Program has been the vehicle by which high yielding broadly adapted varieties have been identified. In the 1970's many more international and regional yield and disease nurseries have come into existence. These nurseries have broadened the base for identifying germ plasm of superior adaptation and for expanding disease resistance on a global basis.

Of special importance for identifying disease resistance are the IBWSN, RDISN, (Regional Disease and Insect Screening Nursery from Middle East and Asia operated by CIMMYT/ICARDA for the regions of the Middle East, sub-continent and Africa), VEOLA (Vivero de enfermedades y observación de Latino America operated by the CIMMYT Regional Program based at Quito, Ecuador), and the ISWRN (International Spring Wheat Rust Nursery operated by USDA).

Information for adaptation and disease resistance of winter wheat comes from the IWWPN (International Winter Wheat Performance Nursery operated by the University of Nebraska/USAID) and the IWSWSN (International Winter x Spring Wheat Screening Nursery operated by Oregon State University/CIMMYT).

Many years of ISWYN trials identified Siete Cerros and Anza as cultivars with wide adaptation. This is verified by the release and production on a large scale of these two varieties on all continents.

The results of the 13th and 14th ISWYN indicate that the wide adaptability of Pavon 76 and Nacozari 76 is parallel to Siete Cerros and Anza. The geneology of these two cultivars is presented in figures 1 and 2. These two varieties were selected from top crosses whose ancestry represented widely adapted cultivars and other cultivars of wide geographical origin.

Table 2 presents the pattern of adaptation of 14 of the highest yielding lines in the 10th IBWSN represented by 10 different crosses. These are Pavon "S" CM–8399; Glea–Gaines; Brochis "S" CM–58872; Jupateco 73; Emu "S" CM–8327; Bluejay "S" (Nacozari "S") CM–5287; Chiroca "S" CM–8963; Mexp 65 x Sal. Sea. P106–19 (Variety from Lebanon); Moncho "S" CM–8288; and Oldafo 41A (variety from Rhodesia). It is apparent from the pattern of adaptation in table 2, that there are differences in adaptation of these lines, but all demonstrate a wide range of adaptation.

CD. OBREGON CYCLE

Approximately 50 hectares of land were sown to segregating generations, yield trials, small multiplication plots, breeding nurseries, and observational plantings from world wide cooperators at Cd. Obregon in the 1977-78 season. The planting season was normal with a good stand establishment. Good leaf and stem rust infections from both natúral and artifical inoculation developed, facilitating selection for these diseases.

The temperatures for the growing season period November–April for 1977-78 averaged 2^{o}C above the average for the previous 10 years. The temperatures during November, December and January were the highest in the last 11 years.

Figure 3 shows the maximum, minimum and mean temperatures for the months of November through April compared to the means for the last 10 years. Evaporation is compared against the average of the last seven years. These high temperatures and increased evaporation during the months of November, December and January reduced tillering and development of the head primordia. Since irrigation was on a time schedule, the high temperatures and evaporation also caused some early drought stress.

The climatic conditions in 1977-78, combined with irrigation problems, resulted in a substantial yield reduction. This is apparent in table 3 where an average of 7348 kg/ha was obtained in 1975-76, 6957 kg/ha for year 76/77 and 5676 kg/ha for 77/78. These figures are based on yields of the top 142, 150 and 175 varieties respectively in the yield experiments for those years.

This is further demonstrated in table 4, where 13 cultivars were yield tested and protected with the leaf rust fungicide Bayleton^{R}. The yield ranged from 4585 kg/ha for the variety Tanori 71 to 5721 kg/ha for Zaragoza 75. These are highly significant differences between the yield of the varieties, but the overall yield level of all the varieties is about two t/ha less than expected for normal conditions.

TWELFTH INTERNATIONAL BREAD WHEAT SCREENING NURSERY

Yield trials in Cd. Obregon in 1977-78 evaluated 1740 advanced lines from the 1977 harvests at Obregon and Toluca. These lines were also evaluated for leaf and stem rust in Mochis, and Rio Bravo, Mexico. The best disease resistant and high yielding lines from this material were selected to make up the 12th IBWSN with 465 entries, including check varieties, which was sent to 180 locations world wide.

The best 95 entries in the 12th IBWSN which represents 56 different crosses are presented in table 5. This table gives yield (compared to the highest yielding check in the same experiment), grain color, plant height and the leaf rust and stripe rust reaction at the Mexican locations listed. All of the selections listed in table 5 will be tested in elite yield trials in four Mexican locations (Roque, Mochis, Cd. Obregon and Hermosillo) for evaluation and possible inclusion in future International Yield Trials. Some of these lines, after more intensive testing in Mexico, may be released as Mexican varieties.

ELITE TRIALS AND MULTIPLICATION

In the 1977-78 season, a twenty one entry elite selection yield trial comprising the highest yielding lines from the 1976-77 season with Mexican cultivars as checks, was planted in Cd. Obregon, Hermosillo and Celaya, Mexico. The yields in kg/ha and as a per cent of Pavon 76 yield for the elite trial at these three locations, are presented in table 6.

Based on the yield in the elite and other yield trials and rust reaction in Cd. Obregon, Mochis, Roque, El Batan, Poza Rica and Rio Bravo, Mexico, five advanced lines from four crosses have been increased and given to INIA–CIANO for possible release as cultivars in Mexico. These lines are given in table 7 with yield and rust reaction at the locations indicated.

These lines were derived from the following crosses: Buck Buck "S" = Bucky–Maya 74 "S" (Bb x HD832.5.5–On/Cno–Pj62) CM–31678; Titmouse "S" = (Pl/Inia–Cno x Cal) Bjy "S" CM–30136; Vireo "S" = Inia "S"–On x Inia–Bb/Coc75 CM–28235; and Junco "S" = Bb–Gallo x Carp/Pavon "S" CM–33483. The first four lines in table 7 have hard wheat quality, and the last one has soft wheat quality.

TOLUCA AND EL BATAN CYCLE

The breeding nursery at Toluca was normal in respect of plant diseases, climatic conditions and agronomic development. However excessive lodging occurred due to causes as yet unknown. There was an excellent development of stripe rust, leaf rust, scab and *Septoria nodorum* in the entire nursery. The nurseries were sprayed with Benlate^R to protect against *Fusarium nivale,* a disease that is not a problem in any of the spring wheat areas of the world. At Toluca, about 100,000 plants from F_2–F_7 were pulled. After screening for disease and seed characteristics 30,000 were advanced and planted in Cd. Obregon for the next cycle.

At El Batan, plant development was excellent and was better than in any of the previous eight years. The season was also characterized by an excellent development of leaf and stem rusts facilitating good selection. At San Jose, two kilometers north of the El Batan station, 1760 advanced lines were yield tested in 46 yield trials. At the same time they were evaluated for diseases at Toluca, Refugio, Roque and Saltillo, in Mexico. Some 575 of the best lines, determined by yield performance at San Jose and disease resistance at the other four locations, were kept for yield and disease evaluation in Cd. Obregon and other Mexican sites in 1978-79. These yield experiments were conducted under high fertility and maximum irrigation schedules resulting in yields up to nine t/ha.

The yield performance of 65 advanced lines, representing 47 crosses, which gave the highest yield at San Jose, are presented in table 8 together with the data on grain color, height and disease reaction at the other test sites listed. The high yields at El Batan may indicate adaptation at other similar high altitude locations. The 575 high yielding lines from San Jose trials will be sent to the CIMMYT regional programs in Kenya and the Andean Region for further evaluation under high altitude conditions.

WINTER X SPRING PROGRAM

This program is conducted in collaboration with the Oregon State University at Corvallis, Oregon. The conditions at the Toluca station during the winter are severe enough to allow direct planting of winter types in November with natural vernalization. January plantings of spring wheat will bring both winter and spring types to flowering in May, thereby facilitating crossing.

About 1500 simple spring x winter crosses are made annually by CIMMYT to divide with Oregon State University. The world wide sources of the winter wheat lines in the winter wheat crossing block are given in table 9. The number of lines from each continent is as follows: South America 43, North America 227 (U.S.A.), Western Europe 74, Eastern Europe 74, Turkey 16, Far East 80 and South Africa 1.

Seed from the crosses is divided equally with Oregon State University. At Oregon State University these F_1's are grown at the Hyslop Research Farm at Corvallis. There, the F_1's are crossed to winter wheat. Segregating generations from these crosses are grown at Hyslop, (1000 mm precipitation), Pendleton (400 mm rainfall), and Moro (300 mm rainfall) for selection under varied climatic and disease conditions.

Advanced lines selected from these winter-spring crosses are distributed through the International Winter x Spring Wheat Screening Nursery to more than 70 locations throughout the world. The climate in many of the LDC's requires some winter hardiness or facultative growth habit which can come from this type of germ plasm.

The Spring-Winter Program at CIMMYT crosses the F_1's with spring types and these are then incorporated into the regular spring wheat segregating populations. The high yielding advanced lines are then distributed through all of CIMMYT's international nurseries. Twenty one of the high yielding advanced lines from spring-winter crosses are listed in table 10. The winter wheat lines used in the crosses listed in table 10 originated in Holland, Soviet Union, Oregon (U.S.A.), Chile, Argentina, West Germany, Rumania and Yugoslavia.

The winter variety Kavkaz from the Soviet Union has proven to be an excellent combiner with the spring type wheat. The light insensitivity of Kavkaz may contribute to the good combining ability with light insensitive spring wheat types.

SPRING X WINTER FACULTATIVE WHEATS

In many regions of the world, a long season wheat is needed to take advantage of particular rainfall patterns and late frost periods. For example, the central and western parts of India (Madhya Pradesh, Karnatka and Maharashtra) need to seed at the end of September to take advantage of the residual monsoon moisture for stand establishment, and have a longer maturation cycle than shorter season wheat types planted in November. Areas of Argentina, North Africa, and the Near East need facultative wheats with some cold tolerance to avoid late spring frosts.

Beginning in 1978 in Cd. Obregon, F_2 Spring x Winter populations were planted at the beginning of October to allow selection of intermediate maturing types which will stand high temperatures early in the season.

8156 MULTILINE

CIMMYT has been involved for eight years in an international program to develop a multiline composite variety based on the 8156 genotype. In the process of developing single, top and double crosses of the 8156 type, many components have been developed and distributed in areas where this genotype is adapted. CIMMYT's responsibility has been to develop and distribute components to national programs which will evaluate and select the components which will go into combinations for release as multiline varieties.

INDIAN MULTILINES

In 1978 India released three multiline composite varieties based on the 8156 genotype. These releases were from the Indian Agricultural Research Institute, New Delhi, the Punjab Agricultural University and the C.S.A. Agricultural University, Kanpur.

In the case of Punjab, of the six components used in the multiline variety, three were produced at CIMMYT. At Kanpur, all the components were CIMMYT derived.

Although multiline varieties offer the stability of high yield potential through protection from serious disease epiphytotics, with the exception of India, there has been very little effort by national programs to develop multiline varieties. The major problem has been the lack of adequate seed programs and technology in the LDC's to multiply the components and maintain a multiline component variety.

In 1977 the 6th International Multiline (8156) Nursery consisting of 90 components was distributed to 30 locations in regions of 8156 adaptation. Some of the very best high yielding components of this nursery were assembled as a Multiline (8156) Yield Trial. It was sent to one location in each of India, Pakistan, Egypt and Algeria and was also planted at Cd. Obregon. Table 11 presents the yield of this multiline trial grown at Cd. Obregon.

The yield of multiline composites B6–0Y, B8–0Y, and B9–0Y are statistically comparable to Jupateco 73 and Nacozari 76, but not to Pavon 76, and they were superior to Siete Cerros. Since Siete Cerros was not protected against rust, the yield was reduced by rust infection.

In table 12, the yields of the components within a composite are compared with the yield of the composite. In general, the average yield of the individual components which comprised a composite, was about the same as the composite yield. In only one composite was the yield variation more than 500 kg/ha and in general, the yield variation was less than 300 kg. It appears that, at least in this trial, the yield of a composite will approach the average yield of the components.

BREEDING FOR ALUMINUM TOXICITY RESISTANCE

There are large areas of wheat production or areas of potential wheat production which have acid soils and aluminum toxicity problems. This is a serious problem in wheat production in Brazil and East Africa. A program was initiated five years ago to transfer resistance to aluminum toxicity (crestamento) into high yielding, disease resistant, semidwarf wheat types.

The resistance now available is located primarily in tall, low yielding, poor agronomic types of wheat. Peculiarly, Alondra "S", a high yielding semidwarf from the CIMMYT program which carries a rye translocation from Wq-RM, does very well in aluminum toxic acid soils, even though it has been demonstrated to be susceptible to aluminum toxicity. The nature of its high performance is unknown (although Septoria resistance may be a factor), but because of its good agronomic type, Alondra is being widely crossed in the Brazilian breeding program. This could have the effect of narrowing the genetic base.

To broaden the base for resistance to disease, agronomic adaptability and yield, CIMMYT has crossed the aluminum resistant parents listed in table 13 to many widely adapted high yielding semidwarf wheat selections.

CIMMYT has 286 lines from 135 crosses selected for agronomic and disease resistance under Mexican conditions, which are homozygous resistant to "crestamento" in Brazil. The first homozygous "crestamento" resistant lines with good agronomic semidwarf characters will be available in 1980 from the CIMMYT program.

COOPERATIVE PROGRAM ON ALUMINUM TOXICITY

For the last five years, CIMMYT has provided facilities for the Brazilian programs (Fecotrigo, Embrapa and Ocepar) whereby Brazilian F_1 crosses are grown in Cd. Obregon to be intercrossed among themselves, CIMMYT F_1, and other germ plasm. Brazilian personnel, in consultation with CIMMYT/Bread Wheat Staff, determine and execute the crosses and selection at Cd. Obregon.

This has accelerated the generations for selection by planting alternately in Brazil and Mexico in the same year. This has also allowed selection for aluminum toxicity resistance in one cycle and for superior agronomic types under favorable disease and production conditions in the other cycle, as well as expanding the range of adaptation of the crosses.

In 1978 CIMMYT established a one year cooperative program with Dr. C.F. Konzak at Washington State University who will test a number of CIMMYT advanced lines and breeding material under laboratory conditions for aluminum toxicity resistance.

PROGRAM FOR RESISTANCE TO HELMINTHOSPORIUM SATIVUM

There are relatively large areas of wheat production where *Helminthosporium sativum* is a serious problem, for example in Eastern India, Bangladesh, Brazil and East Africa. The CIMMYT program has been primarily involved in evaluating advanced lines at the Poza Rica Experiment Station in Eastern Mexico under tropical conditions where this disease and leaf rust are endemic.

In the 1977-78 season, 2470 lines from the PC's, crossing block and 11th IBWSN were evaluated for *H. sativum* at the Poza Rica Station. A severe epidemic of this disease developed and destroyed a major portion of the nursery. About 200 lines which showed promising field resistance were harvested. After selection for lines without seed shriveling and black point, 131 lines from 80 crosses were retained and distributed to 50 locations world wide where this problem has been reported. These lines along with the leaf rust reactions in Poza Rica, are given in table 14.

The results of this international testing under variable environments, will identify those lines with superior resistance to *Helminthosporium* and these can be cycled into the breeding program. These lines also offer an opportunity for direct release in areas where this disease is a problem.

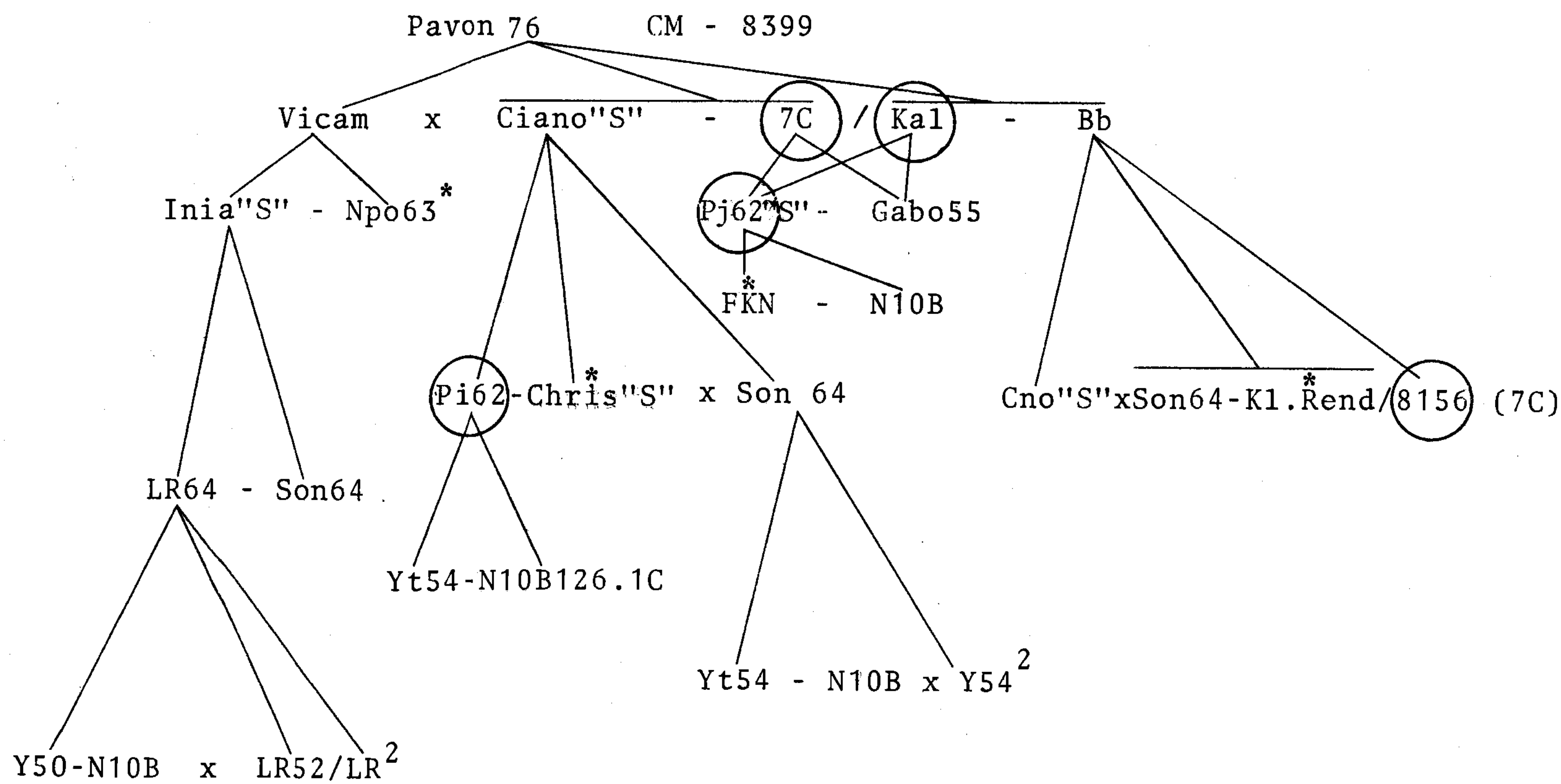
PROGRAM FOR EARLY MATURITY

The emphasis on broad adaptation and high yield as represented in Siete Cerros, Anza, Pavon 76 and Nacozari 76 has resulted in the selection of later maturing lines. Early varieties such as Inia 66 and Sonalika have not shown broad adaptation and they yield well only under certain specific short season conditions. However, early maturity is needed especially in rotation with other crops. Examples are India, Bangladesh and South Korea where a rice-wheat rotation is being practiced.

Some of the earliest germ plasm is in Chinese and Korean wheat. In 1978, this germ plasm was crossed into the main CIMMYT material for increasing earliness in good, broadly adapted CIMMYT lines. From the advanced CIMMYT material, 234 lines were identified in 1978 to be as early as Tanori 71 and Inia 66. These lines will be evaluated for yield and the best lines will be distributed internationally to the appropriate areas.

At CIMMYT's Toluca Experiment Station, Mexico the drying of sheaves (in the background) is a necessary operation before threshing the single plant selections.

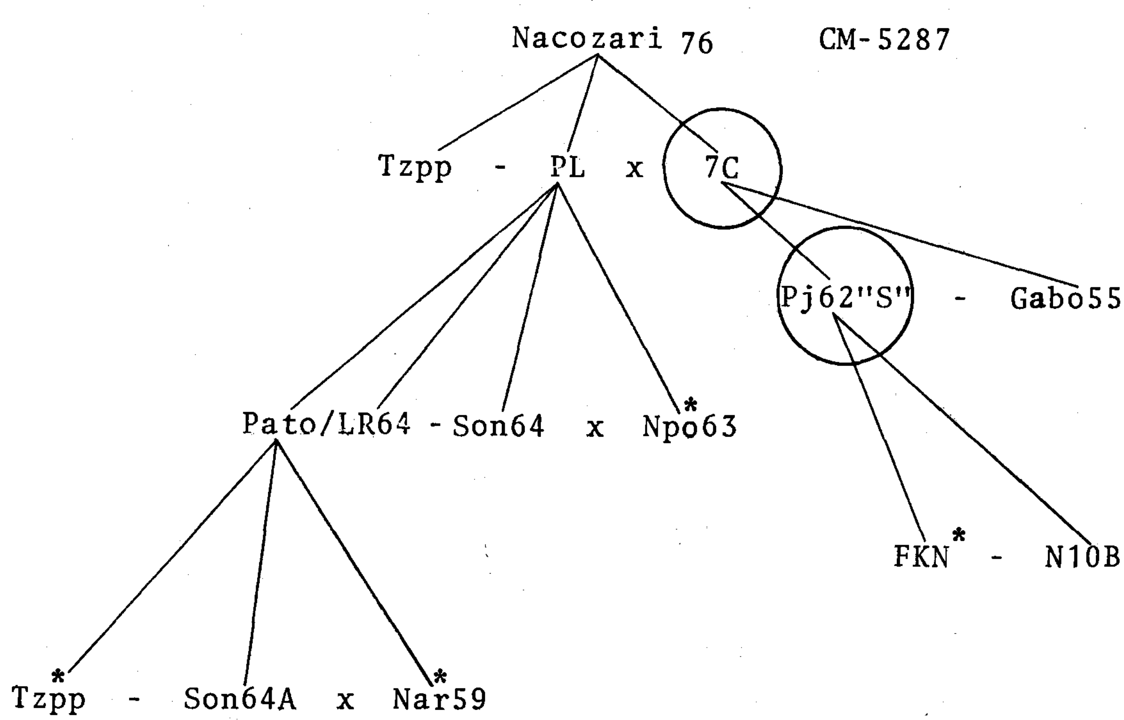
Figure 1. GENEALOGY OF PAVON 76



* Cultivars developed and adapted outside of Mexico

O Proven to be widely adapted by International Yield Trials

Figure 2. GENEALOGY OF NACOZARI 76



* Cultivar developed and adapted outside of Mexico
O Proven to be widely adapted by International Yield Trials

FIGURE 3. Weather data for CIANO Experiment Station Cd. Obregon, Mexico comparing long time average temperatures and evaporation with 1977-78 conditions.

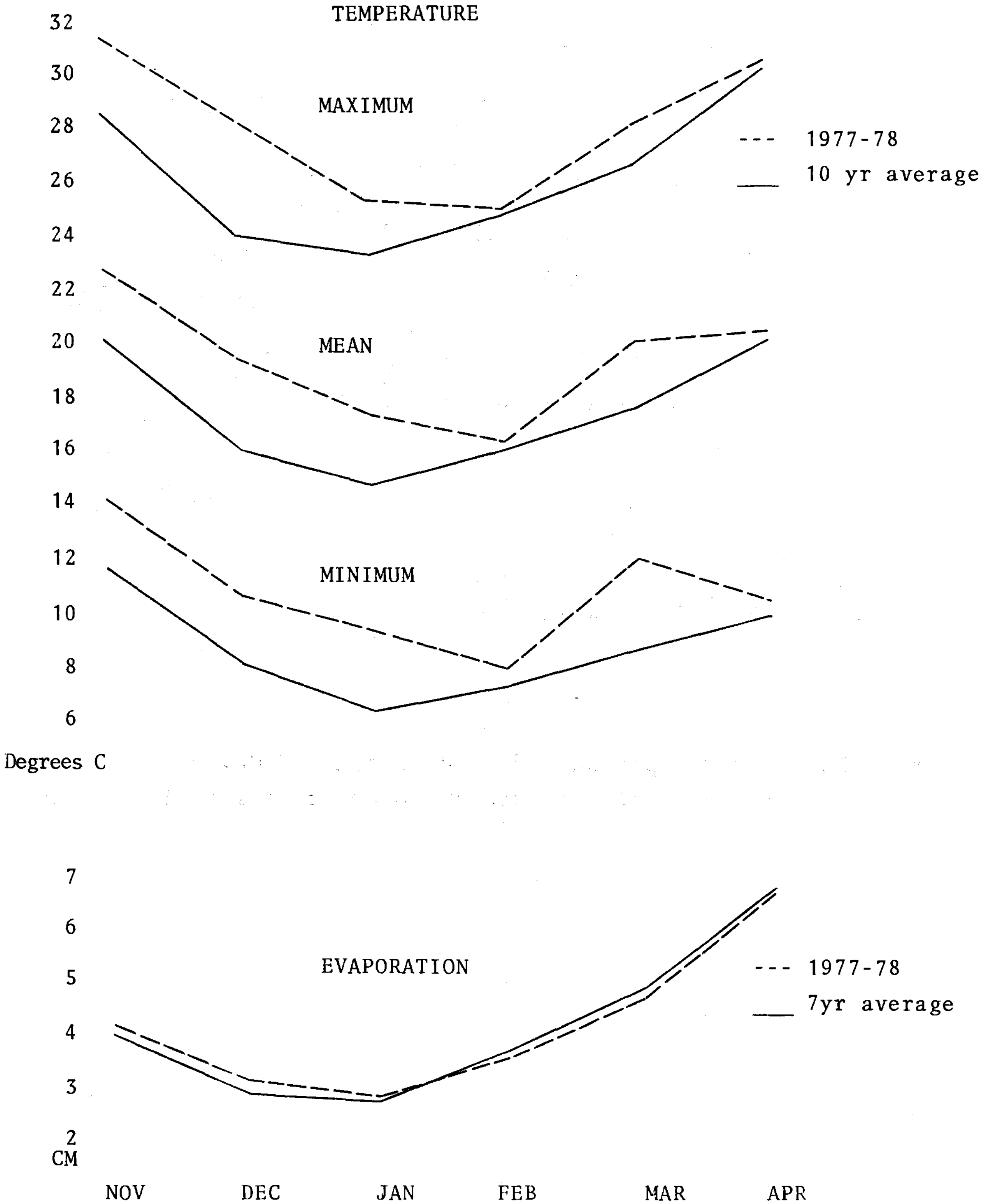


TABLE 1. List of CIMMYT derived selections released as cultivars in 1978.

CIMMYT Name and Pedigree	Cultivar Name	Country
Son-Kl.Rend x Bb	Sonka Inia	Chile
Nadadores"S"	SN A2	Chile
Cajeme 71=Bb#4	Marinela	Chile
Anza	SN 1	Chile
Bb-8156	Costa 78	Peru
TL 365A.34-Sx x CC CM-11699-K-1Y-6M-1Y-0M	Imbabura	Ecuador
Pi62^4-LR^4 x Tzpp/Knott	Itapura 25	Paraguay
Alondra"S"	Alondra	Brazil
Maya 74"S"/Kal-Bb x 7C-Nad63 CM-11771-H-3Y-8M-1Y-1M-1Y-0Y	Tecpan	Guatemala
ML(8156) Components	Bithoor	India
Pavon 76	Pavon 76	Pakistan
Cuckoo"S"	Abu Ghraib 3	Iraq
Anza	Ghriss 75	Algeria
Syrimex	Setif 76	Algeria
Arz	Beni Slimane 76	Algeria
Mexicano 1481	Tessalah	Algeria
Pavon"S"	Cheliff 78	Algeria
Y50$_E$-8156 x Kal/Tob-Cno"S"	Romi	Spain
7C x Tob-Cno"S"	Mahissa 16	Spain
[Cheg-Gto/S64xTzpp-Y54)S64]/Y50$_E$-8156 x Kal	Mahissa 18	Spain
Tob-8156 x CC-Inia/Yr70	Mahissa 19	Spain
Yecora"S" 70	Aerie	South Africa
Bb x Cno-Son64	Helene	South Africa
Inia-P4160	Elize	South Africa
Inia 66-Cal	SST3	South Africa
Cal-Tob66	SST2	South Africa
Inia-Cal	SST16	South Africa
Bb-"S"-Inia66 x Cal	SST6	South Africa

TABLE 2. Pattern of adaptation of the best yielding lines of 10th IBWSN.

Site where entry was in top 10%

Line or Cross	27	75	132	135	165	242	312	313	326	48	84	121	50	53	99	310	317	344	16	32
Pavon"S"	x	x	x	x	x	x	x	x	x	x	x	x								
Pavon"S"	x			x	x			x				x	x	x	x	x	x	x	x	
Glea-Gaines						x		x												x
Brochis"S"			x										x		x		x		x	
Brochis"S"			x								x	x								x
Jupateco 73								x					x	x						
Emu"S"	x	x		x	x						x						x	x		
Bluejay"S"					x						x			x	x	x				
Chiroca"S"		x					x								x				x	
Mexp.65xSal.Sea. P106-19				x												x				
Chiroca"S"		x	x				x												x	
Pavon"S"					x		x	x	x					x	x	x			x	
Moncho"S"					x				x		x				x					x
Oldafo 41A						x		x							x	x		x		

Line or Cross	70	101	130	144	159	308	309	335	338	29	31	64	137	336	10	7	74	6	42	337	345	170	323	43	158	346	8
Pavon"S"																											
Pavon"S"																											
Glea-Gaines	x	x	x	x	x	x	x	x	x																		
Brochis"S"	x									x	x	x	x	x	x												
Brochis"S"					x				x	x				x	x	x	x										
Jupateco 73						x							x						x	x	x	x					
Emu"S"			x			x															x		x				
Bluejay"S"				x											x		x			x		x		x			
Chiroca"S"	x				x							x				x				x					x		
Mexp.65xSal.Sea. P106-19	x	x			x	x	x												x					x			
Chiroca"S"	x	x	x	x			x									x											
Pavon"S"																			x								
Moncho"S"																x			x			x			x		x
Oldafo 41A		x				x															x		x	x			

S I T E   N U M B E R S

6	Bahteem, Egypt	74	Thessaloniki, Greece	308	Backweston, Ireland
7	Cairo, Egypt	75	Martonvasar, Hungary	309	Henrykow, Poland
8	Kafr el Sheikh, Egypt	84	Alentejo, Portugal	310	Jerez, Spain
10	Arusi, Ethiopia	99	Georgan, Iran	312	Buenos Aires, Argentina
16	Lilongwe, Malawi	101	Baghdad, Iraq	313	Roseworthy, South Australia
27	Bethlehem, South Africa	121	Winnipeg, Canada	317	Taiz, Yemen
29	Gezira R.S., Sudan	130	Monterrey, Mexico	323	Luzon, Philippines
31	Kassala, Sudan	132	Sonora, Mexico	326	Sensako, South Africa
32	Kartoum, Sudan	135	Meza, Arizona	335	Missouri, U.S.A.
42	Dacca, Bangladesh	137	Davis, California	336	Alanjuela, Costa Rica
43	Ishwedi, Bangladesh	144	Aberdeen, Idaho	337	Isabela, Philippines
48	Madhya Pradesh, India	158	San Benito, Bolivia	338	Matagalpa, Nicaragua
50	New Delhi, India	159	Dos Cerrados, Brazil	344	Kena, Egypt
53	Uttar Pradesh, India	165	Carillanca, Chile	345	Mead, Nebraska
64	Chunnam, South Korea	170	Ancash, Peru	346	Oslo, Norway
70	Helsinki, Finland	242	Oslo, Norway		

TABLE 3. Comparison of the average yield level of the three highest yielding selections for past 3 years at Cd. Obregon.

Year	* Average Yield kg/ha	No. of Experiments
1975-76	7348	48
1976-77	6957	50
1977-78	5676	58

* Results based on the yields of the top 142, 150 and 175 varieties respectively in the three year periods shown above.

TABLE 4. Yield of varieties treated and untreated with Bayleton leaf rust fungicide, Cd. Obregon 1977-78.(Yield values= kg/ha).

Variety	Treated	Untreated	Difference
Zaragoza 75	5721	5725	+4
*Pavon"S"	5712	5395	-317
Yecora 70	5546	4832	-714
Hermosillo 77	5525	4918	-607
Jupateco 73	5466	5272	-194
Pavon 76	5324	5360	+36
Salamanca 75	5205	5635	+430
Siete Cerros 66	5156	4788	-368
Anza	5125	4922	-203
Torim 73	4806	4799	-7
Sonora 64	4752	4486	-266
Tanori 71	4585	4246	-339
Pima 77	5096	5079	-17
C.V.	5.4%	7.3%	
L.S.D.0.05	388	517	

* CM-8399-D-4M-3Y-0M

TABLE 5. Characteristics of selections under preliminary increase as cultivar candidates, Cd. Obregon, Yaqui, 1978.

Cross and Pedigree	Yield kg/ha	Grain color	Height (cm)	RUST REACTION: Leaf Rust Obregon	Leaf Rust Mochis	Leaf Rust R. Bravo	Leaf Rust P. Rica	Stripe rust Toluca
Ceb 148(Cno"S"-Inia"S" x Lfn/Tob x Kl.Pet-Raf) SWM-1368-500Y-1B-501Y-503M-0Y	** 6125 / 6109 7C	2BS	87	0F1	TMR	10MR-MS	TS	0
Ceb 148(Cno"S"-Inia"S" x Lfn/Tob x Kl.Pet-Raf) SWM-1368-500Y-1B-501Y-504M-0Y	5895 / 6109 7C	2BS	90	TMR	0	5MR-MS	5S	0
Au x Kal-Bb SWM-1703-27Y-1M-5Y-2M-0Y	5840 / 5967 Her 77	3R	88	TMS	5MS-S	TR	0	30MR-MS
Kvz-HD2009 SWM-2984-1M-1Y-1M-2Y-0M	5851 / 5182 7C	2^{+}R	98	5MS-S	TMS	TR	TR	40MS
NdD-Sel101^2 x Pavon"S" SWM-4249-1Y-1M-2Y-0M	5719 / 5711 Mex 75	2B	92	5MS	5S-MS	30MS-MR	5MS-S	TR
NdD-Sel101^2 x Pavon"S" SWM-4249-1Y-4M-2Y-0M	6042 / 6218 Mex 75	2B	93	TMR-MS	TMS	20MS-S	5S	5R-MR
(NdD-WW x Lee - Fn/N)Ti71 Resel SWM-4589-7Y-1M-3Y-0M	5643 / 5928 Her 77	2RS	83	10MR-MS	TMS	TR	TR	10R
(NdD-WW x Lee-Fn/N)Ti71 Resel SWM-4589-7Y-2M-0Y	5896 / 5542 Caj 71	1R	80	TMR	TMR	10MS	TMR	TMR
(NdD-WW x Lee-Fn/N)Ti71 Resel SWM-4589-7Y-8M-1Y-0M	5772 / 6218 Mex 75	2RS	85	TMS-MR	TMS	10R-MR	TR	10R-MR
(NdD-WW x Lee-Fn/N)Ti71 Resel SWM-4589-7Y-18M-1Y-0M	6102 / 5768 Nac 76		91	TMR-MS	TMS-S	TR	TMS	5MR-MS
Car 422-Anahuac 75 SWM-4610-2Y-17M-2Y-0M	5708 / 5768 Nac 76	2BS	90	TMS	10S	10MS	TMS	10MR
Car 422-Anahuac 75 SWM-4610-2Y-20M-1Y-0M	5634 / 5624 Pima 77	2BS	85	5MS-S	0	TR	TS	TMR-MS
(Pts/Tob-Cfn x Bb)Bb x HD832.5.5-On CM-20769-A-8Y-1M-2Y-5M-1Y-0M	5960 / 6109 7C	2B	102	0	0	TR	TMS	30MR-MS
Yding"S" x Bb-Cha CM-25995-1Y-2Y-0Y	5689 / 5858 Nac 76	2B	82	TMR	0	40MS	0	TR
/(Pak F46313/Tob-Cfn x Bb)B.Man-On x Cal/Maya 74"S" CM-26346-B-12Y-8Y-3M-1Y-0B	5794 / 5883 Nac 76	2+B	87	TMR	0	TR	TMS	TR
Bluejay"S"-Torim 73 CM-28173-18Y-7M-5Y-0M	6077 / 6121 Jup 73	2B	95	10MS/20S	5MS	20MS	10MS	TR
(Tp x Cno-No66/Bb-Cno)Za75 CM-29077-2M-2Y-3M-2Y-0M	5462 / 5585 Torim 73	2^{+}R	78	10MS-MR	no plant	no plant	TR	10R-MR

** Lower figure equals best check variety and yield. Upper figure equals Obregon results.

TABLE 5. continued

Cross and Pedigree	Yield kg/ha	Grain color	Height (cm)	RUST REACTION Leaf Rust Obregon	Mochis	R. Bravo	P. Rica	Stripe rust Toluca
Maya"S"74-Moncho"S" CM-29251-3M-17Y-4M-0Y	6088 5967 Her 77	2^{+}B	86	TMS	0	TR	0	10MR
Titmouse"S" CM-30136-18M-1Y-1M-0Y	6055 6127 Jup 73	2R	93	0	0	20MS-MR	TS	TS
Tanager"S" CM-30697-2M-13Y-7M-0Y	5719 5300 Pima 77	2B	95	0	0	TR	0	TMR
Au-Tob x Saka CM-30835-R-7Y-1M-2Y-0M	5994 5754 7C	3R	82	TMS-S	50S	10MR-R	TR	30MR-MS
Kl.H686·F2600- Sr70 x Tob-Cno"S" CM-30986-I-1Y-1M-1Y-1M-1Y-0B	5650 5920 7C	2B	96	TMR	TMR	TR	TR	20MR-MS
Buteo"S" CM-31070-Y-1Y-3M-2Y-1M-2Y-0B	6227 5920 7C	2BS	88	0	0	TR	TS	10R-MR
Buckbuck"S" CM-31678-R-4Y-2M-15Y-0M	5874 5861 Nac 76	2R	79	0	0	5MS	10MR	TR
Buckbuck"S" CM-31678-R-4Y-2M-15Y-2M-1Y-0B	6139 5675 Pavon 76	2R	93	TMS	no plant	no plant	no plant	10MR-MS
Buckbuck"S" CM-31678-R-4Y-2M-21Y-2M-0Y	6308 5967 Her 77	3R	83	10MS-MR	0	TMS	TMS	10R
Buckbuck"S" CM-31678-R-4Y-2M-24Y-1M-0Y	6275 5967 Her 77		83	TMR	0	TMR	TR	10MR
Buckbuck"S" CM-31678-R-4Y-2M-500Y-503M-500Y-0M	5682 5367 Her 77	2R	87	0	0F1	TR	TMR	10R
Buckbuck"S" CM-31678-R-4Y-7M-1Y-2M-1Y-0B	6048 5675 Pavon 76	2R	95	TMR-R	TMS	TR	5S	10MR
Yr Resel(B)-Hork"S" CM-31934-1Y-1M-2Y-0M	5602 5582 Yr 70	2B	64	10S-MS	0	TR	TS	30MR-MS
Coc 75-Hork"S" CM-32041-3M-1Y-0M	5314 4933 Yr 70	2R	77	0	TMS	0	TS	20MS-MR
Coc 75-Hork"S" CM-32041-78M-2Y-0M	5241 4933 Yr 70		77	0	0	TR	TS	10MS-MR
Y50E-Kal^{3} x Hork"S" CM-32111-1M-1Y-7M-0Y	6203 6211 7C	2 seg	94	TMS-MR	20S	TMS	5R-MR	20MR-MS
Y50E-Kal^{3} x Hork"S" CM-32111-1M-1Y-12M-2Y-0M	5949 5858 Her 77	2 seg	92	0	TMS	TMS	TR	10MR-MS

TABLE 5. continued

Cross and Pedigree	Yield kg/ha	Grain color	Height (cm)	RUST REACTION: Leaf Rust Obregon	Mochis	R. Bravo	P. Rica	Stripe rust Toluca
Y50E-Kal^3 x Hork"S" CM-32111-1M-2Y-4M-1Y-0M	5946 5861 Nac 76	3R	87	TMS	TS	30MR-MS	0	20MR-MS
PV18A-Cno67 x Hork"S" CM-32151-8Y-2M-4Y-0M	5669 5913 Nac 76	3R	84	0	TMR	10MR	TMS	10MR-MS
Pavon"S"(Bb-Cno"S" x Jar/Orizaba"S") CM-32534-6Y-2M-0Y	5579 5079 Nac 76	2R	87	5MS	TS-MS	20MS-MR	0	5MR
Pavon"S"-Huac"S" CM-32537-7Y-7M-5Y-0M	5831 6121 Jup 73	3R	85	5MS-MR	20MS-S	TR	10MS	5MR-MS
Abura-Mazoe (Gb) x Bchs"S" CM-32622-10M-1Y-0M	5790 5516 Nac 76	2R	90	TR-MR	0	5S-MS	TR	TR
Abura-Mazoe (Gb) x Bchs"S" CM-32622-38Y-1M-1Y-0M	5760 5774 Mex 75	2R	83	TMS	TMS	TMS	TS	TR
Bb x Tob-Cno/Huac"S" CM-32763-1M-3Y-1M-0Y	5802 5542 Caj 71	2R	73	5S	0	10S-MR	TS	5R
Veery"S" CM-33027-F-1M-9Y-0M	6025 5858 Nac 76	2R	87	TMR-MS	0	10MR-MS	0	TR
Veery"S" CM-33027-F-3M-3Y-1M-0Y	5750 4796 Pima 77	2R	87	0	0	30MS	0	10R-MR
Veery"S" CM-33027-F-4M-3Y-0M	5959 5015 Yr 70	2R	80	TMR	0	10MR-MS	0	TR
Veery"S" CM-33027-F-12M-1Y-4M-0Y	5759 4796 Pima 77	2R	88	TMS	TR	TMR	0	TMR-R
Veery"S" CM-33027-F-12M-1Y-6M-0Y	5780 4796 Pima 77	2R	88	T-20MS	TR-MR	TMS	0	TMR
Kvz-Ti71/Maya74"S" x Bb-Inia CM-33089-W-3M-7Y-3M-0Y	4476 4346 Za 75	1B	83	10R-MR	0	5MS	TR	TR
Chat"S" CM-33090-M-4M-2Y-5M-0Y	6046 5238 Pavon 76	2R	95	TR	TMS	10MR-MS	TS	40S-MS
Chat"S" CM-33090-M-4M-2Y-5M-1Y-0M	5820 5933 7C	2^+B	92	5MR-MS	TMS	20R	5MS	50S-MS
Chat"S" CM-33090-N-1M-1Y-0M	5975 5858 Nac 76	2B	83	0	0	TR	0	10MR-MS
Bobwhite"S" CM-33203-F-4M-4Y-1M-1Y-0M	6140 5858 Nac 76	2R	94	TMR	TR	TR	TMS	TMR-MS

TABLE 5. continued.

Cross and Pedigree	Yield kg/ha	Grain color	Height (cm)	RUST REACTION Leaf Rust Obregon	Mochis	R. Bravo	P. Rica	Stripe Rust Toluca
Bobwhite"S" CM-33203-G-9M-2Y-500M-500Y-0M	4720 / 4346 ZA 75	2B	94	0	0	20MS	TR	TR
Bobwhite"S" CM-33203-K-8M-1Y-1M-1Y-0M	5693 / 6222 Nac 76	2R	89	TMR	0	10MS-MR	TMR	TMR
Bobwhite"S" CM-33203-K-9M-1Y-1M-1Y-0M	5469 / 5585 Torim 73	2R	78	TMR	0	TR	TMS	TMR
Bobwhite"S" CM-33203-K-9M-1Y-1M-3Y-0M	5713 / 5585 Torim 73	3R	76	0 fleck	0	TMR	TMS	10MR
Bobwhite"S" CM-33203-K-9M-24Y-0M	5411 / 5188 Mex 75	3B	86	0	5MR	TR	0	10R
Bobwhite"S" CM-33203-N-1M-1Y-1M-1Y-0M	5654 / 5783 7C	2R	96	TR	0	TR	TS	TMR
Bobwhite"S" CM-33203-N-1M-1Y-6M-1Y-0M	6284 / 5997 7C	2^{+}R	100	5MR-R	5MR	TMR	TR	5MS
Swift"S" CM-33232-C-5M-1Y-10M-0Y	5799 / 5777 Mex 75	2R	98	TMS	TMS	TMS	10S	TMR
Maipo"S"-Pj62 x Emu"S" CM-33254-T-1M-1Y-6M-3Y-0M	6113 / 6046 Her 77	2R	87	5R-MR	0	TMS	TS	10MR
Maipo"S"-Pj62 x Emu"S" CM-33254-T-1M-1Y-6M-500Y-0M	5692 / 6046 Her 77	2R	89	5MR-MS	TMS	5MS	10S	0
Harrier"S" CM-33435-Y-2M-3Y-0M	5723 / 5754 7C	3B(PB)	90	5S-MR	TMS	10R-MR	TR	10MR
Junco"S" CM-33483-H-3M-1Y-1M-3Y-0M	6275 / 5861 Nac 76	2B	89	TR	TMS	TMS	TMS	10MR
Bb-Gallo x Y50E-Kal^{3}/Lfn x HD832-Bb CM-34574-F-1M-5Y-1M-1Y-0M	5782 / 6222 Nac 76	1B	86	0	0	TMR-MS	TS	10R
Gallo-Cuckoo"S" x Kvz-Sx CM-34630-D-5M-2Y-1M-1Y-0M	5828 / 6222 Nac 76	2^{+}B	87	TS-MR	0	5MS	TMR	TMR
Gallo-Cuckoo"S" x Kvz-Sx CM-34630-D-5M-2Y-3M-3Y-0M	5839 / 6222 Nac 76	2^{+}B	87	0fleck	0	10MS-S	TMS	0
Towhee"S" CM-34709-G-15M-5Y-2M-0Y	5658 / 6127 Jup 73	3B	98	0	10MS	10MS-S	0	10R-MR
Nad63-Tor x Pichon/Bluetit"S"-Mesabi"S" CM-34726-F-2M-2Y-4M-1Y-0M	5862 / 5861 Nac 76	2^{+}B	91	5MS-MR	5MR-MS	TMS	TS	TR

TABLE 5. continued.

Cross and Pedigree	Yield kg/ha	Grain color	Height (cm)	RUST REACTION Leaf Rust Obregon	Mochis	R. Bravo	P. Rica	Stripe Rust Toluca
Bluejay"S"-Grajo"S"(Maipo"S"/Bb x Tob-Cno) CM-34742-E-2M-8Y-2M-1Y-0M	5994 5861 Nac 76	2B	92	TS	TMS	TMR	10S	0
Yding"S"-Zz"S" CM-35048-33Y-2M-1Y-0M	5239 5536 Her 77	2B	76	TMS	0	5MS-S	TMS	10R-MR
Sparrow"S"-Pavon"S" CM-35210-48M-1Y-0M	5681 6054 Nac 76	2BS	92	5MR	0	10MS-MR	TS	10R
Desc#2 x Kal-Bb CM-37154-8Y-5M-1Y-0M	5810 5582 Yr 70	2R	75	20MS-S	TMS	20S	10S	30MS-MR
Ti71 Resel-Coc 75 CM-36487-65Y-6M-0Y	5882 6325 Yr 70	2R	82	10S	10MR	TR	0	40MS-MR
Br74.72-Jup 73 CM-36889-14Y-3M-2Y-0M	5705 5870 Pima 77	2^{+}R	100	TMS	TMR-MS	5MR-R	TS	5MR
Fath-Coc 75 CM-36896-10Y-2M-7Y-0M	6210 5582 Yr 70	2B*	99	10S-MS	0	40MS	TMS-S	0
Moncho"S"-Condor"S" CM-36925-3Y-3M-4Y-0M	5678 5913 Nac 76	2B	82	10MR-MS	0	TMR	5MS	20MS
/(Cal x Cno"S"-Inia"S"^{2}/Bb-TobxCno^2-Chr)Sajame"S"/7C CM-37477-C-1Y-7M-0Y	5139 5079 Nac 76	2RS	83	TMR-R	0	10MR-MS	TS	10R-MR
Jup 73-Zp"S" x Coc 75 CM-37614-B-12Y-5M-1Y-0M	5773 5381 Nac 76	2^{+}R	90	20S-MS	20S	50MS-S	TR	TMR
Jup 73-Zp"S" x Coc 75 CM-37614-B-14Y-4M-1Y-0M	6004 5381 Nac 76	2R	90	0,	TMR	10R-MR	TR	10R
Jup 73-Zp"S" x Coc 75 CM-37614-B-14Y-4M-3Y-0M	6188 5381 Nac 76		92	5MS-S	TMS	10MS	TMS	TMR
Jup 73-Zp"S" x Coc 75 CM-37614-B-14Y-5M-1Y-0M	5748 5381 Nac 76		92	10MS-MR	TS	40MS	TR	TR
(Bb-Cno x Inia-Soty/Sparrow"S")Pavon"S" CM-37705-C-1Y-4M-0Y	5802 6325 Nac 76	2R*	83	0	TMS	5MR	0	30MR-MS
(Bb-Cno x Inia-Soty/Sparrow"S")Pavon"S" CM-37705-G-2Y-3M-1Y-0M	5464 5687 Nac 76	2B	80	0	TMR	TR	TR	10MR-MS
(Cno"S"-Soty x Tob"S"/Tob^2-Npo x Inia"S"-Npo)Mon"S" CM-37756-A-7Y-3M-1Y-0M	5550 5687 Nac 76	2B	82	0,	5S	TR	TMS	10MR-MS
Ymh-Popo"S" x 7C CM-37855-A-1Y-8M-1Y-0M	5730 5789 Mex 75	3R	95	5MS-MR	20S	TMR	TR	50MR-MS

TABLE 5. continued.

Cross and pedigree	Yield kg/ha	Grain color	Height (cm)	RUST REACTION Leaf Rust Obregon	Mochis	R. Bravo	P. Rica	Stripe Rust Toluca
Ymh-Popo"S" x 7C CM-37855-A-1Y-8M-3Y-0M	5663 5783 7C	3R	83	TMR	5MS-S	TMS-MR	TMS	10MR-MS
Ymh-Popo"S" x 7C CM-37855-A-1Y-10M-1Y-0M	5616 5782 7C		84	0;	TS	TMS	TMR	20MR-MS
Ore F1 158-Fdl x Mef"S"-Tib63^2/Coc75 CM-37987-I-1Y-2M-2Y-0M	5381 5344 Pima 77	2^+B	82	TR	TMS	TR	TR	20R-MS
Ore F1 158-Fdl x Mef"S"-Tib63^2/Coc75 CM-37987-I-1Y-6M-0Y	5752 5238 Mex 75	2B	80	0	TR-MR	TR	0	20R-MR
Emu"S"-Mildress x Kal-Bb CM-38199-A-1Y-7M-0Y	5974 5542 Caj 71	2 seg	77	10MS	TMR	10MS	5MR	10R-MR
Emu"S"-Mildress x Kal-Bb CM-38199-L-11Y-1M-1Y-0M	5697 5885 Mex 75	2R	92	10S-MS	0	TMS	5S	TMR
T.aest x Kal-Bb/Anahuac 75 CM-38236-L-6Y-1M-0Y	5785 6327 Nac 76	2R*	81	5R	5MS	5MS	0	10R-MR
Yding"S" x Kal-Bb/Hork"S"-Mo73 CM-38558-A-7Y-9M-1Y-0M	5702 5782 7C	2R*	96	TS	TMS	10MR-MS	TR	TR
(Maya74"S"/Kal-Bb x 7C-Nad63)Hork"S" CM-39814-500M-502Y-0M	5840 5183 7C	2B	95	5R-MR	0	30MS-MR	TMR	30MR-MS
Heima-Coc75 x Bjy"S" CM-41195-J-7M-1Y-0M	5362 4933 Nac 76	2B	71	TS	TMS-S	5MR-MS	20S	0

B= White grain; R= Red Grain; S= Soft grain.

TABLE 6. Yield of elite selection advanced lines grown at three location in Mexico for possible release as cultivars.

Variety	Pedigree	Yield kg/ha Obregon	Hermosillo	Celaya	Average Yield	% Pavon 76
Vireo"S"	CM-28235-2Y-6Y-0M	5261	6979	9972	7404	109.2
Veery"S"	CM-33027-F-15M-500Y-0M	5889	6275	9171	7115	105.0
Solsort"S"	CM-10712-1Y-1M-6Y-1M-1Y-0Y	4692	6819	9472	6994	103.2
Buckbuck"S"	CM-31678-R-4Y-2M-21Y-0M	5828	6014	9037	6956	102.6
*Nacozari 76		4725	6771	8875	6790	100.2
Veery"S"	CM-33027-F-3Y-1Y-0M	5286	7007	8069	6787	100.1
Pavon"S"	CM-8399-D-4M-3Y-0M-0BK	5539	6160	8644	6781	100.0
*Pavon 76		5414	6069	8852	6778	100.0
Titmouse"S"	CM-30136-3Y-1Y-0M	5000	6257	9014	6757	99.7
Dickcissel"S"	CM-31099-C-1Y-3Y-0M	5372	6111	8685	6721	99.2
Bluejay"S"	CM-5287-J-1Y-2M-1Y-4M-0Y-501Y-0M	4953	6600	8694	6716	99.1
Buck Buck"S"	CM-31678-R-4Y-2M-5Y-0M	5278	5965	8898	6714	99.1
Pavon"S"	CM-8399-D-4M-3Y-3M-1Y-0M	5556	6465	8060	6694	98.8
Flicker"S"	CM-8954-B-7M-1Y-1M-1Y-0M-2Ptz-0Y	5617	5833	8227	6559	96.8
Titmouse"S"	CM-30136-4Y-1Y-0M	4528	6264	8861	6551	96.7
Venern"S"	CM-5375-F-1Y-1M-1Y-1M-0Y	4819	6111	8565	6498	95.9
Hermosillo 77	CM-20668-D-4Y-4M-1Y-0Y	4325	6257	8648	6410	94.6
Owl"S"	CM-34704-C-2M-500Y-0M	4336	6069	8306	6237	92.9
Junco"S"	CM-33483-C-7M-1Y-0M	5078	5792	7782	6217	91.7
*Torim 73		4251	6000	7625	5959	87.9
*Pima 77		4639	6160	6806	5868	86.6

*Mexican Commercial cultivars

TABLE 7. Promising advanced lines under increase in Mexico for possible release as cultivars.

PM-	Grain Color	Yield* Obregon 76-77	Obregon 77-78	Hermosillo 77-78	Roque 77-78	Reaction to Puccinia recondita 1978 Obregon	Mochis	Roque	Batan	Poza Rica	Rio Bravo
Buckbuck"S" CM-31678-R-4Y-2M-21Y-0M	Red	7301/6420 Kal-Bb	5828/5414 Pavon 76	6014/6771 Nacozari 76	9037/8875 Nacozari 76	TMR	TR	10R	TR	10MS	TR
Buckbuck"S" CM-31678-R-4Y-2M-5Y-0M	white	7199/6420 Kal-Bb	5278/5414 Pavon 76	5965/6771 Nacozari76	8898/8875 Nacozari76	TMR	TR	TR	TR	10MS	TR
Titmouse"S" CM-30136-3Y-1Y-0M	Red	7110/5788 Torim 73	5000/5414 Pavon 76	6257/6771 Nacozari76	9014/8875 Nacozari76	20MS	TR	5S	10MR	10MR	10MR
Vireo"S" CM-28235-2Y-6Y-0M	White	7321/7435 Nacozari 76	5261/5414 Pavon 76	6979/6771 Nacozari 76	9972/8875 Nacozari 76	TR	TMS	TR	TR	0	TMS
Junco"S" CM-33483-C-7M-1Y-0M	White	7153/7053 Nacozari 76	5078/5414 Pavon 76	5792/6771 Nacozari 76	7782/8875 Nacozari 76	10M	TMR	10R	10MR	TR	TMR

* First number is the yield of the PM. The second number is the yield of the highest check variety in the experiment and is indicated below the yield. Yield= Kg/ha. PM= Advanced Lines

TABLE 8. Highest yielding selections from the experiments at San Jose, El Batan 1978 and their rust reactions at 4 locations in Mexico.

Cross and Pedigree	Yield kg/ha	Seed Color	Height* cm	Stem Rust Refugio	Stem Rust Roque	Leaf Rust Refugio	Leaf Rust Roque	Leaf Rust Toluca	Leaf Rust Saltillo	Stripe rust Toluca
Bb-Gallo x Y50E-Kal^3/Lfn x HD832-Bb CM-35574-F-4M-1Y-1M-500Y-101B-0Y	8708 7517 Tes 76	2B	105	30MR	0	-	20MR	TR	TMR	5MS
Bb-Gallo x Y50E-Kal^3/Lfn x HD832-Bb CM-35574-F-4M-1Y-1M-500Y-100B-0Y	8458 7517 Tes 76	2B	100	30MS	TS	-	TR	TR	5MR	20MS
Buckbuck"S" CM-31678-R-4Y-2M-500Y-506M-500Y-500M-0Y	8083 7517 Tes 76	R	100	0	0	5MR	20MR	0	TR	5R
Cebeco148/Ron-ChaxBb-Nor67{{/HK38MA(4777/ReixY-Kt)/Yr} Tucan"S"} CM-33682-L-1Y-1Y-8M-1Y-100B-0Y	7900 6667 Tes 76	2R	90	20MS	0	20MR	seg 0 20MS	0	0	TMR
Ti 71 Resel-Huacamayo"S" CM-39321-16M-1Y-2M-0Y	7825 6667 Tes 76	2R	105	40MS	0	40S	50MS	TR	TMR	10MR
Kal-Bb x Moncho"S" CM-40226-7M-4Y-3M-0Y	8467 6633 Tes 76	2B	100	20MS	20MS	TMS	40MS	0	TMR	5MR
Kal-Bb x Moncho"S" CM-40226-7M-5Y-4M-0Y	8242 6633 Tes 76	2B	105	5MR	10S	10MR	10MR	0	TMR	0
Bluejay"S"-Jupateco 73 CM-40038-21M-1Y-2M-0Y	8233 6633 Tes 76	2R	95	5S	20S	10MR	40S	0	TMS	TMR
Maya 74"S"-Pavon"S" CM-39426-3M-5Y-1M-0Y	7858 7717 Tes 76	2B	100	10MS	TMS	10MS	TS	0	TMR	TR
Maya 74"S"-Pavon"S" CM-39426-8M-2Y-1M-0Y	7758 7717 Tes 76	2B	110	TMS	TS	TR	5R	0	5MR	0
/Bb(Son64-An64 x Nad63/Jar"S")/Pavon"S" CM-40581-8M-3Y-3M-0Y	7575 6950 Coc 75	2B	100	10MR	10MS	10MS	-	0	0	5MR
K4500.2-Bluejay"S" CM-40480-26M-5Y-1M-0Y	7142 6950 Coc 75	2B	100	20MR	0	20MR	20MS	0	TR	10MR
HD 2206-Hork"S" CM-39808-62M-1Y-1M-0Y	8200 7767 Tes	2B	105	TMR	TMS	30MR	20MS	TMS	10MS	20MS
R37-Golils 121/Cno-Inia"S" x HD 832-On SWM-4585-74M-1Y-2M-0Y	7375 7067 Pavon 76	2B	100	10MR	20MS	TMS	-	0	TMR	10MR
Protor-Jupateco 73 CM-36876-3M-1Y-2M-0Y	7892 7875 Pavon 76	1R	110	TMR	0	10MR	50MS	0	TMS	30MS
Cno-7C x Kal-Bb/Pci"S" CM-29686-103M-1Y-1M-0Y	7858 7858 Pavon 76	2B	100	10MR	10MR	30MS	50S	0	5MS	40MR
Cno-7C x Kal-Bb/Pci"S" CM-29686-74M-5Y-2M-0Y	7758 7858 Pavon 76	2R	105	10MS	0	TMR	10MR	0	TMR	40MR

TABLE 8. continued.

Cross and Pedigree	Yield kg/ha	Seed color	Height* cm	Stem Rust Refugio	Stem Rust Roque	Leaf Rust Refugio	Leaf Rust Roque	Leaf Rust Toluca	Leaf Rust Saltillo	Stripe Rust Toluca
Bjy"S" x Tp(Cno-Inia"S")[2] CM-29989-122M-1Y-2M-0Y	7817 / 7692 Mapache	2R	115	TMR	0	20MR	60S	0	TMS	0
Yding"S"-Pci"S" CM-35044-110M-1Y-3M-0Y	7700 / 6483 Tes 76	2B(S)	95	10MS	20MS	-	-	TR	TMR	TR
V64125.1.14 x Kal-Bb/Pavon"S" CM-41213-C-1M-3Y-1M-0Y	7342 / 7592 Mapache	2B	105	20MS	10MS	20MS	20MS	0	5MR	10MS
/Lfn-M2(4777/Rei x Y-Kt)/Maya 74"S" SWM-4743-14Y-1M-3Y-2M-0Y	8033 / 8575 Pavon 76	3R	105	20MS	10S	-	-	0	TMR	TR
7C-Pavon"S" CM-36569-8Y-1M-1Y-1M-0Y	7642 / 6467 Pima 77	2B	95	10MS	0	5MS	20MS	T	TMR	5MR
Anahuac-Ti71 Resel CM-37024-21Y-1M-7Y-2M-0Y	7492 / 8083 Mapache	2R	100	10S	0	-	30MS	0	5MR	10R
Pavon"S"-Huacamayo"S" CM-32537-22Y-2M-4Y-1M-0Y	7700 / 6653 Pavon 76	2R	100	20S	40MS	-	-	T	TMR	5MR
Tanager"S" CM-30697-15Y-4M-4Y-2M-0Y	7558 / 7683 Pavon 76	2B	110	0	0	10MR	-	0	TMR	TR
Pavon"S"(Bb-Cno"S" x Jar/Orizaba"S") CM-32534-6Y-3M-1Y-1M-0Y	7725 / 6667 Bit"S"	3R	90	TMS	0	TMS	10MR	0	0	TR
SD 22.40.1 x Fury-Bb/Moncho"S" CM-37757-C-2Y-3M-1Y-1M-0Y	7950 / 8008 Pavon 76	3B	105	20MS	5S	-	-	TR	TMR	TR
(Bb-Cno x Inia-Soty/Sparrow"S")Pavon"S" CM-37705-K-2Y-7M-3Y-1M-0Y	7642 / 8008 Pavon 76	3R	95	TS	0	5MS	10MR	0	TR	10MR
Emu"S"-Mildress x Kal-Bb CM-38199-F-2Y-3M-1Y-1M-0Y	8091 / 7508 Tes 76	2R	95	0	TMS	TMR	20MS	0	0	0
Veery"S" CM-33027-F-8M-1Y-8M-1Y-2M-0Y	7817 / 5908 Coc 75	2R	95	0	10MS	20MS	50MS	0	TMR	TR
Veery"S" CM-33027-F-12M-1Y-12M-1Y-1M-0Y	7750 / 5909 Coc 75	2R	95	0	TR	10MS	60S	0	TR	0
Veery"S" CM-33027-I-2M-1Y-2M-1Y-1M-0Y	7525 / 7583 Pavon 76	2R	85	0	TMS	-	50S	TR	TMR	30MR
Bobwhite"S" CM-33203-G-5M-6Y-1M-1Y-1M -0Y	8958 / 7442 Tes 76	2R	85	10MR	TMR	-	80S	0	TMR	70S
Bobwhite"S" CM-33203-K-9M-15Y-1M-4Y-3M-0Y	8833 / 7442 Tes 76	2B	100	0	TMS	TR	20MS	0	0	20R

TABLE 8. continued

Cross and Pedigree	Yield kg/ha	Seed Color	Height* cm	Stem Rust Refugio	Stem Rust Roque	Leaf Rust Refugio	Leaf Rust Roque	Leaf Rust Toluca	Leaf Rust Saltillo	Stripe Rust Toluca
Bobwhite"S" CM-33203-K-9M-15Y-1M-4Y-1M-0Y	8475 7442 Tes 76	2B	100	0	5MS	0	40MS	TR	0	0
Bobwhite"S" CM-33203-K-9M-9Y-4M-1Y-2M-0Y	8133 7442 Tes 76	2B	85	TMR	0	TMR	10MR	TR	0	20MR
Bobwhite"S" CM-33203-K-9M-33Y-1M-1Y-1M-0Y	7775 6442 Tes 76	2B	100	TR	TR	5MR	20MR	TR	TR	0
Bobwhite"S" CM-33203-K-9M-24Y-1M-1Y-2M-0Y	7717 6142 Tes 76	2B	95	0	TR	TMR	10MR	TR	TMR	0
Harrier"S" CM-33435-P-1M-6Y-1M-1Y-1M-0Y	7608 6733 Coc 75	2B	120	30MS	40S	20MS	TMS	0	TMS	10MR
Maya 74"S"-Sparrow"S" x Sap"S" CM-33475-L-1M-2Y-2M-3Y-1M-0Y	7058 6708 Mex 75	-	100	5MS	0	40MS	60S	0	TMR	TR
Gallo-Yr Resel(B)/Au x Kal-Bb CM-34603-A-1M-3Y-3M-3Y-1M-0Y	8733 8458 Pavon 76	2B(S)	95	5R	0	5MS	40MS	0	TMR	TR
Gallo-YrResel(B)/Au x Kal-Bb CM-34603-A-1M-3Y-1M-5Y-3M-0Y	8467 8454 Pavon 76	2B(S)	105	0	0	5MS	50S	TR	TMR	TR
Owl"S" CM-34704-I-1M-1Y-1M-1Y-2M-0Y	8000 7375 Tes 76	2R	105	TS	TS	TMR	30MS	0	TR	10MR
Towhee"S" CM-34709-J-1M-2Y-1M-6Y-1M-0Y	7708 7375 Tes 76	2R	110	TMR	30MS	0	40MS	0	TMR	0
Kl.H.645.Y48000-Jup73{Kal-Bb/CnoxBb-Gallo(I67 xS 310-Pi/LR-II18.47)/Cgñ} CM-36090-I-2M-1Y-3M-2Y-3M-0Y	7058 5871 Coc75	2R	95	10MR	10MS	30MR	-	0	10MS	TMR
Kl.H.645.Y48000-Jup73{Kal-Bb/CnoxBb-Gallo(I67 x S310-Pi/LR-II 18.47)/Cgñ} CM-36090-I-2M-1Y-5M-1Y-1M-0Y	7758 5871 Coc75	2R	90	10MR	40MS	20MS	-	0	30MR	30MR
Bjy"S"-Grajo"S"(Maipo"S"/Bb x Tob-Cno) CM-34742-F-7M-1Y-1M-1Y-2M-0Y	7475 5871 Coc75	2R	110	10MR	0	-	-	TR	TMR	20MS
Hork"S"-Mochis 73 CM-32226-4M-15Y-1M-3Y-1M-0Y	7408 6200 Pavon 76	2R	105	0	10MS	0	-	0	TR	40MR
Torim 73-Huacamayo"S" CM-31985-7M-2Y-1M-1Y-1M-0Y	7400 6200 Pavon 76	2B	125	TS	TS	TMR	TMR	TR	TR	0
Kvz-HD 2009 SWM-2984-1M-1Y-1M-2Y-1M-0Y	7400 6200 Pavon 76	2R	105	0	5MS	5MS	50S	0	0	0
Kal-Bb x Cj 71"S"/Hork"S" CM-32418-1M-1Y-6M-1Y-2M-0Y	7233 6200 Pavon 76	2B	95	5S	5MS	5MS	30MR	0	TMS	10MR

TABLE 8. continued

Cross and pedigree	Yield kg/ha	Seed color	Height* cm	Stem Rust Refugio	Stem Rust Roque	Leaf Rust Refugio	Leaf Rust Roque	Leaf Rust Toluca	Leaf Rust Saltillo	Stripe Rust Toluca
(Tp x Cno-No66/Bb-Cno)Za 75 CM-29077-2M-2Y-1M-4Y-1M-0Y	7633 / 8525 Pavon 76	2R	90	0	-	TMR	-	0	TR	10MR
Maya74"S"-Moncho"S" CM-29251-3M-17Y-14M-1Y-1B-0Y	7717 / 8158 Pavon 76	2B	105	-	-	-	-	0	5MR	5R
Valvidia"S" CM-30109-1M-1Y-4M-1Y-2B-0Y	8575 / 7567 Pima 77	2R	100	TR	20S	-	40MS	0	5MS	5MS
Tanager"S" CM-30697-2M-10Y-1M-2Y-2B-0Y	8550 / 7000 Coc 75	2B	105	0	TMR	TMR	60S	0	0	TR
Tanager"S" CM-30697-2M-3Y-5M-1Y-1B-0Y	8217 / 7000 Coc 75	2R	100	0	TMS	TMS	--	0	0	TR
Brochis"S"-Pavon 76 CM-35317-2M-1Y-8M-2Y-1B-0Y	7917 / 7450 Pavon 76	-	100	TMR	0	5S	60S	TR	0	5R
Maya74"S"/Npo-Cdl x Bb-Cno"S" CM-29255-3M-2Y-1M-1Y-2B-0Y	7650 / 7450 Pavon 76	2B	110	10MR	20S	20MR	-	TMR	10MS	5MR
Sparrow"S"-Grajo"S" CM-35195-1M-3Y-1M-1Y-1B-0Y	7525 / 7450 Pavon 76	2R	100	5MS	TMR	10MS	-	0	TMS	30MS
Yding"S"/(Fn-Th^3 x II44.29-Th^2/Cfn^4)Sr/ CM-35735-3M-11Y-13M-1Y-1B-0Y	7450 / 6266 Tes 76	2R	105	0	-	-	-	TR	TMS	TR
Yding"S"/(Fn-Th^3 x II44.29-Th^2/Cfn^4)Sr/ CM-35735-3M-8Y-2M-1Y-1B-0Y	7033 / 6266 Tes 76	2R	110	0	TR	-	10MS	0	0	TR
Gallo-Aust.II61.157 x Cno-No66/Moncho"S" CM-30003-14Y-3Y-1M-5Y-2B-0Y	7300 / 5933 Mapache	2B	105	0	0	TMS	-	0	TMR	TMR
Gallo-Aust.II61.157 x Cno-No66/Moncho"S" CM-30003-14Y-3Y-1M-5Y-1B-0Y	7192 / 5733 Mapache	2B	110	0	0	TMS	-	0	TMS	TMR
Pci"S"-Pavon"S" CM-30185-1Y-1Y-5M-1Y-1B-0Y	8125 / 7186 Pavon 76	2B	110	10MS	0	-	20S	TR	TR	TR

* Height at Toluca averages at least 10cm more than at Obregon

TABLE 9. Sources of winter wheats by country represented in CIMMYT winter wheat crossing block.

Country	Number of lines
Argentina	1
Chile	42
France	24
Great Britain	39
Holland	2
West Germany	7
Austria	2
Soviet Union	13
Hungary	6
Poland	6
Romania	31
Yugoslavia	18
Turkey	16
Washington, USA	4
Oregon, USA	162
Indiana, USA	6
Kansas, USA	5
Colorado, USA	12
Nebraska, USA	29
North Carolina, USA	1
Texas, USA	1
Oklahoma, USA	3
Montana, USA	4
South Korea	21
Japan	1
China (PRC)	58
South Africa	1

TABLE 10. Advanced line derivatives of Spring x Winter crosses with high yield potential and good disease resistance.

Cross	Cross Number
Ceb 148(Cno"S"-Inia"S" x Lfn/Tob x Kl.Pet-Raf)	SWM-1368
Au x Kal-Bb	SWM-1703
NdD-Sel 101^2 x Pavon"S"	SWM-4249
(NdD-WW x Lee-Fn/N)Ti 71 Resel	SWM-4589
Car 422-Anahuac 75	SWM-4610
Au-töb x Saka	CM-30835
Kl.H686.F2600 - Sr70 x Tob-Cno"S"	CM-30986
Kvz-Buho"S" x Kal-Bb=(Veery"S")	CM-33027
Kvz-Ti71 x Tito"S"=(Chat"S")	CM-33090
Au x Kal-Bb/Wqp"S"=(Bobwhite"S")	CM-33203
Gallo-Cuckoo"S"x Kvz-Sx	CM-34630
Ymh-Popo"S" x 7C	CM-37855
Ore F1 158-Fd1 x Mef"S"-$Tib63^2$/Coc75	CM-37987
Emu"S"-Mildress x Kal-Bb	CM-38199
T. aest x Kal-Bb/Anahuac 75	CM-38236
Heima-Coc75 x Bjy"S"	CM-41195
Ceb 148/Ron-ChaxBb-Nor67{{/HK-38MA(4777/ Rei-Y-Kt)/Yr} Tucan"S"}	CM-33682
R37-Golils 121/Cno-Inia"S" x HD832-On	SWM-4585
V64125.1.14 x Kal-Bb/Pavon "S"	CM-41213
Gallo-Yr Resel(B)/Au x Kal-Bb	CM-34603
Kl.H.645.Y48000-Jup73{[CnoxBb-Gallo(I67xS310-Pi/LR-II18.47)] Cgñ}	CM-36090

TABLE 11. Yield of multiline composite varieties and their components compared to standard varieties, Cd. Obregon, 1977-78.

No.	Variety or selection	Pedigree	Yield kg/ha
33	Pavon 76		7531
25	Flicker"S"	CM-8954-B-7M-1Y-1M-0Y	7403
40	Flicker"S"	CM-8954-B-7M-1Y-1M-1Y-0M	7378
4	Jupateco 73		7344
12	Bb-Kal	CM-9160-11M-5Y-5M-2Y-0M	6964
30	Hugo #1		6944
*26	B6-0Y		6847
9	Ron-Cha x Bb-Nor67	CM-5484-F-5Y-4M-3Y-3M-1Y-0M	6794
*28	B8-0Y		6764
*20	B9-0Y		6739
4	Brochis"S"	CM-5872-C-1Y-1M-3Y-0M	6725
31	Bolsena"S"	CM-8625-G-1M-4Y-1M-0Y	6708
14	Bb-Kal	CM-9160-11M-5Y-4M-2Y-0M	6700
34	Brochis"S"	CM-5872-C-1Y-1M-1Y-1M-0Y	6661
21	Brochis"S"	CM-5872-C-1Y-5M-1Y-2M-0Y	6656
2	Harrier"S"	CM-33435-Y-2M-3Y-0M	6636
19	Brochis"S"-7C	CM-28784-3Y-2Y-0M	6586
*22	B-12		6569
*18	B-13		6536
5	Vanern"S"	CM-5375-F-1Y-1M-3Y-1M-0Y	6489
8	Vanern"S"	CM-5375-F-1Y-1M-1Y-1M-0Y	6442
13	Vanern"S"	CM-5375-F-1Y-1M-3Y-1M-0Y	6411
*32	B-15		6389
*15	B-14		6369
36	Brochis"S"	CM-5872-C-1Y-5M-2Y-2M-0Y	6317
*10	B-10		6294
28	Nacozari 76		6275
37	Pollo "S"	II-35129-26Y-2M-1Y-1M-1Y-0M	6228
7	IWP 85 = $S221-SS^2$	72L-178	6161
39	Bolsena"S"	CM-8625-G-1M-4Y-1M-1Y-4M-0Y	6119
*17	B-11		6108
24	Buteo"S"	CM-31070-S-3Y-7Y-0M	6006
23	Local Check		5986
11	Pima 77		5975
35	Siete Cerros		5900
38	IWP 19=E6254-Kal^2	72L-41	5722
35	Osprey"S"	CM-8701-A-1M-2Y-1M-3Y-0M	5658
1	Osprey"S"	CM-8701-A-1M-2Y-3Y-0M	5628
27	Bb-Nor67 x Cno"S"-7C	CM-1586-500M-500Y-500B-0Y	5536

CV 6.2% F= 13.02**
$LSD_{0.05}$ 641 kg/ha Mean yield = 6369 kg/ha
* Multiline composites

TABLE 12. Comparison of the yield of multiline composite varieties, respective components and the average of the components, Y 77-78.

ML Composite	Components		Yield kg/ha	Ave. yield of components
B6-0Y			6847	6918
	Brochis"S"	CM-5872-C-1Y-1M-3Y-0M	6725	
	Ron-Cha x Bb-Nor67	CM-5484-F-5Y-4M-2Y-1M-0Y	6794	
	Flicker"S"	CM-8954-B-7M-1Y-1M-0Y	7403	
	Bolsena"S"	CM-8625-G-1M-4Y-1M-1Y-0M	6708	
	Bb-Kal	CM-9160-11M-5Y-2Y-0M	6964	
B8-0Y			6764	6237
	Brochis"S"	CM-5872-C-1Y-5M-2Y-2M-0Y	6317	
	Flicker"S"	CM-8954-B-7M-1Y-1M-1Y-0M	7378	
	Bolsena"S"	CM-8625-G-1M-4Y-1M-1Y-4M-0Y	6119	
	IWP 19=E6254-Kal^2	72L-41	5722	
	Pollo"S"	II-35129-26Y-2M-1Y-1M-1Y-0M	6228	
	Osprey"S"	CM-8701-A-1M-2Y-1M-3Y-0M	5658	
B9-0Y			6739	6353
	Brochis"S"	CM-5872-C-1Y-5M-2Y-2M-0Y	6317	
	Flicker"S"	CM-8954-B-7M-1Y-1M-1Y-0M	7378	
	Bolsena"S"	CM-8625-G-1M-4Y-1M-1Y-4M-0Y	6119	
	IWF 19= E6254-Kal^2	72L-41	5722	
	Pollo "S"	II-35129-26Y-2M-1Y-1M-1Y-0M	6228	
B-10			6294	6513
	Bb-Nor67 x Cno"S"-7C	CM-1586-500M-500Y-500B-0Y	5536	
	Ron-Cha x Bb-Nor67	CM-5484-F-5Y-4M-3Y-3M-1Y-0M	6794	
	Brochis"S"	CM-5872-C-1Y-5M-1Y-2M-0Y	6656	
	Harrier"S"	CM-33435-Y-2M-3Y-0M	6636	
	Hugo I		6944	
B-11			6108	6407
	Bb-Nor67 x Cno"S"-7C	CM-1586-500M-500Y-500B-0Y	5536	
	Ron-Cha x Bb-Nor67	CM-5484-F-5Y-4M-3Y-3M-1Y-0M	6794	
	Brochis"S"	CM-5872-C-1Y-1M-1Y-1M-0Y	6661	
	Harrier"S"	CM-33435-Y-2M-3Y-0M	6636	
B-12			6569	6564
	Brochis"S"	CM-5872-C-1Y-1M-1Y-1M-0Y	6661	
	Osprey"S"	CM-8701-A-1M-2Y-3Y-0M	5628	
	Flicker"S"	CM-8954-B-7M-1Y-1M-0Y	7403	
B-13			6536	6664
	Brochis"S"	CM-5872-C-1Y-1M-1Y-1M-0Y	6661	
	Flicker"S"	CM-8954-B-7M-1Y-1M-0Y	7403	
	Brochis"S" - 7C	CM-28784-3Y-2Y-0M	6586	
	Buteo"S"	CM-31070-S-3Y-7Y-0M	6006	
B-14			6369	6434
	Vanern"S"	CM-5375-F-1Y-1M-1Y-1M-0Y	6442	
	Bb-Kal	CM-9160-11M-5Y-4M-0Y	6700	
	IWP 85= S221-SS^2	72L-178	6161	
B-15			6389	6512
	Vanern"S"	CM-5375-F-1Y-1M-3Y-1M-0Y	6411	
	Bb-Kal	CM-9160-11M-5Y-5M-0Y	6964	
	IWP 85= S221-SS^2	72L-178	6161	
Siete Cerros			5900	
Pima 77			5975	
Nacozari 76			6275	
Jupateco 73			7344	
Pavon 76			7531	

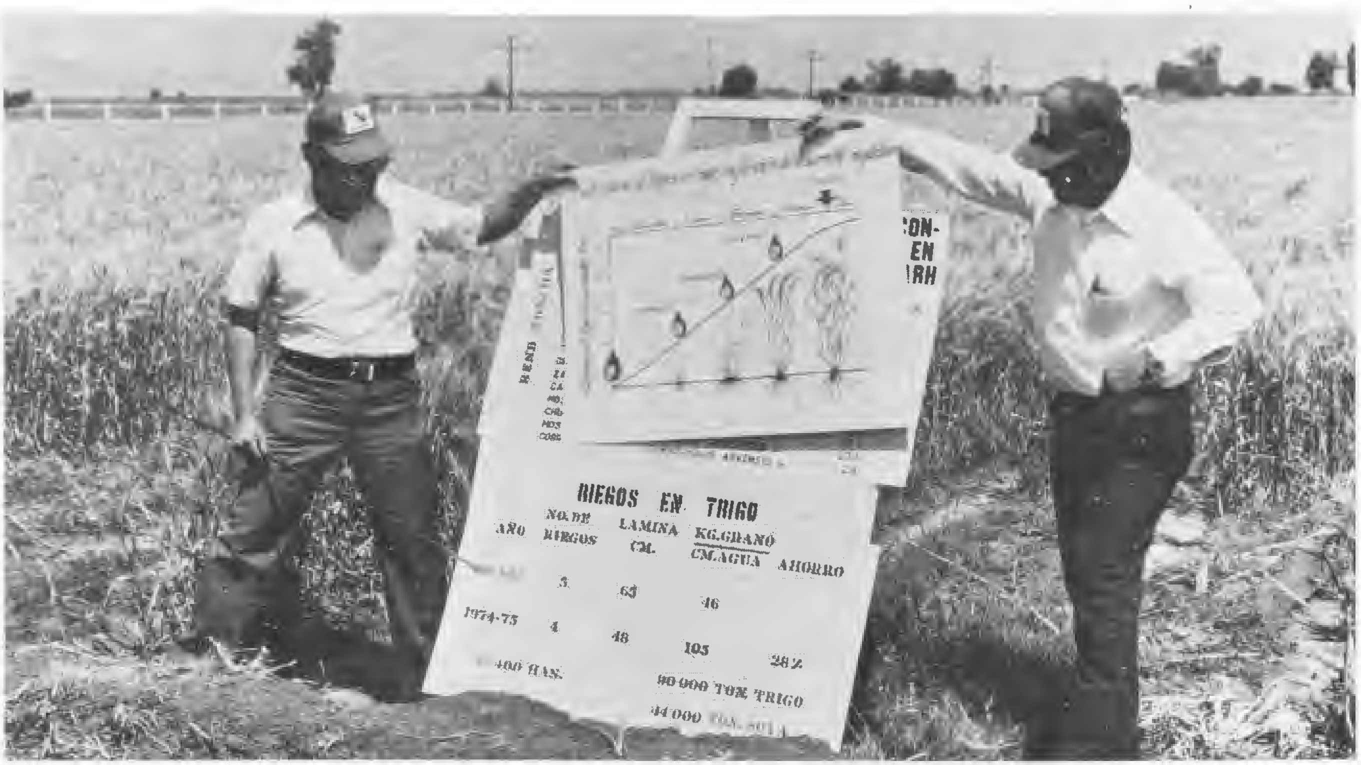
ML = Multiline Y = Yaqui, 1977-78

TABLE 13. List of varieties having resistance to aluminum toxicity (crestamento) used as parents in 135 crosses to produce lines with homozygous resistance.

Name	Name
Alondra"S" **	PAT 7219
* Wq-RM	PAT 72160
* Kavkaz	PAT 72195
* Aurora	PAT 72219
* Cebeco 148	CEP 7431
Cinquentenario	PF 69162
Jacui	PF 7065
Maringa	PF 70354
Londrina	PF 70402
Nobre	PF 7178
Abura	PF 72225
Coxilha	PF 72254
Lagoa Vermelha	PF 72640
	PF 7326
Ias 52	PF 7331
Ias 54	PF 7371
Ias 55	PF 74267
Ias 57	PF 11.1001.62
Ias 58	CNT 7
Ias 62	
Ias 63	Pel SL 1268.69
Ias 64	Pel 73280
BH 1146	EC 493.9.11
B 1701	

* Winter Wheat

** Susceptible to aluminium toxicity but does well in acid soils.



Dr. Carlos Torres of INIA staff, Cd. Obregón, Mexico, speaking to international visiting scientists about the critical vegetative stages for irrigation of wheat.

TABLE 14. List of advanced lines resistant to *Helminthosporium sativum* and leaf rust in tropical conditions of Poza Rica, Mexico.

Name and pedigree	Reaction to leaf rust
BH 1146	
YT 27	
PF 69129	
PF 71131	30S
PF 7339	20MS
L 2000/731	
L 2266/1406.101	
L 2565/1406.100	
MN 72135	TMS
Pj62-Cal x Tob-Era	
Jungfrau"S" II 20794-4e-4e-4e	10S
Pollo"S" II 35129-26Y-2M-1Y-1M-1Y-0M-(1-61B)	
Son64-SS2 x Alondra "S" SWM 3417-1Y-13M-3Y-0M	TMS
Sturdy-Mo 73 SWM 3966-IPR-24M-OPR	
Mildress-Coc 75 SWM 4127-1Y-2M-5Y-0M	TR
Coc75 {/Pch(Kt54A-N10B x Kt54B/Nar59)^2/Hn IV} SWM 5089-11M-1Y-0M	TMR
Pato x cc-Inia CM 1021-2MB-2BK-OBK-OBK-OKe	
Bb-Nor67 x Cno"S"-7C CM 1586-5M-500Y-500B-0Y	10S
Bb-Nor67 x Cno"S"-7C CM 1586-500M-500Y-500B-0Y	TR
Tob^2-7C CM 5207-C-3Y-4M-0Y	TMS
Bb-Cno/Cno"S"-No66 x Pi62 CM 5620-D-3Y-1M-2Y-2M-oY	TMS
Chiroca "S" CM 8963-A-1M-1Y-1M-3Y-0M	
Alondra "S" CM 11683-1Y-1M-1Y-13M-1Y-500Y-0M	TMS
Cno-No66 x CC-Inia/Kal-Bb CM 15433-45Y-5M-1Y-8Y-0Y	

TABLE 14. continued

Name and Pedigree	Reaction to leaf rust
Cno-No66 x CC-Inia/kal-Bb CM 15433-45Y-5M-3Y-8Y-1Y-0B	10S
Coq-Kal x Pato (R)-Tnb 69 CM 21110-F-3Y-10M-2Y-8Y-4Y-0M	
Cno"S"-7C CM 25322-6M-1R-205M-300Y-101M-0Y	TMS
Zz"S"-Sajame"S" CM 25741-58Y-1Y-1Y-1M-0Y	10S
Zz"S"-Sajame"S" CM 25741-58Y-3Y-1Y-2M-1Y-0B	20S
Maipo"S"-Maya 74"S" CM 25762-1Y-0Y	TS
Maya 74"S" CM 27829-19Y-1M-4Y-0M-3LD-3LD	
Vireo"S" CM 28235-2M-13Y-1M-3Y-0M	TMS
Hork"S" x Y50E-Kal[3] CM 29025-1M-3Y-1M-0Y	TS
(Tp x Cno-No66/Bb-Cno)Za75 CM 29077-4M-4Y-6M-0Y	TMS
(Tp x Cno-No66/Bb-Cno)Za75 CM 29077-6M-1Y-2M-0Y	TMS
(Tp x Cno-No66/Bb-Cno)Za75 CM 29077-4M-4Y-1M-1Y-0M	TR
Maya 74"S"-BJY"S" CM 29244-6Y-3M-1Y-0M	10S
Bb-Gallo x Sajame"S" CM 29299-4Y-3Y-1M-1Y-0B	5S
Bb x Tob-Cno/SKa CM 29482-15Y-1Y-1M-1Y-0B	TMR
Bb x Tob-Cno/SKa CM 29482-15Y-1Y-1M-4Y-0B	TS
Gallo-Aust II 61.157 x Cno"S"-No66/Pci"S" CM 29682-10Y-1Y-1M-1Y-0B	TS
Cno-7C x Kal-Bb/Pci"S" CM 29686-13M-1Y-0M	10MR
Cno-7C x Kal-Bb/Pci"S" CM 29686-27Y-2M-0Y	TS
Bluejay"S"/Tp(Cno-Inia"S")3 CM 29989-20Y-1M-0Y	TS
Tucan"S"-Moncho"S" CM 30005-8Y-1Y-0B	

Name and Pedigree	Reaction to leaf rust
Titmouse"S" CM 30136-1Y-3M-2Y-0M	5S
Titmouse"S" CM 30136-18Y-2Y-1M-0Y	5S
Titmouse"S" CM 30136-3Y-1Y-0M	
Titmouse"S" CM 30136-1Y-10M-1Y-0M	5MS
/Cal-Pj62(Cno-Son64/Tob-Cfn x Bb)/Pavon"S" CM 30700-3M-2Y-4M-1Y-0B	TMS
Siskin"S"-Canario"S" CM 30610-1Y-6M-0Y	O
Siskin"S"-Canario"S" CM 30610-1Y-8M-1Y-0M	TMR
Siskin"S"-Canario"S" CM 30610-1Y-2M-1Y-0M	O
Siskin "S"-Canario"S" CM 30610-1Y-7M-1Y-0M	TR
(Tob"S"-Npo x CC-Inia/Cno-No66)Sajame"S" CM 30663-3M-3Y-1M-0Y	20S
(Tob"S"-Npo x CC-Inia/Cno-No66)Sajame"S" CM 30663-3M-3Y-4M-0Y	10S
Tanager"S" CM 30697-2M-15Y-1M-0Y	TR
Tanager"S" CM 30697-2M-10Y-11M-0Y	TS
Tanager"S" CM 30697-2M-10Y-4M-0Y	TMS
Tanager"S" CM 30697-2M-11Y-1M-0Y	O
Tanager"S" CM 30697-15Y-5M-0Y	TMR
Tanager"S" CM 30697-2M-10Y-8M-0Y	O
Tanager"S" CM 30697-2M-3Y-7M-0Y	O
Tanager"S" CM 30697-11Y-1M-0Y	O
REDPOLL"S" CM 31068-W-1Y-2M-5Y-2M-1Y-0B	10S
REDPOLL"S" CM 31068-W-1Y-1M-1Y-1M-0Y	TS

TABLE 14. continued

Name and Pedigree	Reaction to leaf rust
Cno"S"-Pj62 x On-II60.147/Bb-Gallo CM 31126- Q-1Y-1M-5Y-0M	
Au-Up301 x Gallo-Sx CM 31154-N-2Y-9Y-5M-0Y	O
Pewee"S" CM 31630-H-3Y-1M-1Y-0M	TR
Pewee"S" CM 31630-I-6Y-1M-3Y-1M-0Y	TS
Pewee"S" CM 31630-G-4Y-1M-1Y-0M	TMS
Pewee"S" CM 31630-G-4Y-2M-1Y-0M	TMR
Pewee"S" CM 31630-G-4Y-1M-1Y-0M	
Pewee"S" CM 31630-G-4Y-2M-1Y-0M	
Pewee"S" CM 31630-H-3Y-1M-1Y-0M	
Pewee"S" CM 31630-H-3Y-1M-2Y-0M	
Pewee"S" CM 31630-H-3Y-1M-4Y-0M	
Pewee"S" CM 31630-H-3Y-1M-6Y-0M	
Pewee"S" CM 31630-H-3Y-1M-10Y-0M	
Pewee"S" CM 31630-H-3Y-1M-500Y-0M	
Pewee"S" CM 31630-I-1Y-2M-4Y-0M	
Pewee"S" CM 31630-I-6Y-1M-1Y-0B	
Gallo-Huac"S" CM 32318-38Y-1M-1Y-0M	TMS
Kal-Bb x Cj71"S"/Alondra"S" CM 32421-4M-1Y-2M-2Y-0M	5MS
Kal-Bb x Cj71"S"/Ald"S" CM 32421-4M-1Y-2M-1Y-0M	5MS
Pavon"S"-Huac"S" CM 32537-21Y-2M-6Y-0M	TR
Bananaquit"S" CM 32556-3M-501Y-519M-0Y	TS

TABLE 14. continued.

Name and Pedigree	Reaction to leaf rust
Au-Yr Resel (B)(Bb-Ska x Cdl/Cj71) CM 33098-B-1M-1Y-1M-0y	O
Bobwhite"S" CM 33203-J-2M-5Y-6M-0Y	TR
Maipo"S"-Pj62 x Emu"S" CM 33254-L-1M-4Y-1M-1Y-0M	5MS-S
Junco"S" CM 33483-I-1M-5Y-1M-4Y-0M	5MS
Kvz- Gv"S"(Ron-Cha xBb-Nor67/Emeck 132) CM 33942-C-1M-1Y-3M-0Y	O
Bb-Gallo x Y50E x Kal^3/Lfn x HD 832-Bb CM 34574-F-1M-9Y-1M-2Y-0M	5MS
Bb-Gallo x Y50E-Kal^3/Lfn x HD 832-Bb CM 34574-F-1M-14Y-2M-2Y-0M	TMS
Bb-Gallo x Y50E-Kal^3/Lfn x HD 832-Bb CM 34574-F-1M-1Y-3M-0Y	O
Bb-Gallo x Y50E-Kal^3/Lfn x HD 832-Bb CM 34574-F-1M-14Y-0M	O
Yding"S"-Pima77 CM 35042-70M-1Y-0M	TR
Yding"S"-Pci"S" CM 35044-87M-1Y-0M	TR
Yding"S"-Pci"S" CM 35044-96M-1Y-0M	TMS
Yding"S"-Pci"S" CM 35044-2M-1Y-2M-0Y	5S
Yding"S"-Zz"S" CM 35048-43Y-3M-1Y-0M	TMS
Desc #2 x Kal-Bb CM 36154-8Y-5M-1Y-0M	10S
Ti71 Resel-Coc75 CM 36487-50M-3Y-0M	TS
Ti71 Resel-Coc75 CM 36487-110Y-1M-0Y	O
Fury-Mochis 73 CM 36732-16Y-15M-4Y-0M	TR
Ollanta-Torim73 CM 36820-10Y-1M-1Y-0M	TMS
Ollanta-Torim 73 CM 36820-10Y-1M-2Y-0M	10MS
Jup73-Alondra"S" CM 36867-18Y-27M-1Y-0M	O

TABLE 14. continued.

Name and Pedigree	Reaction to leaf rust
Jup 73-Emu"S" CM 36869-1Y-5M-1Y-0M	TMS
Bon-Jup73 CM 36872-27Y-16M-1Y-0M	O
Bon-Jup73 CM 36872-27Y-14M-5Y-0M	10S
Bon-Jup73 CM 36872-27Y-8M-2Y-0M	5S
Bon-Jup73 CM 36872-27Y-9M-5Y-0M	TMS
Bon-Jup73 CM 36872-27Y-14M-2Y-0M	10S
Bon-Jup73 CM 36872-27Y-1M-0Y	O
Br 74.72-Cocoraque 75 CM 36889-14Y-3M-2Y-0M	TS
Br 74.72-Cocoraque 75 CM 36889-31Y-10M-0Y	5S
Condor"S"(RR 68-WW15/Bj"S"-On^{2}x Bon) CM 36902-1Y-5M-0Y	TS
Condor"S"(RR 68-WW15/Bj"S"-On^{2}x Bon) CM 36902-1Y-9M-0Y	O
Torim 73 x Kal-Bb CM 37130-6Y-3M-0Y	O
BH 11.46 x Kal-Bb CM 37155-4Y-21M-2Y-0M	TR
Su-II54.30^{2}xBo42(CalxCno-Inia"S"^{2}/Bb-Tob x Cno^2-Chr)] Orizaba"S"- 7C/Cno-Chr x Flr-No66 CM 37678-B-1Y-1M-3Y-0M	5S
(Bb-Cno x Inia-Soty/Sparrow"S")Pavon"S" CM 37705-M-9Y-2M-4Y-0M	TMR
(Bb-Cno x Inia-Soty/Sparrow"S")Pavon"S" CM 37705-C-1Y-4M-0Y	O
Ore F1 158-FDL x Mef"S"-Tiba 63^2/Coc75 CM 37987-I-1Y-2M-0Y	TMS
Ti 71 Resel-PIMA77/Kal-Bb x Mildress CM 38494-J-1Y-1M-1Y-0M	30S
Roedel-Suwon 92 x Rq 73[(Cal x Cno"S"-Inia"S"^{2}/Bb-Tob x Cno^2-Chr)Sap"S"] CM 39269-D-3Y-1M-3Y-0M	5S
Maya 74"S"-Pavon"S" CM 39426-1M-1Y-0M	TS
Pato-On x Maya 74/Maya 74"S" CM 39440-26M-3Y-0M	5MS
[Cno-8156 x Tob-Cno(No66/12300 x LR64-8156)]Trifon"S" CM 40631-9M-3Y-0M	TS
Chr-Yding"S"(B.Aust-Nad63 x Kal-Bb/Cno"S"-7C x Bb-Cal) CM 41383-H-5M-1Y-0M	10S

Durum Wheat

INTRODUCTION

This chapter summarizes the results, observations and data obtained during the winter and summer seasons, 1977-78, from nurseries grown at different locations in Mexico and abroad.

Durum wheat (*Triticum durum*) is a tetraploid species (28 chromosomes) which is grown very extensively in U.S.S.R., India, Mediterranean-Middle East dryland regions, Canada, U.S.A. and Argentina. Although the international marketing of durum wheat generally requires good quality for pasta products, very large quantities of durum grain of varied characteristics, are utilized as local home-made bread and food, like flat unleavened bread in the Middle East countries, couscous in North Africa, chapatis in India, bulgur in Turkey and mote in the Andean Countries.

As a class, durum wheats exhibit a much better ability to produce well in dry areas, than do bread wheats, but they do not differ significantly from bread wheats with respect to the various diseases that can attack them. Nevertheless, their virulences may vary with the areas where the two species are more extensively grown. Very often the resistance observed in one area is not sufficient to protect the crop when grown in a different area.

The durum wheat breeding program at CIMMYT embraces four main objectives to cater for the various different areas in the world:

1. Increase yields.
2. Stabilize yield, achieving a more general adaptation.
3. Develop appropriate materials with specific adaptation.
4. Incorporate satisfactory industrial quality.

Important progress has been reported from programs where CIMMYT's durum materials are being distributed throughout the world. New cultivars like Amal 72, Dicle 74 and Firat have good possibilities in North Africa and Middle East countries. Such advanced lines as Loon "S", Scarcies "S", Harlequin "S", Bittern "S", Guillemot "S", and Kranich "S" are reported performing well at various locations in Africa and the Middle East. This indicates that high yielding durum cultivars are being derived and have good future possibilities, even in areas where durum is not yet a significant crop. A good example is Kranich "S" which yielded 7839 kg/ha, in irrigated trials in Zambia in 1977.

YIELD TRIALS RESULTS

Results obtained from 17 yield tests planted at CIANO, Cd. Obregon, Sonora, Mexico, during the season 1977-1978 show a somewhat lower yield than during the two previous years at the same station. Tables 1 and 2 show these differences. This diminishing trend was also observed for bread wheat and triticale (see figure 1). It can be considered to be due largely to a warmer than normal season. However despite adverse weather conditions in the Northwest part of Mexico, the newly developed durum lines continue to show good performance.

High performance durum lines were observed at CIANO in the 1977-1978 season in trials which included 510 new durum lines and checks of bread wheat, durum and triticale. All this material was planted in trials of 30 entries with three replications in randomized complete block designs. They were grown under irrigation and very good cultural conditions.

Results for the top three yielding entries and the best check in 17 trials are summarized in Table 3. These data show that the durum check varieties Cocorit 71 and Mexicali 75 failed to appear as the best check in any of the trials, and that the triticales Mapache and Beagle appeared nine and eight times respectively as best checks. Thirty durum wheat lines however, yielded from 5-14 per cent more than the checks and they are summarized in Table 4. Also, the following nine lines have repeated their good yield performances at Cd. Obregon, Sonora during the last two growing seasons:

Bittern "S"	CM-9799-126M-1M-3Y
Bittern "S"	CM-9799-126M-1M-4Y-0Y
Bittern "S"	CM-9799-126M-1M-5Y-0Y
Skimmer "S"	CD-1610-C-1Y-3Y
Guillemot "S"	CD-14646-C-1Y-1M-1Y-0Y
Rokel "S"	CD-1895-12Y-1Y
Tokel "S"	CD-1895-12Y-0Y-2E
Goose "S"	CM-10143-19M-2Y-1M-1Y-0Y
Goose "S"	CM-10143-19M-2Y-1M-1Y-0Y-1ptz

Some of these lines could possibly be grown as commercial varieties in areas of the world, where their performance has been superior at locations indicated in the reports of the 5th, 6th and 7th Elite Durum Yield Trials, (EDYT) and 8th and 9th International Durum Yield Nurseries (IDYN). See tables 5, 6 and 7. Some lines showing good performance are:

Bittern "S"	CM-9799-126M-1M-4Y-0Y
Bittern "S"	CM-9799-126M-1M-5Y-0Y
Guillemot "S"	CD-14646-C-1Y-1M-1Y-0Y
Goose "S"	CM-10143-19M-2Y-1M-1Y-0Y
Scarcies "S"	CM-10162-76M-4Y-0M
Cr x T. dic.V.Vern-Gll "S"	D-10182

Summaries of the 8th EDYT planted at various locations in the world are presented in table 8. They indicate a 11.6 per cent increase in yield over the 1st EDYT. The data obtained from summer plantings at El Batan, Mexico indicate a 25.4 per cent increase of the 8th EDYT over the 7th EDYT nurseries. Although these results on yield are encouraging, the same reports indicate the possibility of improving yields even further, if better resistance to such diseases as powdery mildew, *Septoria,* leaf rust and stem rust is incorporated into those materials being distributed through the international nurseries.It is also apparent that improvement is still possible in yield stability.

DISEASE RESISTANCE

Although yields of durum wheats have increased in several locations in the world, greater gains could be achieved if adequate resistance and tolerance to powdery mildew (*Erysiphe graminis*), septoriasis (*Septoria tritici and Septoria nodorum*), leaf rust (*Puccinia recondita*), and stem rust *(Puccinia graminis)*, head scab (*Fusarium sp*) and barley yellow dwarf virus (BYDV), were incorporated in the durum materials included in international nurseries.

The data in tables 6 and 7 for the 8th and 9th IDYN nurseries clearly demonstrate that the lowest coefficients of infection for powdery mildew on durum wheats were 28-32 and 44-47; for *Septoria tritici* 21-26 and 21-22; leaf rust 0-19 and 9-12; stem rust 11-17 and 8-11 and BYDV 18-22 and 13-19 respectively in the two nurseries, and are less than adequate for protection of the crop, and therefore yields are affected where these occur.

Reactions were observed for leaf rust, yellow rust, stem rust, head scab, *Septoria tritici and Fusarium nivale*, on better yielding durum lines harvested at Cd. Obregon in 1977-78 and tested for those diseases at various locations in Mexico. They indicate that good yielding durum materials exist which have satisfactory resistance to leaf rust, yellow rust, and stem rust, but possess inadequate resistance to headscab, *Septoria tritici and Fusarium nivale*. Tables 9 and 10 summarize these data.

The CIMMYT screening nursery (10th IDSN), observational nursery (LO), and the crossing block (CB), were tested for diseases by the Plant Pathology Section, at several locations in Mexico, where the incidence of certain diseases is high and sufficient for preliminary screening and selection of resistant good types for immediate use in crossing programs. Some lines and varieties showing good resistance to various diseases were the following:

1.	**Resistant to *Fusarium* (head scab)**	**Reaction**
	USA.0640-Fg"S" x Fg"S"-Ruff"S" CD-14119-E-7Y-1M-2Y-3M-0Y	T
	Pg"S"-Ggo VZ380 x S15-Cr"S" CD-10671-P-8M-3Y-2M-1Y-1M-0Y	0
	Inrat 69	0
	Swan"S" CD-16707-H-3M-3Y-0M	T
	Gdo VZ471-Br"S" x Pg"S"/Rabi"S" CD-12498-6Y-1M-4Y-0M	0
	Ramsey	0
	A 63037/Sentry 66058-81T-1T-2T-2T-0T	0
	Wakooma	0
	Canoco 0217	0
	Spoonbill"S" CD-17680-1Y-500M-0Y	0
	Eider"S" CD-10535-D-1M-1Y-4M-0Y	0
	S. Cp. DD Mut.	0
	Castel Porziano	0
2.	**Resistant to *Septoria tritici***	
	Ruff"S"-Mexi"S" x Snipe"S" CD-18150-5Y-1M-0Y	2
	(Plc"S"-Cr"S" x Rabi"S"/Candeal II) Kif"S" CD-19327-E-2Y-4M-0Y	2
	Teal"S" x Cp-St464^2[Gta"S" (ZB-LK x 60.120/ Gll"S")] CD-16723-B-1M-1Y-0M-0Y	2
	USA.0640-Fg"S" x Fg"S"-Ruff"S" CD-14119-E-7Y-1M-2Y-3M-0Y	1
	USA.0640-Fg"S" x Fg"S"-Ruff"S" CD-14119-F-1Y-4M-1Y-4M-0Y	2
	Erpel-Ruso CD-10437-13M-3Y-1M-2Y-2M-0Y	2

Pg"S"-Ggo VZ380 x S15-Cr"S" CD-10671-P-8M-3Y-2M-1Y-1M-0Y	2
Waha"S" CD-17904-B-3M-1Y-1Y	2
T. dic. V. Vern-GII"S" D-23636-1M-6R-0M	2
Waha"S" CM-17904-D-3M-1Y-0Y	1
A63037/Sentry 66058-81T-1T-2T-2T-0T	1.0
Snipe"S" CM-13414-1Y-3M-0Y	1.5
Canoco. 0217	2.0
S. Cp. D D Mut.	2.0

3. **Resistant to leaf rust and stem rust, (from 0-TMR)**

Swan"S"
CD-16707-G-7M-2Y-6M-0Y

(Plc"S" x Salti-Autma-Hiti/Fg"S") Mexi"S"
CD-16895-A-3M-2Y-2M-0Y

Tubeno"S"
CD-7894-3M-1Y-5M-2Y-2M-0Y

Bittern"S"
CM-9799-126M-1M-3Y

Bittern"S"
CM-9799-126M-1M-4Y-0Y-0M

Flamingo"S"
D-27582-8M-13Y-2M-0Y

Sandpiper"S"
CM-10142-39M-0Y-0bk

Memo"S"
CD-10521-H-5M-500Y-1M-0Y

Memo"S"
CD-10521-H-5M-501Y-9M-0Y

Cfn 5-Fg"S" x Ptl"S"
CM-17780-C-8M-1Y-0Y-1B

Kif"S" x Ruff"S"-Fg"S"
CD-127-5Y-2M-0Y

Alcid"S"
CD-7449-1Y-2M-3Y-2M-0Y

Avocet"S"
CD-1074-1Y-3Y

Tropic bird"S"
CD-3569-8Y-2M-0Y

Duck"S"
CM-19901-B-1YD (10-1B-1Y-0B)

Gdo VZ449

Shearwater"S"
HRL-861-2B-0Y-2B-0Y

Waha"S"
CM-17904-B-3M-1Y-1Y-0B

In summer plantings conducted at several locations in central and northern Mexico, there were 114 lines with reactions of 0-TR to stem rust and 27 lines with a reaction of 0-TR to leaf rust in the summer plantings conducted at several locations in the central and northern part of Mexico.

Observations made on several durum nurseries planted at Izmir, Turkey in 1978, indicate that durums developed for the high moisture areas of Mediterranean countries need to have acceptable resistance to stem rust, stripe rust, leaf rust, *Septoria tritici,* common bunt, covered smut, and powdery mildew. Some of the more resistant materials observed at Izmir were the following:

1. **Resistant to stem rust**	**Reaction**
T. dic. V. Vern-GII"S" D-23077-1M-1Y-4M-0Y	0-TR
Gdo VZ394	0
HD 4500-Fg"S" x Cr"S"-Gs"S" CD-13923-C-1Y-1M-0Y	0
Gs"S"-Tc60 x S15-Cr"S" CD-10514-G-7M-2Y-2M-0Y	TR
Quilafen	0
Ward	0
7175-Ward	0
Magh 72	0
Balcarceño INTA	0

2. **Resistant to leaf rust**	
Mexi"S"-P66/270 x Gta"S" CD-13252-8Y-2M-0Y	0
Saba x Gs"S"-Fg"S" CD-13889-A-2Y-3M-0Y	0
[Gta"S"-Fg"S"(61.130 x Lds/GII"S")]AA"S"-Fg"S" CD-14091-F-2Y-1M-0Y	0
[Gta"S"-Fg"S"(61.130 x Lds/GII"S")]AA"S"-Fg"S" CD-14091-F-2Y-3M-0Y	0
[Gta"S"-Fg"S"(61.130 x Lds/GII"S")]AA"S"-Fg"S" CD-14091-F-4Y-1M-1Y	0

Anhinga"S"	0
Tag.B.B.-HD/Fg"S"-Pal.20C-606 x Mexi"S"-Ruff"S" CD-14162-A-1Y-5M-0Y	0
Cr"S"-Tag.B.B. x Pg"S"-Ralle"S" CD-14234-G-2Y-3M-0Y	0
Memo"S" CD-10521-I-20M-1Y-0Y	0
Jo"S"-AA"S" x Mexi"S" CD-7917-5M-1Y-1M-0Y	0
Shearwater"S" HRL-861-2B-0Y-2B-100Y-4M	0
Shearwater"S" HRL-861-2B-0Y-2B-100Y-5M	0
3. Resistant to *Septoria tritici*	
Taganrog Buck Balcarce	1
Preto Amarelejo	1
4. Resistant to powdery mildew	
Gediz"S" D-27534-1M-1Y-1M-0Y	2
Boyeros"S" CD-4404-J-5Y-0Y-0M	2
Domel"S" D-33674-500Y-500B-0Y	1
D 67.3-Gta"S" CM-19314-73-2B-1Y-2Y-3M	2
21564-Cr"S" x Can.0137/Rabi"S"-Fg"S" CD-10728-A-3M-1Y-2M-0Y	2

There were 58 lines with a zero reaction to yellow rust, and the variety Candealfen had 0-0-5MR-0 to stem rust, leaf rust, yellow rust and *Septoria* respectively. Also, line /E 3728-Cp^3/Gz(Yt54$_E$-Cp^3 x Gz)/Tc A 4090-17P-2P-1P showed a zero reaction to all diseases present.

All these data obtained from a wide geographic area indicate that there are good possibilities of combining genes which are capable of giving adequate resistance or tolerance to the most prevalent durum diseases. The Durum Wheat Program at CIMMYT uses information from many sources on the reactions observed in its international nurseries and cooperating national programs, in order to make crosses among the available materials in a type of modified recurrent selection program, in which top and multiple crosses are featured.

DURUM WHEAT QUALITY

Data obtained for the best yielding durum lines harvested in Y 1977-78 and presented in table 11, indicate the possibilities for obtaining good yielding durum lines of acceptable and satisfactory quality. Although the season at Cd. Obregon was affected by unusually hot weather, which accelerated maturity and affected grain filling, the hectoliter weight observed on these good yielding lines was generally of 80 kg/hl or higher.

The protein content was 10 per cent or better, and the carotene content of grain and semolina ranged at five or higher ppm. It is highly desirable to have a high carotene content in macaroni. Regarding gluten strength, these lines are generally strong or medium-strong, with an evaluation of good to very good.

Efforts are made to maintain good hectoliter weight, and improve kernel size, protein content and spaghetti color. For these purposes, most new crosses utilize parental lines of satisfactory quality containing the traits to be incorporated in the crosses being planned. Then, during the course of developing new lines, early generations (F_2, F_3 and F_4) are screened for pigment content, at the CIMMYT quality laboratory where only those lines having five or more ppm of pigment are retained for further selection in the program. Complete testing for quality is conducted on advanced materials included in yield trials and international nurseries of various types.

COLD RESISTANCE OR COLD TOLERANCE

Continued screening for sub-zero temperature resistant materials is conducted during the winter season in Toluca, Mexico. Those lines or varieties with resistance or good tolerance to frost damage are used in crosses with agronomically desirable materials. In 1978, the program distributed 55 sets composed of 60 F_2 cold tolerant bulks. They were more frequently requested than other F_2 materials.

A new group of 212 F_1's of crosses between cold tolerant materials and spring types was sown at Yaqui in 1978-1979. Top and double crosses will be made for further recombinations of the parental lines involved. Also some F_2 bulks will be distributed from the more promising types in the group.

The program is screening the USDA durum collection at Toluca and Cd. Obregon, during 1978-79 winter season in order to select cold tolerant materials at Toluca and spring (early) types at Cd. Obregon. Crosses will be made to develop lines having those two characteristics combined with other desirable traits.

EARLY AND DROUGHT TOLERANT MATERIALS

Although year after year a large number of crosses are made for earliness, these materials need to be screened and selected at appropriate sites in the world. The durum program at CIMMYT searches the world collection and USDA durum collection, as well as other sources in order to select early materials, and use them in new crosses. Nine early drought tolerant lines were received from Russia, and sown in Cd. Obregon and Toluca in 1978-1979. These lines are: Melanopus 69, Gordeiforme 189, Melanopus 1932, Melanopus 32, Raketa, Krasnokutka 6, Bezencukskaja 141, Celinogradskaja 75 and Orenburgskaja 2. Later, crosses will be made using these lines and those found in the USDA durum collection, to combine these features with other desirable characteristics.

IMPROVING AGRONOMIC TYPE

During visits to Argentina and Chile in 1977 and to Algeria, Syria and Turkey in 1978, strong recommendations were made for developing medium-tall or nearly normal size durum materials. The CIMMYT program is now giving strict attention to making crosses for this purpose, and in Mexico, is selecting types with these characteristics. This year, the program distributed 50 sets of F_2 bulks which are expected to provide segregation for taller plants having good straw strength and other desirable traits.

Regarding earliness, it was noted in Argentina and Chile, that there is a preference for semi-late cold tolerant materials, whereas in Syria, Turkey and North Africa early materials are required. The CIMMYT program is endeavouring to satisfy these divergent needs in the new lines being developed. Tables 12 and 13 show promising segregating lines and selections made at Cd. Obregon and Toluca, respectively, in the 1977-78 season.

IMPROVING FERTILITY AND SEED SET

Selection for highly fertile materials of the 8th EDYT nursery was carried out during the season 1977 and at Yaqui in 1977-1978. The preliminary data are presented for the nine most fertile lines and checks in table 14. Fertility appears to be 10 per cent better during the summer crop than when the same lines are grown at Cd. Obregon during the winter months, but the more fertile lines behave very consistently during the two seasons.

The number of spikelets per spike was only four per cent higher in the winter crop than in summer. The 1000 kernel weight was 36 per cent higher for the winter crop than for summer, undoubtedly due to the longer cooler filling period. This factor appears to have contributed to the better yields of the more highly fertile lines during the winter plantings at Cd. Obregon 1977-78 over those planted during the summer 1978 at El Batan.

It is necessary to continue the search for more highly fertile materials with long lax and semi lax heads in such nurseries as the observational nursery, screening nursery, CB from other countries, etc. and use them in crosses. This approach has been followed during the last two seasons, and segregation for these characters is now occurring in thousands of lines planted at Yaqui in 1978, for the 1978-79 growing cycle.

INTERNATIONAL NURSERIES

The CIMMYT Durum Program distributed 352 sets of nurseries to 66 countries throughout the world as follows:

F_2 Irrigation	49 sets
F_2 Dryland	50 sets
F_2 Cold Tolerant	55 sets
CB (Crossing Block)	29 sets
IDSN (International Durum Screening Nursery)	79 sets
IDYN (International Durum Yield Nursery)	76 sets
EDYT (Elite Durum Yield Trial)	14 sets

The F_2 Irrigation group generally includes crosses with short stiff-straw, suitable for irrigated, highly fertile areas, whereas the F_2 Dryland and Cold Tolerant groups may be expected to segregate for semi-tall types. The CB, IDSN and EDYT include advanced materials, with immediate possibilities for commercial use and as sources of parental types for national crossing programs.

FIGURE 1.- GRAPHIC REPRESENTATION OF YIELD FOR FIVE TOP YIELDING LINES ON THREE SEASONS

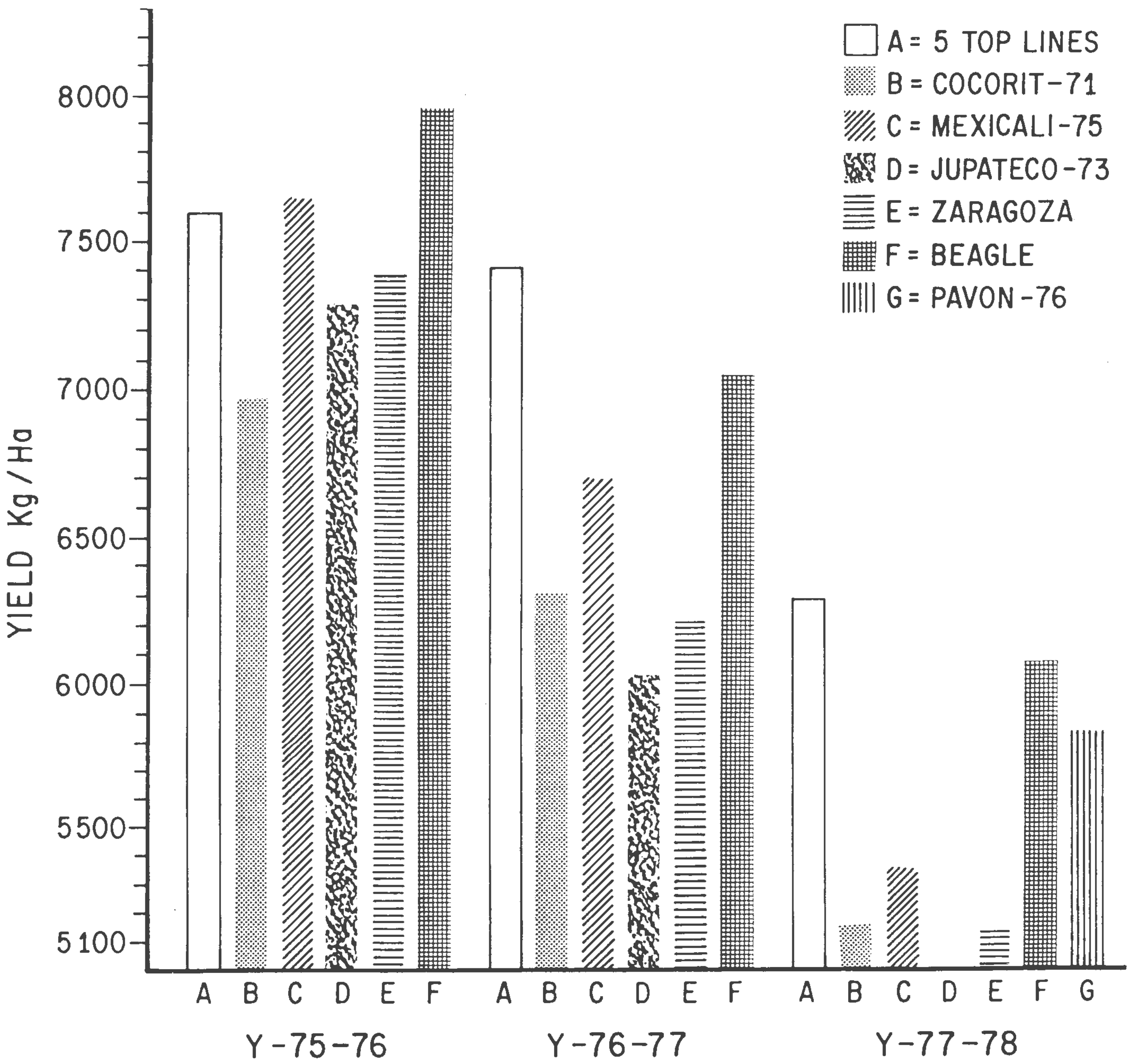


TABLE 1. Yield of the top five durum wheat lines and check varieties seasons Y 75-76, Y 76-77 and Y 77-78. (Yield values - kg/ha)

Lines and varieties		Seasons Y75-76	Y76-77	Y77-78	Avg.
Five top durum lines (average)		7636	7425	6306	7122
Cocorit 71	(Durum check)	6983	6312	5145	6146
Mexicali 75	(Durum check)	7668	6735	5358	6857
Jupateco 73	(Bread wheat check)	7311	6046	-	6678
Zaragoza 75	(Bread wheat check)	7383	6241	5134	6252
Pavon 76	(Bread wheat check)	-	-	5858	5858
Beagle	(Triticale check)	7968	7043	6109	7040
	Avg.	7492	6634	5652	6565

Y = Yaqui, Mexico.

TABLE 2. Yield of the top five durum wheat lines and check varieties in per-cent of the best check. Seasons Y75-76, Y76-77 and Y77-78.

Lines and varieties		Seasons Y75-76	Y76-77	Y77-78
Five top durum lines (average)		95.8	105.4	103.2
Cocorit 71	(Durum check)	87.6	89.6	84.2
Mexicali 75	(Durum check)	96.2	95.6	87.7
Jupateco 73	(Bread wheat check)	91.7	85.8	-
Zaragoza 75	(Bread wheat check)	92.6	88.6	84.0
Pavon 76	(Bread Wheat check)	-	-	95.8
Beagle	(Triticale check)	100.0	100.0	100.0

Y = Yaqui, Mexico.

TABLE 3. The Top three yielding durum lines and checks, in 17 yield trials. Cd.Obregón, Sonora. Mexico 1977-1978.

Var. No.	Cross and pedigree	Yield Kg/ha	Rank	% Best check	Days to flower	Height cm	L.R. reac.
8	Chichicuilote "S" CD-1314-A-1Y-2Y	7 039	1	111	74	90	0
21	Rokel "S" CD-1895-12Y-0Y-2E	6 922	2	109	75	90	0
13	Mallard"S" CD-1894-3Y-1Y-8M-1Y-0M	6 768	3	107	75	90	0
30	MAPACHE (Best check Exp. I)	6 323	11	100	69	105	0
43	Bittern"S" CM-9799-126M-1M-4Y-0Y-0M	6 888	1	114	75	90	0
42	Bittern"S" CM-9799-126M-1M-3Y	6 704	2	111	76	90	0
45	Goose"S" CM-10143-6M-3Y-1M-2Y-0Y-2ptz	6 702	3	111	82	95	0
60	BEAGLE (Best check Exp. II)	6 053	16	100	75	120	0
69	Guillemot "S" CM-14646-C-1Y-1M-1Y	7 200	1	107	82	95	0
62	Shoveler "S" CD-10569-C-10M-1Y-0M	6 913	2	103	71	90	0
70	Guillemot "S" CM-14646-C-1Y-1M-1Y-0Y	6 894	3	102	82	90	0
90	MAPACHE (Best check Exp. III)	6 740	6	100	67	115	15MS
99	Gta"S"-Mexi"S" CD-771-1Y-2Y-4M-0Y	6 505	1	100	71	90	0
106	Ch67-21563 x Inrat69/S.15-Cr"S" CD-4430-D-6Y-1M-0Y	6 457	3	100	72	90	0
101	Tropic bird "S" CD-3568-5Y-1M-0Y	6 396	4	99	77	90	0
120	BEAGLE (Best check Exp. IV)	6 480	2	100	77	130	0
132	Winged "S" CM-18577-11Y-6Y-2Y-0Y	6 653	1	102	73	90	TR
141	Fg"S" D-27582-8M-13Y-2M-0Y	6 409	3	98	73	95	0
122	Goose"S" CM-10143-19M-2Y-1M-1Y-0Y	6 328	4	97	77	100	0
150	MAPACHE (Best check Exp. V)	6 548	2	100	66	105	0
170	Rokel "S" CD-1895-12Y-2Y-2M-0Y	6 403	1	112	75	85	5MR
155	Scarcies "S" CM-10162-76M-0Y-2Y	6 268	2	109	81	95	0
171	Mexi"S"-Gta"S" CD-1896-1Y-3Y-2M-0Y	6 066	3	106	71	90	10MR
180	BEAGLE (Best check Exp. VI)	5 742	7	100	84	130	0
201	Widgeon "S" CD-7459-9Y-7M-0Y	6 520	1	105	82	80	0
183	Boyero"S" CD-4404-B-9Y-3M-0Y	6 331	2	102	70	95	0
192	Gs"S"-Tc60 x Mexi"S" CD-4807-A-5Y-3M-0Y	6 271	3	101	68	85	TR
210	MAPACHE (Best check Exp. VII)	6 188	4	100	71	105	TR
234	21563-AA"S" x Mexi"S" CD-7917-5M-1Y-1M-0Y	6 130	1	106	69	90	TR
216	Winged "S" CD-18577-11Y-7Y-1Y-3M-0Y	5 954	2	102	75	95	TR
233	Tubeno "S" CD-7849-3M-3Y-6M-0Y	6 855	3	100	70	90	20MR
240	BEAGLE (Best check Exp. VIII)	5 810	5	100	75	130	15MR
244	Kolenten "S" CD-10011-23M-3Y-4M-0Y	6 850	1	113	76	95	5MR
247	Tezontle "S" CD-10549-U-7M-2Y-1M-0Y	6 288	2	104	73	95	TR
265	Redhead "S" CM-13102-10M-1Y-0M	6 254	3	103	82	90	5MR
270	MAPACHE (Best check Exp. IX)	6 068	6	100	65	105	TR

TABLE 3. continued

Var. No.	Cross and pedigree	Yield Kg/Ha	Rank	%Best check	Days to flower	Height cm	L.R. reac.
281	Stifftail "S" CD-16677-A-7M-9Y-0M	6 612	1	109	76	95	0
291	Swan "S" CD-16707-H-3M-3Y-0M	6 515	2	108	75	95	TMS
286	Oviachic65-Cp x Fg"S"/Ruff"S"-Fg"S" CD-16696-F-3M-4Y-0M	6 464	3	107	72	95	TR
300	BEAGLE (Best check Exp. X)	6 045	11	100	76	130	TR
319	BD1543-Inrat69 x Coot"S"/Gta"S" CD-13557-J-3Y-3M-1Y-0M	6 281	1	100	70	100	TR
311	Gdo VZ471-Br"S" x Pg"S"/Rabi"S" CD-12498-6Y-1M-4Y-0M	6 192	3	99	73	90	TR
312	Gdo Vz471-Br"S" x Pg"S"/Rabi"S" CD-12498-6Y-6M-2Y-0M	6 112	4	97	77	90	10MR
330	MAPACHE (Best check Exp. XI)	6 276	2	100	66	95	20S
347	Ente"S"-Mario"S" CD-7498-14Y-6Y-1M-1Y-0M	6 272	1	107	69	90	30MS
354	Ente"S"-Mexi"S" CD-8153-12M-3Y-3M-1Y-0M	6 067	2	103	75	90	TR
346	(Ch67 x 21563-Cr"S"/Ward)Mexi"S"-Candeal II CD-14432-B-3Y-1M-1Y-0M	5 940	3	101	70	75	TR
360	BEAGLE (Best check Exp. XII)	5 880	4	100	75	125	5MS
373	Pg"S" x Ruff"S"-Fg"S" CD-8942-32M-1Y-5M-3Y-0M	5 844	3	97	75	90	0
370	Pg"S" x Ruff"S"-Fg"S" CD-8942-26M-1Y-3M-1Y-0M	5 714	4	95	75	90	TR
371	Pg"S" x Ruff"S"-Fg"S" CD-8942-32M-1Y-3M-1Y-0M	5 597	5	93	75	95	TR
390	MAPACHE(Best check Exp. XIII)	6 024	1	100	69	100	20S
393	Kolenten "S" CD-10011-14M-2Y-1M-2Y-0M	6 396	2	97	76	85	TR
401	Erpel"S"-Ruso CD-10437-31M-1Y-1M-1Y-0M	6 272	3	95	83	85	TS
404	Erpel"S"-Ruso CD-10437-47M-3Y-8M-1Y-0M	6 091	4	92	84	85	20MS
420	BEAGLE (Best check Exp. XIV)	6 575	1	100	76	130	TS
432	Memo"S" CD-10521-I-4M-3Y-1M-1Y-0M	6 503	2	98	76	75	TR
440	Eider "S" CD-10535-D-1M-1Y-1M-2Y-0M	6 378	3	97	84	85	TR
430	Memo"S" CD-10521-I-4M-1Y-1M-1Y-0M	6 162	4	93	81	85	10MR
450	MAPACHE (Best check Exp. XV)	6 605	1	100	67	105	TR
471	USA.0681-D6811 x Rabi"S"-Fg"S" CD-10742-E-3M-1Y-1M-2Y-0M	6 037	3	96	80	90	TR
455	Misri-Mexi"S" x Snipe"S" CD-10662-F-1M-1Y-2M-1Y-0M	6 017	4	96	82	80	TR
456	Misri-Mexi"S" x Snipe"S" CD-10662-F-1M-1Y-2M-3Y-0M	6 005	5	95	81	80	TS
480	BEAGLE (Best check Exp. XVI)	6 289	1	100	82	135	5MS
501	Guillemot "S" CM-14646-C-1Y-1M-1Y-0Y	6 977	1	110	82	95	TR
482	Skimmer "S" CD-1610-C-1Y-3Y	6 884	2	108	81	90	TS
484	Rokel "S" CD-1895-12Y-1Y	6 840	3	108	69	85	TS
510	MAPACHE (Best check Exp. XVII)	6 361	12	100	71	110	TR

L.R. reaction = Leaf rust reaction
MR = Moderately resistant
TS = Trace susceptible
R = Resistant
MS = Moderately susceptible
TR = Trace resistant
S = Susceptible

TABLE 4 . The better yielding durum lines and their agronomic data: Cd.Obregón, Sonora Mexico; 1977-1978.

Var No	Cross and pedigree	Yield Kg/ha	Rank	% of best check	Days to flower	Height (cm)
8	Chichicuilote "S" CD-1314-A-1Y-2Y	7039	1	111	74	90
13	Mallard "S" CD-1894-3Y-1Y-8M-1Y-0M	6768	3	107	75	90
21	Rokel "S" CD-1895-12Y-0Y-2E	6922	2	109	75	90
31	Tropic bird "S" CD-3568-8Y-1M-3Y-0M	6454	5	107	82	90
42	Bittern"S" CM-9799-126M-1M-3Y	6704	2	111	76	90
43	Bittern"S" CM-9799-126M-1M-4Y-0Y-0M	6888	1	114	75	90
45	Goose"S" CM-10143-6M-3Y-1M-2Y-0Y-2ptz	6702	3	111	82	95
47	Goose"S" CM-10143-19M-2Y-1M-1Y-0Y-1ptz	6508	4	108	80	100
51	Erp"S"-Ruso CD-10437-13M-3Y-0M	6413	6	106	82	85
69	Guillemot "S" CM-14646-C-1Y-1M-1Y	7200	1	107	82	95
155	Scarcies "S" CM-10162-76M-0Y-2Y	6268	2	109	81	95
170	Rokel "S" CD-1895-12Y-2Y-2M-0Y	6403	1	112	75	85
171	Mexi"S"-Gta"S" CD-1896-1Y-3Y-2M-0Y	6066	3	106	71	90
201	Widgeon "S" CD-7459-9Y-7M-0Y	6520	1	105	82	80
234	Jo"S" x AA"S"-Mexi"S" CD-7917-5M-1Y-1M-0Y	6130	1	106	69	90
244	Kolenten "S" CD-10011-23M-3Y-4M-0Y	6850	1	113	76	95
279	Stifftail "S" CD-16677-A-7M-5Y-0M	6442	4	107	73	100
281	Stifftail "S" CD-16677-A-7M-9Y-0M	6612	1	109	76	95
286	Ovi65-Cp x Fg"S"/Ruff"S"-Fg"S" CD-16696-F-3M-4Y-0M	6464	3	107	72	95
287	Ovi65-Cp x Fg"S"/Ruff"S"-Fg"S" CD-16696-F-3M-9Y-0M	6369	6	105	75	100
291	Swan "S" CD-16707-H-3M-3Y-0M	6515	2	108	75	95
295	Lds Mut-Gta"S" x Rabi"S"-31810/Kn"S" CD-16881-E-2M-2Y-0M	6414	5	106	73	80
347	Ente"S"-Mario"S" CD-7498-14Y-6Y-1M-1Y-0M	6272	1	107	69	90
482	Skimmer "S" CD-1610-C-1Y-3Y	6884	2	108	81	90
483	Mallard"S" CM-1894-3Y-0Y-1E	6709	6	105	74	85
484	Rokel "S" CD-1895-12Y-1Y	6840	3	108	69	85
485	Rokel "S" CD-1895-12Y-0Y-2E	6738	5	106	71	90
491	Bittern"S" CM-9799-126M-1M-5Y-0Y	6707	7	105	76	90
493	Goose"S" CM-10143-19M-2Y-1M-1Y-0Y	6779	4	107	80	90
501	Guillemot "S" CM-14646-C-1Y-1M-1Y-0Y	6977	1	110	82	95

TABLE 5. Five top yielding durum lines and varieties of the 5th, 6th, and 7th EDYT nurseries.

Variety and pedigree	Origin	Yield Kg/ha
5th EDYT, 1974-1975 (8 locations)		
Jupateco 73 (Bread wheat check)	Mexico	4208
Egret"S"	Mexico	4201
CM-14566-E-500Y-12M-0Y		
Gediz"S"	Mexico	4193
D-27534-1M-1Y-1M		
Cormorant"S"	Mexico	4180
CM-2999-28Y-7M-2Y-0M		
Goose"S"	Mexico	4073
CM-10143-24M-1Y-1M-0Y		
6th EDYT, 1975-1976 (4 locations)		
Cr"S"-Gs"S" x Pg"S"	Mexico	5815
CM-13434-5Y-1M-4Y-0Y		
Goose"S"	Mexico	5725
CM-10143-19M-2Y-1M-1Y-0Y		
Cocorit 71 (Check)	Mexico	5585
Yellowlegs"S"	Mexico	5576
CM-17142-8M-3Y-0Y		
Frigate"S"	Mexico	5575
CM-17904-D-3M-1Y-0Y		
7th EDYT, 1976-1977 (15 locations)		
Beagle (Triticale check)	Mexico	4111
Local check	-	3749
Bittern"S"	Mexico	3736
CM-9799-126M-1M-4Y-0Y		
Bittern"S"	Mexico	3732
CM-9799-126M-1M-5Y-0Y		
Mexicali 75 (check)	Mexico	3662

TABLE 6. Superior durum lines of the 8th IDYN, 1976-1977.

Variety or cross and pedigree	Origin	
Good Yield		Kg/Ha
Bittern "S" CM-9799-126M-1M-4Y-0Y	Mexico	3735
Oldsquan "S" CM-12969-2Y-1M-1Y-0Y	Mexico	3686
Goose "S" CM-10143-6M-3Y-1M-2Y	Mexico	3613
Good Hectolitre Weight		Kg/hl
Ruff"S"-Fg"S" CM-9880-25M-1Y-1M-1Y	Mexico	79
Anhinga"S" D.22234-52M-3Y-1M-0Y	Mexico	79
Bittern "S" CM-9799-126M-1M-4Y-0Y	Mexico	78
Early		Days to fl.
Mexicali 75 (Durum check)	Mexico	90
Mexicali"S" CM-470-1M-2Y-0M	Mexico	90
Jupateco 73 (Bread wheat check)	Mexico	90
Bacum (Triticale check)	Mexico	90
Resistant to Yellow Rust		Coeff.of inf.
Oldsquan "S" CM-12969-2Y-1M-1Y-0Y	Mexico	0
Gediz"S" D.27534-1M-1Y-1M-0Y	Turkey	0
Balcarceño INTA	Argentina	0
Bacum (Triticale check)	Mexico	0
Resistant to Leaf Rust		
Balcarceño INTA	Argentina	0
Gdo VZ512	Italy	0
Bacum (Triticale check)	Mexico	15
Ruff"S"-Fg"S" CM-9880-25M-1Y-1M-1Y	Mexico	16
Brant"S"=(Amal 72) D-24102-10Y -3M-100Y-0M	Tunisia	19
Resistant to Stem Rust		
Bacum (Triticale check)	Mexico	6
Gediz"S" D.27534-1M-1Y-1M-0Y	Turkey	13
Cocorit"S" D.27617-21M-300Y-0B	Mexico	11
Yemen-Cr"S" x Plc"S"/Rabi"S" CM-19361-4Y-0M	Mexico	15
Bittern "S" CM-9799-126M-1M-4Y-0Y	Mexico	16
Ruff"S"-Fg"S" CM-9880-25M-1Y-1M-1Y	Mexico	17
Anhinga"S" D-22234-52M-3Y-1M-0Y	Mexico	17
Resistant to Mildew		Coeff. of Inf.
Bacum (Triticale check)	Mexico	18
Cando	U.S.A.	28
Gdo VZ512	Italy	32

TABLE 6. continued

Variety or cross and pedigree	Origin	
Resistant to Septoria tritici		
Cando	U.S.A.	21
Ward	U.S.A.	21
Cocorit"S" D-27617-21M-300Y-0B	Mexico	26
Inrat 69	Tunisia	26
Resistant to BYDV		
Yellowlegs "S" CM-17142-8M-3Y-0Y	Mexico	18
Cando	U.S.A.	22
Macoun	Canada	22
Tolerant of Frost Damage		% Dam.
Cocorit "S" D-27617-21M-300Y-0B	Mexico	20
Gediz"S" D-27534-1M-1Y-1M-0Y	Turkey	26
Macoun	Canada	27
Resistant to Shattering		% Shat.
Yellowlegs "S" CM-17142-8M-3Y-0Y	Mexico	0
Ruff"S"-Fg"S" CM-9880-25M-1Y-1M-1Y	Mexico	0
Capeiti	Italy	0
Macoun	Canada	0
Resistant to Neck Breakage		% Bre.
Yellowlegs "S" CM-17142-8M-3Y-0Y	Mexico	0
Balcarceño INTA	Argentina	0
High 1000 KW		Gr.
Ruff"S"-Fg"S" CM-9880-25M-1Y-1M-1Y	Mexico	50
Mexicali 75 (check)	Mexico	49
Mexicali"S" CM-470-1M-2Y-0M	Mexico	49
Bittern "S" CM-9799-126M-1M-4Y-0Y	Mexico	48
Anhinga"S" D-22234-52M-3Y-1M-0Y	Mexico	48
Cocorit"S" D-27617-21M-300Y -0B	Mexico	48
Low Yellow Berry		% YB
Ruff"S"-Fg"S" CM-9880-25M-1Y-1M-1Y	Mexico	3
Yemen-Cr"S" x Plc/Rabi"S" CM-19361-4Y-0M	Mexico	12
Macoun	Canada	12

TABLE 7. Summary of preliminary results of 9th IDYN, 1977-1978.

Variety or cross and pedigree	Origin	Level of Character
High yielding lines, kg/ha in(33 observations)		
Bittern"S"	Mexico	4493
CM-9799-126M-1M-5Y-0Y		
Mallard"S"	Mexico	4366
CM-1894-3Y-0Y-0M		
Snipe"S"	Mexico	4314
CM-13414-1Y-3M-0Y		
Yellowlegs"S"	Mexico	4208
CM-17142-8M-3Y-1Y-0Y		
Rokel"S"	Mexico	4168
CD-1895-12Y-0Y-0M		
***Resistant to yellow rust on leaves (8 observations)**		
Rokel"S"	Mexico	4
CD-1895-12Y-0Y-0M		
Goose"S"	Mexico	4
CM-10143-6M-3Y-1M-2Y-0Y		
RAJ.911	India	2
Parana 66/253	Argentina	3
Resistant to yellow rust in heads (2 observations)		
Snipe"S"	Mexico	0
CM-13414-1Y-3M-0Y		
Yellowlegs"S"	Mexico	2
CM-17142-8M-3Y-1Y-0Y		
Local check		0
Parana 66/253	Argentina	0
Resistant to leaf rust (30 observations)		
Bittern"S"	Mexico	10
CM-9799-126M-1M-5Y-0Y		
Bacum (Triticale check)	Mexico	12
Jupateco (Bread wheat check)	Mexico	12
Gdo VZ 512	Italy	9
Badri	Algerie	9
Resistant to stem rust (13 observations)		
Bittern"S"	Mexico	11
CM-9799-126M-1M-5Y-0Y		
Bacum (Triticale check)	Mexico	3
Jupateco (Bread wheat check)	Mexico	10
Crosby	U.S.A.	8
Resistant to powdery mildew (6 observations)		
Bacum (Triticale-check	Mexico	6
Local check	Mexico	44
Crosby	U.S.A.	47

TABLE 7.continued

Variety or cross and pedigree	Origin	Level of Character
Resistant to Septoria tritici (9 observations)		
Snipe	Mexico	21
CM-13414-1Y-3M-0Y		
Balcarceño INTA	Argentina	22
Crosby	U.S.A.	21
Resistant to Barley Yellow Dwarf Virus (2 observations)		
Yellowlegs"S"	Mexico	19
CM-17142-8M-3Y-1Y-0Y		
Local check		13
Crosby	U.S.A.	19
Resistant to lodging (%,27 observations)		
Local check		17
13D.1814 x BD.1708-BD.1543	Tunisia	17
RAJ.911	India	9
Creso	Italy	13
Resistant to shattering (%, 3 observations)		
Snipe"S"	Mexico	7
CM-13414-1Y-3M-0Y		
Quilafen	Chile	0
Badri	Algerie	0
Crosby	U.S.A.	0
High test weight (kilograms, 33 observations)		
Bittern"S"	Mexico	81
CM-9799-126M-1M-5Y-0Y		
Jupateco 73 (Bread wheat check)	Mexico	81
Anhinga	Mexico	81
D-22234-52M-3Y-1M-0Y		
High 1000 kernel weight (gr., 47 observations)		
Bittern"S"	Mexico	50
CM-9799-126M-1M-5Y-0Y		
Mallard"S"	Mexico	52
CD-1894-3Y-0Y-0M		
Mexicali 75 check	Mexico	50
RAJ.911	India	54
Low percent of yellow berry (3 observations)		
Rockel"S"	Mexico	1
CD-1895-12Y-1Y-0M		
Gediz"S"	Turkey	0
D-27534-1M-1Y-1M-0Y		
JNK	India	1

* Resistance to diseases is indicated as coefficient of infection.

TABLE 8. Yield summary for eight EDYT nurseries planted at various locations throughout the world. Overall average yields each year and percentage difference in succeeding years.

TRIAL	YEAR	NO. OF OBS.	YIELD KG/HA	PER CENT DIFF.
1ST EDYT	1970 - 1971	9	3367	0.0
2ND EDYT	1971 - 1972	9	3425	+ 1.7
3RD EDYT	1972 - 1973	10	2959	- 13.6
4TH EDYT	1973 - 1974	12	3102	+ 4.8
5TH EDYT	1974 - 1975	8	3842	+ 23.8
6TH EDYT	1975 - 1976	4	5261	+ 36.9
7TH EDYT	1976 - 1977	15	3516	- 33.1
8TH EDYT	1977 - 1978	13	3759	+ 6.9

TABLE 9. Rust reactions of higher yielding durum lines. Cd. Obregón, Sonora, México. Y 1977-1978

Var. No.	Cross and pedigree	Leaf Rust				Yellow Rust		Stem Rust	
		Y77-78	B-78	M-78	R-78	B-78	M-78	R-78	Nav.78
8	Chichicuilote "S" CD-1314-A-1Y-2Y	0	0	TMS	20MS	5R	0	30MS-S	TMR
13	Mallard"S" CD-1894-3Y-1Y-8M-1Y-0M	0	0	0	TMR	TR	0	TMS	TMR
21	Rokel "S" CD-1895-12Y-0Y-2E	0	TMR	TMR	TMS	5R	0	10MR	TMS
31	Tropic bird "S" CD-3568-8Y-1M-3Y-0M	0	0	0	0	0	0	TR	TR
42	Bittern"S" CM-9799-126M-1M-3Y	0	0	0	0	TR	0	TR	0
43	Bittern"S" CM-9799-126M-1M-4Y-0Y-0M	0	TR	TR	TMR	TR	0	TMR	TMR
45	Goose"S" CM-10143-6M-3Y-1M-2Y-0Y-2ptz	0	TR	0	TMS	0	0	10S	5MS
47	Goose"S" CM-10143-19M-2Y-1M-1Y-0Y-1ptz	0	TR	TR	30MS-S	TR	0	10S	TMS
51	Erp"S"-Ruso CD-10437-13M-3Y-0M	0	TR	0	5MS-S	TR	0	10MS	0
69	Guillemot "S" CM-14646-C-1Y-1M-1Y	0	0	TR	10MS	5R	0	0	0
155	Scarcies "S" CM-10162-76M-0Y-2Y	0	TR	TMR	TMS	TR	TR	10MS	0
170	Rokel "S" CD-1895-12Y-2Y-2M-0Y	5MR	TR	TMR	10MR	TR	TR	0	TMS
171	Mexi"S"-Gta"S" CD-1896-1Y-3Y-2M-0Y	10MR	5MR	TR	5S	TR	TR	0	0
201	Widgeon "S" CD-7459-9Y-7M-0Y	0	TR	TMS	10MS-MR	10MR	TR	0	TMR
234	Jo"S"-AA"S"-Mexi"S" CD-7917-5M-1Y-1M-0Y	TR	0	TMR	TMS	TR	0	10MS-S	0
244	Kolenten "S" CD-10011-23M-3Y-4M-0Y	5MR	TR	TMR	20MS	TR	TR	10MS-S	40MR-MS
279	Stifftail "S" CD-16677-A-7M-5Y-0M	TR	TR	0	20MR-MS	TR	0	10MR	0
281	Stifftail "S" CD-16677-A-7M-9Y-0M	0	5MS	TR	30S	TR	0	TMR	0
286	Ovi65-Cp x Fg"S"/Ruff"S"-Fg"S" CD-16696-F-3M-4Y-0M	TR	0	0	20MS	0	0	0	0
287	Ovi65-Cp x Fg"S"/Ruff"S"-Fg"S" CD-16696-F-3M-9Y-0M	0	0	0	TS	TR	0	0	0
291	Swan "S" CD-16707-H-3M-3Y-0M	TMS	0	0	5S	TR	0	10S	0
295	Lds Mut-Gta"S" x Rabi"S"-31810/Kn"S" CD-16881-E-2M-2Y-0M	10MR	20MS	TMR	40MS	0	0	TMS	0
347	Ente"S"-Mario"S" CD-7498-14Y-6Y-1M-1Y-0M	30MS	5R	TMR	40MS-S	5R	0	30S	0
482	Skimmer "S" CD-1610-C-1Y-3Y	TS	5S	5MR	20MR-MS	10MR	TR	TS	5MS
483	Mallard"S" CM-1894-3Y-0Y-1E	TMR	TR	0	TMR	TR	TR	20S	0
484	Rokel "S" CD-1895-12Y-1Y	TS	5S	TMR	10MS	0	TR	0	5MR-MS
485	Rokel "S" CD-1895-12Y-0Y-2E	TMR	TR	TR	10MS	5R	TR	0	5MS-S
491	Bittern"S" CM-9799-126M-1M-5Y-0Y	TMR	TR	0	TMR	0	TR	10S	0
493	Goose"S" CM-10143-19M-2Y-1M-1Y-0Y	TR	10MS	TMR	40MS-S	TR	0	30MS-S	10MS-S
501	Guillemot "S" CM-14646-C-1Y-1M-1Y-0Y	TR	5S	5MS	10S	5R	0	TMS	TR
27	Cocorit C 71(Check)	0	5R	TMR	20MS-MR	TR	0	0	0
26	Mexicali 75 (Check)	0	10MS	10MS	50S	TR	TR	TMS	5S

Y = Yaqui Valley, Mexico
B = El Batan, Mexico
M = Toluca, Mexico
Nav. = Navidad, Mexico

R = Resistant
S = Susceptible
MR = Moderately resistant
MS = Moderately susceptible
T = Trace

TABLE 10. Reaction to various diseases of higher yielding durum lines.
Cd. Obregon, Sonora, Mexico 1977-1978.

Var. No.	Cross and pedigree	Head Scab B-78*	Head Scab M-78*	Head Scab Pz-78**	Sept.trit. Pz-78*	Fus.niv. M-78
8	Chichicuilote "S" CD-1314-A-1Y-2Y	1	1	60	6	4
13	Mallard"S" CD-1894-3Y-1Y-8M-1Y-0M	2	1	30	5	3
21	Rokel "S" CD-1895-12Y-0Y-2E	1	1	50	7	8
31	Tropic bird "S" CD-3568-8Y-1M-3Y-0M	1	2	5	5	3
42	Bittern"S" CM-9799-126M-1M-3Y	1	1	20	6	2
43	Bittern"S" CM-9799-126M-1M-4Y-0Y-0M	1	1	30	5	2
45	Goose"S" CM-10143-6M-3Y-1M-2Y-0Y-2ptz	1	0	10	4	4
47	Goose"S" CM-10143-19M-2Y-1M-1Y-0Y-1ptz	2	0	40	6	5
51	Erp"S"-Ruso CD-10437-13M-3Y-0M	1	2	30	4	7
69	Guillemot "S" CM-14646-C-1Y-1M-1Y	1	0	30	7	7
155	Scarcies "S" CM-10162-76M-0Y-2Y	1	1	10	5	7
170	Rokel "S" CD-1895-12Y-2Y-2M-0Y	2	1	40	7	7
171	Mexi"S"-Gta"S" CD-1896-1Y-3Y-2M-0Y	1	0	5	6	8
201	Widgeon "S" CD-7459-9Y-7M-0Y	1	0	30	7	9
234	Jo"S" x AA"S"-Mexi"S" CD-7917-5M-1Y-1M-0Y	2	0	20	6	3
244	Kolenten "S" CD-10011-23M-3Y-4M-0Y	2	0	20	5	8
279	Stifftail "S" CD-16677-A-7M-5Y-0M	1	0	30	7	3
281	Stifftail "S" CD-16677-A-7M-9Y-0M	0	0	10	6	8
286	Ovi65-Cp x Fg"S"/Ruff"S"-Fg"S" CD-16696-F-3M-4Y-0M	0	0	20	5	1
287	Ovi65-Cp x Fg"S"/Ruff"S"-Fg"S" CD-16696-F-3M-9Y-0M	0	1	20	6	1
291	Swan "S" CD-16707-H-3M-3Y-0M	1	0	T	4	1
295	Lds Mut-Gta"S" x Rabi"S"-31810/Kn"S" CD-16881-E-2M-2Y-0m	1	1	30	5	6
347	Ente"S"-Mario"S" CD-7498-14Y-6Y-1M-1Y-0M	1	0	20	3	3
482	Skimmer "S" CD-1610-C-1Y-3Y	1	0	20	8	-
483	Mallard"S" CD-1894-3Y-0Y-1E	1	0	5	9	3
484	Rokel "S" CD-1895-12Y-1Y	1	1	20	9	5
485	Rokel "S" CD-1895-12Y-0Y-2E	0	1	30	9	6
491	Bittern"S" CM-9799-126M-1M-5Y-0Y	0	0	40	9	6
493	Goose"S" CM-10143-19M-2Y-1M-1Y-0Y	0	0	30	6	6
501	Guillemot "S" CM-14646-C-1Y-1M-1Y-0Y	1	0	20	5	5
27	Cocorit 71 (check)	1	1	50	7	7
26	Mexicali 75 (check)	2	1	40	8	3

B = El Batan, Mexico
M = Toluca, Mexico
Pz= Patzcuaro, Michoacan, Mexico
*= Readings from 0 to9, zero being completely clean
**= Readings indicate% of damaged spikelets

TABLE 11. Quality data of higher yielding durum lines. Cd. Obregon, Sonora, Mexico 1977-1978.

VAR. NO.	CROSS AND PEDIGREE	PH	BP	YB	GRAIN TYPE	% PROT	Car. GRA.	Con. SEM.	ppm MAC.	GLT. STG.	FNL. EV.
08	Chichicuilote "S" CD-1314-A-1Y-2Y	83.5	10	5	2+	10.0	3.9	3.6	0.6	F	B
013	Mallard "S" CD-1894-3Y-1Y-8M-1Y-0M	81.0	5	10	2	10.2	7.5	7.5	4.4	F	MB
021	Rokel "S" CD-1895-12Y-0Y-2E	80.5	5	0	1+	9.7	7.2	6.9	2.4	F	MB
031	Tropic bird "S" CD-3568-8Y-1M-3Y-0M	83.0	20	0	1+	10.6	3.4	3.0	1.2	1/2 F	R
042	Bittern "S" CM-9799-126M-1M-3Y	80.0	5	0	1+	10.1	5.2	5.1	2.0	S	R
043	Bittern "S" CM-9799-126M-1M-4Y-0Y-0M	81.5	5	0	1+	9.7	5.1	5.1	1.8	F	B
045	Goose "S" CM-10143-6M-3Y-1M-2Y-0Y-2Pt Z	81.5	T	T	1	10.2	5.2	5.4	1.4	S	R
047	Goose "S" CM-10143-19M-2Y-1M-1Y-0Y-1Pt Z	81.5	T	0	1	10.0	5.2	5.1	1.6	S	R
051	Erp "S" - Ruso CD-10437-13M-3Y-0M	80.0	5	0	2-	12.1	5.6	5.7	1.8	1/2 F	B
069	Guille mot "S" CM-14646-C-1Y-1M-1Y	82.5	0	5	1+	10.1	7.5	8.0	2.6	F	B
0155	Scarcies "S" CM-10162-76-M-0Y-2Y	81.5	T	0	1+	11.2	8.1	8.3	2.6	F	B
0170	Rokel S"S CD-1895-12Y-3Y-2M-0Y	78.5	5	0	2-	10.3	8.7	8.7	2.0	1/2 F	R
0171	Mexi "S" - Gta "S" CD-1896-1Y-3 Y-2M-0Y	78.5	0	0	1+	10.5	7.5	7.2	2.7	1/2 F	R
0201	Widgeon "S" CD-7459-9Y-7M-0Y	80.0	T	0	1+	10.7	4.2	3.3	1.9	1/2 F	B
0243	Jo "S" x AA "S" - Mexi "S" CD-7917-5M-1Y-1M-0Y	78.0	T	0	2-	11.1	6.9	7.2	2.0	S	R
0244	Kolenten "S" CD-10011-23M-3Y-4M-0Y	81.5	T	T	1	11.2	5.2	4.2	2.6	1/2 F	B
0279	Stifftail "S" CD-16677-A-7M-5Y-0M	81.5	T	0	1+	11.4	6.3	6.3	2.0	S	R
0281	Stifftail "S" CD-16677-A-7M-9Y-0M	80.0	T	0	1+	11.6	6.0	5.2	1.4	S	R
0286	OVI 65 - Cp x Fg "S"/Ruff "S" - Fg "S" CD-16696-F-3M-4Y-0M	80.0	10	0	1+	11.4	5.2	4.3	2.6	1/2 F	B
0287	Ovi 65 - Cp x Fg "S"/Ruff "S" - Fg "S" CD-16696-F-3M-9Y-0M	81.0	10	0	2-	11.7	5.2	4.8	2.7	1/2 F	B
0291	Swan "S" CD-16707-H-3M-3Y-0M	81.5	5	0	2-	11.1	4.6	4.2	2.6	1/2 F	B
0295	Lds Mut - Gta "S" x Teal "S" - Kn "S" CD-16881-E-2M-2Y-0M	82.5	5	0	1+	11.3	4.8	4.2	1.7	1/2 F	R
0347	Ente "S" - Mario "S" Cd-7498-14Y-6Y-1M-1Y-0M	78.5	T	0	2	10.3	6.3	5.7	2.6	1/2 F	R
0482	Skimmer "S" CD-1610-C-1Y-3Y	78.5	T	0	2-	11.5	4.6	3.9	1.6	1/2 F	R
0483	Mallard "S" CM-1894-3Y-0Y-1E	82.5	5	5	1+	10.5	7.6	7.2	4.4	F	B
0484	Rokel "S" CD-1895-12Y-1Y	80.0	T	T	2-	10.1	8.7	8.4	2.7	1/2 F	R
0485	Rokel "S" CD-1895-12Y-0Y-2E	78.5	T	5	2-	10.6	7.8	7.2	2.3	1/2 F	R
0491	Bittern "S" CM-9799-126M-1M-5Y-0Y	85.0	5	T	1	10.5	5.8	5.1	1.9	1/2 F	R
0493	Goose "S" CM-10143-19M-2Y-1M-1Y-0Y	83.5	0	0	1	10.6	5.4	4.8	1.3	S	R
0501	Guillermot "S" CM-14646-C-1Y-1M-1Y-0Y	83.5	T	0	1+	10.9	7.8	7.8	2.6	1/2 F	R
020	Mexicali 75	80.4	20	T	2-	11.6	5.6	5.2	2.4	1/2 F	B
080	Balcarceño INTA	76.0	T	0	2+	12.9	6.3	6.3	5.9	1/2 F	B

PH = Hectolitric weight; BP = per-cent of black point; YB = Per-cent of Yellow berry; Grain Type 1-3, one the best,
Car. Con. ppm = Carotene content in grain, semolina and macaroni , parts per 1000 gr.
GLT & STG=Gluten strenght, S = soft, F = strong
Fnl. ev. = Final evaluation, B = good, MB = very good, R = fair

TABLE 12. Promising durum populations and lines segregating for better agronomic type, and the number of selections made in Cd. Obregon, Sonora. Mexico. 1977-1978.

Row No.	Cross and pedigree	Generation	Selections
03875	Teal"S" x Tag BB/Mal"S"-Dom"S" CD-25604-C	F2-Ind.	13
03654	Pg"S"-Mal"S" x Snipe"S"-Gediz"S" CD-25386-A	F2-Ind.	12
03855	Yel"S"-Bit"S" x Ful"S" - Boy"S" CD-25593-A	F2-Ind.	11
03657	Durum46xBd1548-N262.B/[(Jo"S"/Lk$_E$-Ld390xCh67)Gta"S"]Ful"S"-Boy"S" CD-25395-A	F2-Ind.	11
03403	Ibis"S"-Durum^6 x Glds"S"/Erp"S" CD-25160-A	F2-Ind.	11
03640	LdsMut-Ptl"S"xYel"S"/[(Qfn-Gll"S"xGta"S"/Ibis"S")Magh"S"-Gta"S"] CD-25368-C	F2-Ind.	10
03412	S.0179-PI174646 x Qfn/Boy"S" CD-25169-A	F2-Ind.	10
03303	Ruff"S"-Gta"S" x Ward/Shwa"S" CD-25037-A	F2-Ind.	10
03244	Fg"S"-Mal"S" x Memo"S" CD-24961-B	F2-Ind.	10
03044	Erp"S"-Mal"S"/B.Bal-Dut 13.1.1 x JNK CD-24737-A	F2-Ind.	10
04122	Scar"S"-Dack"S" CD-23268	F2-Bulk	21
04111	Gta"S"-S.0179 x Sapi"S" CD-23223	F2-Bulk	17
04018	Ato"S"-Sapi"S" CD-22801	F2-Bulk	15
04195	Sapi"S"-Goose"S" CD-23742	F2-Bulk	15
04072	Boy"S"-Sapi"S" CD-23021	F2-Bulk	14
04010	Jo"S"-AA"S" x Mexi"S" CD-22745	F2-Bulk	13
04017	Ato"S"-gr"S" CD-22800	F2-Bulk	13
04020	Sapi"S"(Inrat69-gr"S" x Bo"S"/Rabi"S") CD-22819	F2-Bulk	13
04098	Shwa"S"-Goose"S" CD-23178	F2-Bulk	12
04101	Shwa"S"-Bit"S" CD-23184	F2-Bulk	12
04121	Scar"S"-Dack"S" CD-23268	F2-Bulk	12
07412	[(Plc"S"-Cr"S"xRabi"S"/Rabi"S"-Kocobas 10 x Ch67)]Jo"S" CD-22195-A-1M	F3	10
05591	{[(Plc"S"-Cr"S"xMca"S"/D67.3-Cit)BD1814 x BD1788-BD1543]} Bit"S" CD-22009-3M	F3	8
06112	Lds Mut-Ptl"S" x JNK/Qfn CD-22194-D-4M	F3	8
05019	Cr"S"-Gs"S" x Pg"S"/D67.3-Gta"S" CD-20325-9M	F3	7
05121	Shwa"S"-Bit"S" CD-20626-5M	F3	7
05893	(Jo"S" x Gld115-Gll"S"/F8D7)Bit"S" CD-22123-D-9M	F3	7
06024	Gta"S"-HI x Gediz/Boy"S" CD-22141-D-14M	F3	7
06136	Tern"S"-Essaip x Mexi75 CD-22198-C-8M	F3	7
06208	Grebe"S"-Corm"S" x Shwa"S" CD-22237-C-2M	F3	7
06394	Jo"S"-Cr"S" x Teal"S"/TA-Dwarf Durum^2 CD-22293-A-3M	F3	7
07368	Jo"S"-Crist. de Chile x S15-Cr"S"/Tag.B.B. CD-22121-A-1M	F3	7
010333	Dom"S" x Cr"S"-Gs"S"/Sco"S" CD-19743-C-14Y-8M	F4	11
010552	Qfn-Gll"S" x Sapi"S"/Frig"S"-Corm"S" CD-19858-B-3Y-3M	F4	9
09427	(Cr"S"-Gs"S" x Parana/Cr"S"-Gs"S")Ibis"S"-Durum^6 CD-19522-G-3Y-1M	F4	8
07931	Gta"S"-Pg"S" x USDA.580 CD-18533-3Y-3M	F4	7
08231	Magh"S" x Jo"S"-Cr"S"/Snipe"S" CD-18856-4Y-2M	F4	7
08782	Ruff"S"-Mexi"S" x Snipe"S" CD-18150-5Y-2M	F4	7
09702	Gs"S"-Ibis"S" x Kif"S"/USDA.580 CD-19591-M-3Y-4M	F4	7
012447	Stifftail"S" CD-16677-C-10M-2Y-2M	F5	9
011746	(Plc"S"-Cr"S" x Mca"S"/D67.3-Cit71)Boy"S" CD-15685-5M-3Y-1M	F5	8
012232	Win"S"-Candeal II/Mexi75 CD-16557-B-1M-1Y-2M	F5	8
012335	Mexi"S"-Parana x S15-Cr"S"/Kif"S' CD-16621-E-19M-2Y-1M	F5	8
013530	Palest.20C-606 x Mexi"S"/Ruff"S"-Fg"S" CD-10445-1Y-2M-2Y-1M	F6	13
013523	Palest.20C-606 x Mexi"S"/Ruff"S"-Fg"S" CD-10445-1Y-1M-2Y-1M	F6	8

TABLE 13. Promising durum populations and lines segregating for better agronomic type, and the number of selections made in Toluca 1978.

Row No.	Cross and pedigree	Generation	Selections	Grain Type	Pig. ppm.	Days to flower	Height cm
05302	/BD111(Cit"S"-Mca"S"/Pg"S"xGll"S"-Lds56-1)/Egret"S" CD-27427-A	F2-Ind.	18	-	-	-	-
05289	ZB-Moh moudi M'Rari x Jo"S"-Cr"S"/Coot"S"-Marte"S" CD-27417-C	F2-Ind.	10	-	-	-	-
05001	Cit 71 x Chap-21563/Guil "S" CD-27234-A	F2-Ind.	9	-	-	-	-
05285	(ZB-Moh moudi M'Rari/Gta"S"-Rtte x Fg"S")Oyca"S" CD-27416-A	F2-Ind.	9	-	-	-	-
06282	Gr"S"-Lang x Mexi 75/D67-3-Rabi"S" x Cr"S" CD-28026-H	F2-Ind.	8	-	-	-	-
06195	BD2086-Egret"S" x Memo"S" CD-27978-A	F2-Ind.	7	-	-	-	-
06443	Sco"S" x Memo"S"/Gediz"S"-Mexi 75 CD-28161-C	F2-Ind.	7	-	-	-	-
06796	D67-3-Gta"S" x G.58128/Goose"S"-Cit 71 CD-28289-A	F2-Ind.	7	-	-	-	-
01306	JNK-Memo"S" CD-25720	F2-Bulk	39	-	-	-	-
01354	Scar"S"-Gdo.VZ579 x Mexi 75 CD-26073	F2-Bulk	39	-	-	-	-
01415	Ful"S"{Ptl"S"xS15-Cr"S"/(T.dur.Ram-Gll"S"xF3Tun/Cr"S")Gs"S")} CD-26593	F2-Bulk	32	-	-	-	-
01345	{/(Plc"S"-Cr"S"xMca"S"/D67-3-Cit71)Boy"S"/USDA 514}Coot"S" CD-26014	F2-Bulk	28	-	-	-	-
01447	/Gs"S"-Cr"S" x AA"S"/H.O.)Mexi"S"/ Memo"S" CD-27215	F2-Bulk	26	-	-	-	-
01399	Shwa"S"-Bit"S" CD-26406	F2-Bulk	25	-	-	-	-
01414	Ful"S"-JNK CD-26589	F2-Bulk	25	-	-	-	-
08267	{S-0179-PH158xGta"S"-S.0195/(Magh"S"xGs"S"-AA"S"/Rabi"S")21563/}Frig"S" CD-24827-A-2Y	F3	9	2^-	9.0	-	-
010451	Dack"S"-Bit"S" CD-23582-7Y	F3	9	1^+	6.9	-	-
08606	(Plc"S"-Cr"S" x Rabi"S"/Cfn5-Fg"S" x Ptl"S")Ward CD-25012-A-4Y	F3	8	2^-	5.1	-	-
08973	(21563-Gr"S" x Mario"S"/Ggo VZ394-Cit"S")Memo"S" CD-25251-A-1Y	F3	8	2	6.2	-	-
010099	Erp"S"-Mal"S" CD-23069-3Y	F3	8	2	5.5	-	-
08312	Shwa"S"-Mexi 75 x Bit"S" CD-24831-E-5Y	F3	7	2^-	8.1	-	-
08589	/(Pg"S" x Ch67-21563/Guil"S")Qfn/Memo"S" CD-24999-B-4Y	F3	7	2^+	6.9	-	-
08596	Tllo"S" -Bitt"S" x Pg"S" CD-25007-B-2Y	F3	7	2^+	5.6	-	-
08667	Erpel"S"-Gs"S" x Boy"S" CD-25043-A-1Y	F3	7	2	6.2	-	-
08968	Qfn- AA"S"x Gta"S"-Pg"S"/Boy"S" CD-25241-C-1Y	F3	7	2^+	7.2	-	-
010103	Erp"S"-Mal"S" CD-23069-6Y	F3	7	2	5.4	-	-
010138	Duro 5-Ibis"S" x Bit"S" CD-23142-2Y	F3	7	2	6.0	-	-
010277	Gta"S"-Ibis"S" x 1110-KR533/Mexi 75 CD-23238-2Y	F3	7	2^+	6.6	-	-
011669	(D x T) D-Mexi 75 CD-20795-5M-2Y	F4	8	2^-	5.6	-	-
011636	Shwa"S"-Bit"S" CD-20626-8M-3Y	F4	7	2	6.9	-	-
011645	Shwa"S"-Gre"S" CD-20628-7M-1Y	F4	7	2^-	4.6	-	-
011634	Shwa"S"-Bit"S" CD-20626-8M-1Y	F4	6	1^+	5.7	-	-
011653	Shwa"S"-Dack"S" CD-20640-2M-2Y	F4	6	2	5.6	-	-
012186	(Jo"S" x Gld115-Gll"S"/F8 D7)Bit"S" CD-22123-E-2M-2Y	F4	6	2	4.6	-	-
013909	Rugby x Lds Mut-Gta"S" CD-17631-2Y-5M-1Y	F5	4	2	-	89	80
014021	D67.2-Gta"S" x Qfn CD-17815-7Y-1M-3Y	F5	4	2	-	90	85
014104	Goose"S"-Cit 71 CD-17932-1Y-2M-2Y	F5	4	2^-	-	90	80
016383	Ruso x D67.2-Gta"S"/Ruff"S"-Fg"S" CD-16366-B-1M-3Y-2M-3Y	F6	6	-	-	80	90
016792	Win"S"-USA 02237/(21563/Lk_E-Ld390 x Ch67)Gta"S"/ CD-16559-C-7M-2Y-3M-2Y	F6	5	-	-	85	80
016339	Ruso x D67.2-Gta"S"/Ruff"S"-Fg"S" CD-16366-A-1M-1Y-2M-1Y	F6	4	-	-	81	75
016367	Ruso x D67.2-Gta"S"/Ruff"S"-Fg"S" CD-16366-A-6M-2Y-1M-3Y	F6	4	-	-	82	90
016419	Ruso x D67.2-Gta"S"/Ruff"S"-Fg"S" CD-16366-B-4M-4Y-2M-1Y	F6	4	-	-	78	105
016766	Win"S"-Candeal II x Mexi 75 CD-16557-B-1M-1Y-2M-6Y	F6	4	-	-	90	85

TABLE 13. continued

Row No.	Cross and pedigree	Generation	Selections	Grain type	Pig. ppm.	Days to flower	Height cm
016795	Win"S"-USA02237/(21563/Lk$_E$-LD390 x Ch67)Gta"S"/ CD-16559-C-7M-2Y-4M-1Y	F6	4	-	-	80	80
016947	Bit"S"-Adler"S" x Mexi"S"/Sapi"S" CD-16677-A-7M-3Y-3M-3Y	F6	4	-	-	85	80
018286	Fg"S"-Palastinien.20C-606 x Mexi"S"/Ruff"S"-Fg"S" CD-10445-1Y-2M-3Y-2M-3Y	F7	2	2$^-$	-	82	80
018290	Fg"S"-Palastinien.20C-606 x Mexi"S"/Ruff"S"-Fg"S" CD-10445-1Y-2M-4Y-1M-1Y	F7	2	2$^-$	-	80	75

TABLE14 . Preliminary results of fertility studies on durum wheat materials. Season B-1977 and Y 1977-1978.

VARIETY OR CROSS AND PEDIGREE	GRAINS PER SPIKELET	SPIKELETS PER SPIKE	1000 KW GR	YIELD KG/HA
SEASON BATAN 1977				
*Rokel "S" CD-1895-12Y-0Y	3.10 (9)**	16.9 (14)	45.5 (5)	4274 (12)
Bitterns "S" CM-9799-126M-1M-5Y-0Y	3.10 (8)	17.7 (7)	42.1 (11)	3785 (20)
Mexi "S" - Gta "S" CD-1896-1Y-3Y	3.11 (7)	17.0 (13)	45.4 (6)	4618 (7)
*Bittern "S" CM-9799-126M-1M-4Y-0Y	3.14 (6)	17.0 (12)	44.4 (9)	4248 (13)
*Guillermot "S" CM-14646-C-1Y-1M-1Y-0Y	3.26 (5)	17.1 (10)	40.0 (15)	3681 (21)
Fg "S" - Palest. 20C - 606 x Mexi "S"/Rabi "S" CD-10438-4M-1Y-0M	3.30 (4)	16.4 (19)	41.4 (14)	4748 (6)
Shoveler "S" CD-10569-C-10M-1Y-1M	3.35 (3)	17.3 (8)	38.9 (17)	4587 (8)
*Memo "S" CD-10521-I-3M-1Y-0M	3.49 (2)	16.6 (18)	34.8 (20)	3848 (19)
*Shearwater "S" HRL-862-2B-1Y-1B	3.50 (1)	18.0 (3)	33.0 (22)	2254 (25)
Mexicali 75 (Check)	3.00 (12)	14.7 (24)	46.5 (4)	5629 (2)
Jupateco 73 (bread wheat-check)	2.93 (16)	21.0 (2)	28.7 (25)	3645 (22)
Average	3.20	17.2	40.1	4120
SEASON CD. OBREGON, 1977-1978				
Mallard "S" CD-1894-3Y-1Y-5Y-2Y-0M	2.73 (9)	16.8 (2)	63.0 (4)	8536 (2)
Goose "S" CM-10143-6M-3Y-1M-2Y-0Y	2.79 (8)	18.4 (10)	55.0 (18)	7561 (18)
Mallard "S" CD-1894-3Y-0Y-1E	2.83 (7)	16.8 (20)	59.0 (11)	8197 (6)
*Bittern "S" CM-9799-126M-1M-4Y-0Y	2.83 (6)	18.2 (7)	53.0 (20)	8196 (7)
*Rokel "S" CD-1895-12Y-0Y	2.83 (5)	18.6 (8)	59.0 (8)	8197 (5)
Rokel "S" CD-1895-2Y-0Y-2E	2.92 (4)	19.3 (2)	59.0 (10)	8270 (4)
*Guillermot "S" CM-14646-C-1Y-1M-1Y-0Y	2.99 (3)	18.0 (14)	51.0 (21)	8467 (3)
*Memo "S" CD-10521-I-3M-1Y-0M	3.14 (2)	17.8 (16)	47.0 (16)	7061 (24)
*Shearwater "S" HRL-862-2B-1Y-1B	3.73 (1)	18.2 (11)	46.0 (23)	7749 (15)
Mexicali 75 (Check)	2.51 (21)	16.3 (24)	66.0 (2)	7249 (22)
Jupateco 73 (Bread wheat check)	2.72 (10	19.1 (4)	41.0 (25)	6613 (25)
Average	2.91	17.9	54.5	7827

KW = Kernel weight
* = Good fertility at the two seasons
** = Numbers in parenthesis are rankings

B = El Batan, Mexico
Y = Yaqui Valley, Mexico

Triticale

INTRODUCTION

The main objectives of the Triticale Program at CIMMYT are the improvement of yield and adaptation, seed type and test weight, disease resistance and the introduction of new genetic variability.

YIELD AND ADAPTATION

The triticale yields in the 1977-78 crop cycle in Sonora, Mexico were adversely affected by above normal average temperatures in combination with irrigation problems which are described in the Bread Wheat chapter in this annual report publication.

In the yield trials, about 750 advanced triticale lines were evaluated for their yield potential. The best lines were selected and included in the 10th International Triticale Screening Nursery which consisted of 245 entries, including checks. This nursery was distributed to 121 cooperators throughout the world.

Tables 1 and 2 list 33 of the highest yielding lines in comparison with the check cultivars, Beagle and Mapache respectively. The yields given in table 1 are lower than those given in table 2 because of a three weeks' difference in planting date. The earlier planted material (table 1) was affected more by the higher temperatures and consequently yielded less.

Both tables 1 and 2 show that there are better yielding lines than the two checks and some lines with a better yield and better test weight. Table 1 list the lines Drira–Fas 204, Drira–MA, IA–Kla x Cal/Bgl, and Bgl "S"–M2A x Bgl that outyielded Beagle by 11, 14, 14, and 20 per cent respectively. Furthermore, the two lines Drira–MA and IA–Kla x Cal/Bgl had test weights of 72.5 and 72.7 kg/hl, whereas Beagle normally has a test weight of about 68 kg/hl. Table 2 indicates that the newer lines show little yield improvement over Mapache, but there are some lines with equivalent yield and higher test weight than Mapache, such as IRA–No 66, RM x Bgl "S"–M2A, IA–M2A x Pi62/Bgl "S", and M2A–IRA. Some of the lines showing good yield and improved test weight are being multiplied on a small scale.

Figure 1 compares the yield of the best bread wheats with the best triticales. This graph shows the yield average of the best bread wheat from each of 45 experiments versus the yield average of the best triticale from each of 30 experiments. It is evident that presently the two crops have about the same yield potential under Yaqui Valley conditions.

The yields in the Mexican high plateau from El Batan, Mexico and Huamantla, Tlaxcala during the 1978 summer cycle were good. Table 3 shows some of the better than average yielders from the two locations in comparison with the three check cultivars, Beagle, Mapache, and Bacum. It can be seen that some of the newer advanced lines are better than the checks for both yield and test weight.

International triticale yield and screening nurseries have been distributed since 1969-70. These two nurseries serve to distribute the new triticale lines and also allow for identification of lines with wide adaptation. Tables 4 and 5 give the best adapted lines from a preliminary analysis of the 9th International Triticale Yield Nursery and from the 9th International Triticale Screening Nursery, respectively. These tables show that Mapache and Beagle are still the widest adapted lines, though newer lines like M1–Arm and FS 1897 are approaching their adaptation.

The general adaptation of the best triticale strains is also evident from other international nurseries. In the preliminary summary of the 14th International Spring Wheat Yield Trial, in which the triticale line Mapache was included as a check, this triticale line had the best average yield over 71 locations.

Preliminary reports from ICARDA also indicate that the adaptation of triticales is good. The triticale Drira, which was included in the 9th Regional Wheat Yield Trial, had the second best average yield over 19 locations. In the 6th Rainfed Wheat Yield Trial, a triticale selection from a cross, Inia–Armadillo, had the best average yield over 18 locations.

During 1978, several triticale cultivars selected from CIMMYT breeding nursery material were released for commercial production. These releases were selected from early generation material sent out by the CIMMYT Triticale Program. The lines and country of release are as follows:

Line of Population	Name	Country of Release
T–903 (F5–Bulk from CIMMYT)	Siskiyou	California, U.S.A.
Inia–Rye x Armadillo	Welsh	Manitoba, Canada
Early generation bulk from CIMMYT	Mexitol 1	Bulgaria
	NIABT 22	Pakistan
	NIABT 158–4	Pakistan
UM Tcl x Armadillo	Begale	U.S.A.

SEED TYPE AND TEST WEIGHT

One of the major problems in the improvement of triticale has been to improve the test weight of the grain. Triticales have a tendency to produce shrivelled grain at maturity, thereby lowering the test weight and giving a low flour extraction during milling. Normally, triticales produce fairly good test weights under optimal growing conditions, but the test weights tend to drop markedly under poor growing conditions.

This is the reason why the test weights obtained in the 1977-78 cycle are lower than the test weights obtained in the previous cycle. The test weights were also affected by the adverse temperatures which occurred in the 1977-78 cycle. Improvements in test weight and stability of test weight have been difficult to obtain, and progress has been slow.

In 1971 a selection from a cross Inia x Armadillo was found to have a better than average test weight. This selection, named Camel and selections from crosses with Camel, have since been used extensively in the triticale breeding program and marked improvements have been achieved in test weight and plumpness of triticale grains.

In the 1976-77 Yaqui season, 45 triticale advanced lines with better than average test weight were identified. These lines with five checks were formed into a Good Seed Type nursery and sent out internationally to 26 locations, to find out if the improvement in test weight was location specific or would be stable over many different environments.

Reports have been received from eight locations and the results of the best lines are given in table 6. The better lines (in table 6) show a marked improvement over the checks in both average test weight and in stability.

Among the best selections for improved test weight were lines from the cross M2A–Camel, X8386–D, now named Panda "S", a derivative from Camel which was the first line with improved test weight. Two of these lines were included in the Good Seed Type nursery and as seen in table 6, they had the best average test weight.

The Panda "S" lines have produced some of the highest test weights found in triticale; however, agronomically it is undersirable. The lines are low yielding, tall, weak strawed and tend to shatter. Therefore, in 1977 an attempt was initiated to combine the high test weight and good seed type of the Panda selection with the high yield potential of the best triticales.

In the summer of 1977, 10 F_2 populations derived from crosses between Panda "R" and the triticales Setter, Octo Bulk Bush, M2A^2, Bacum "S", Lince, Octo Oc–Agrot, Rahum, Arabian, Mapache, and Yoreme were grown for this purpose. From these 10 populations a total of 6632 selections were forwarded to the F_3 generation in Yaqui 1977-78. In Yaqui, about 1200 of the most uniform F_3 populations were cut in bulk and the 250 bulks with the highest test weight were sent out for international testing. These same populations were tested in Toluca, El Batan, and Huamantla during the summer of 1978.

Table 7 lists the best selections from each of the crosses with the test weights given from four locations in Mexico and the yield data from two locations. It can be seen that the test weight of these selections are better or equal to the test weight of the Panda "R" parent and that the yields are equal or better than the "yield" parent under the high plateau conditions. However, the results from the current cycle in Yaqui are needed to confirm that the objective of combining good seed type and high yield has been achieved.

DISEASE RESISTANCE

The resistance of triticale strains to the three rusts continues to be good, as based on the reactions recorded in the international nurseries. It is apparent from international data that the resistance to leaf rust is less stable than the resistance to stem and stripe rusts, though many lines are resistant to all three rusts under Mexican conditions, as shown in table 8. Efforts are being made to maintain the superior resistance to stem and stripe rust and to improve the resistance to leaf rust.

Table 8 lists 70 lines from the 10th International Triticale Nursery with resistance to leaf rust in three locations in Mexico. All of these lines are also resistant to stem rust and all but four, are resistant to stripe rust. Included in table 8 are the reactions of the 70 lines to scab and *Septoria* at Patzcuaro, Mexico. It shows that there are variations in reaction to scab, and that many of the lines are resistant or moderately resistant to *Septoria*.

International data also show that triticales continue to display considerable resistance to several important crop diseases. Resistance to loose and covered smut still holds across most of the wheat growing regions of the world. Also the resistance of triticale to powdery mildew is holding in areas where mildew is endemic.

Dr. Eyal from Bet Dagan, Israel reported *S. tritici* reactions in the 5th Triticale Disease Resistance Nursery (TDRN) and the following lines showed excellent resistance (0 reaction compared to 80 to 90 per cent for susceptible wheat and durum checks).

1 BVR–Arm"S" x 2763–3M–2N–0Y–6M–0N
12 M2A x 2802–38N–5M–5N–2M–3Y–5M–1Y–0M
18 Arabian "S"

19 M2A^2 x 5290–3N–1M–1Y–0M
20 M2A–1517 x Inia–Guarda
34 Koala
35 Koala "S" x 2091–1M–0N
44 ITA–M2A x Bush x 7340–3M–1Y–0M
48 ITA–Cin x 7585–3M–1Y–100M–0Y

Entries 18, 19, 20 were included in the 5th TDRN as resistant to *S. tritici* in Patzcuaro, Mexico. These lines will be tested in other locations where *S. tritici* is endemic to determine if the resistance holds. These data show that there are a range of reactions to *S. tritici* among triticales and it should be possible to incorporate the resistance into high yielding triticales.

In the subtropical or hotter regions where cereals are grown, the leaf blotching caused by *Helminthosporium spp.,* mostly *H. sativum* but also *H. tritici repentis,* can be very severe. This is especially a problem in certain parts of East Africa, but triticale lines with resistance or moderate resistance have been identified in Zambia as follows:

Navojoa "S"
Rahum "S"
Beagle
RAM "S"
Impala "S"
M2A x 2802–38N–3M–5N–3M–0Y–2M–0Y
M2A–IRA x 10906–16M–1Y–1Y–1M–0Y
M2A–Cin x 12545–102Y–101B–101Y–0Y
M2A–Bgl x 15490–3Y–0M
M2A–Leo x 1273–28Y–1Y–1M–0Y

These lines are presently being tested for *Helminthosporium* reactions at Poza Rica, Mexico.

Ergot (*Claviceps purpurea*) was a severe problem in the early triticales because of their sterility. Today the triticales are mostly fertile and although infection by ergot has decreased it can still be a problem because of the low tolerance to ergot bodies. Therefore, the 9th International Triticale Screening Nursery was tested in Minnesota for reaction to ergot. The infection was measured as the number of ergot bodies in 50 triticale spikes and the 319 entries reacted as follows:

No. Ergot Bodies	Lines
0	55
1	46
2	32
3	26
4	24
4–10	69
10–20	49
>20	17

It is evident that there was a low ergot infection in many lines.

The major virus disease on triticale is Barley Yellow Dwarf Virus (BYDV) which is transmitted by several aphid species. Serious infestations of BYDV have been reported in Chile and the Andean Region of South America but little work has been done yet to screen for resistance. A report from Davis, California, however, indicates that there are good sources of resistance among triticales, at least to the strains of BYDV found in California. The following lines from the 5th Triticale Disease Resistance Nursery were resistant:

Entry No.	Line	Score (1–9 scale)
1	BVR–Arm"S" x 2763–3M–2N –1M–0Y–6M–0N	2
12	M2A– x 2802–38N–5M–5N –2M–3Y–5M–1Y–0M	2
24	M1A x 2148–4N–2M–2Y–1M–0Y	3
31	IRA x 2146–7N–7M–4N–5M–2Y –1M–1Y–0M	2
32	IRA x 2146–7N–8M–5N–2M–0Y	2
33	Tcl short from S.T.	3
34	Koala	1
35	Koala"S" x 2091–1M–0N	3
36	FS 1897	3
38	FS 3972	2
40	M2A–1517 x Inia–Guarda	1
43	Setter	2
44	ITA–M2A x Bush x 7340–3M –1Y–0M	2
45	Beagle	1
46	Inia–Rye x Arm/310/32	3

Whether these lines would also be resistant in other endemic areas for BYDV has yet to be shown. However, it has been observed in Chile and the Andean region that Beagle and its derivatives are apparently less damaged by the disease. This correlates closely with the reaction of Beagle as observed in California.

INTRODUCTION OF GENETIC VARIABILITY

There are three main ways that new germ plasm is introduced into the Triticale Program, viz., (1) creation of new amphiploids (2) triticales from other programs—mainly winter triticales and (3) crosses between triticale x wheat and triticale x rye.

Since 1972-73 serious attempts have been made to increase the number of new triticale amphiploids. Until last cycle, increases in new amphiploids have largely been due to increased number of crosses but real progress has now been achieved in producing new or primary octoploids. Table 9 gives the number of crosses between rye x durum wheat and rye x bread wheat, the number of plants surviving and the number of plants doubled. The percentage of plants doubled has stayed about the same for rye x durum wheat crosses while the percentage of plants doubled from rye x bread wheat crosses increased from 14–36 per cent.

This increase has been achieved by adapting a technique of cutting the tip off the coleoptile 1–2 days after germination; the cut end is then submerged in a 0.05 per cent colchicine solution for 3 hours. After about two weeks, the young seedlings are then transplanted to the field where tillering is greatly increased in comparison with greenhouse tillering. By increasing tillering, the probability of obtaining a double tiller is increased. This technique is now being tried with the rye x durum wheat crosses.

New genetic variability is also added through introductions from other triticale programs. These introductions are mainly from winter triticale programs and they are utilized in the CIMMYT triticale programs through spring x winter crosses.

Crosses between triticale x wheat and triticale x rye have been important in generating new variability in the triticale program. Fertility in the triticales were first found in a cross between triticale x wheat and later the first improved seed type triticale was identified in a wheat x triticale cross (Inia x Armadillo). Also sources of dwarfing have been introduced into triticale from both wheat and rye through crosses of this type. More crosses of this type are being attempted in the search for other sources of fertility and good seed type.

CYTOLOGY

Cytological information is important in the improvement of triticale in order to understand how the improvements are achieved and to make further improvements. Thus it has been hoped to back up seed selection with cytological information in segregating and advanced populations to determine if it could be obtained with the full complement of rye chromosomes or sub—stitutions or gene recombination. Fortunately during the summer, cytological services again became available. Table 10 lists the number of D genome substitutions in 44 advanced triticale lines.

PROTEIN QUALITY

For the past few years a rapid screening technique, the dyebinding capacity (DBC), has been utilized to test advanced lines for better protein quality. During this cycle about 500 lines were screened and the lines shown in table 11 were selected as having possibly a better protein quality index in Yaqui 1977-78. After checking the quality index from Huamantla, 11 of these lines have been selected for detailed protein analysis.

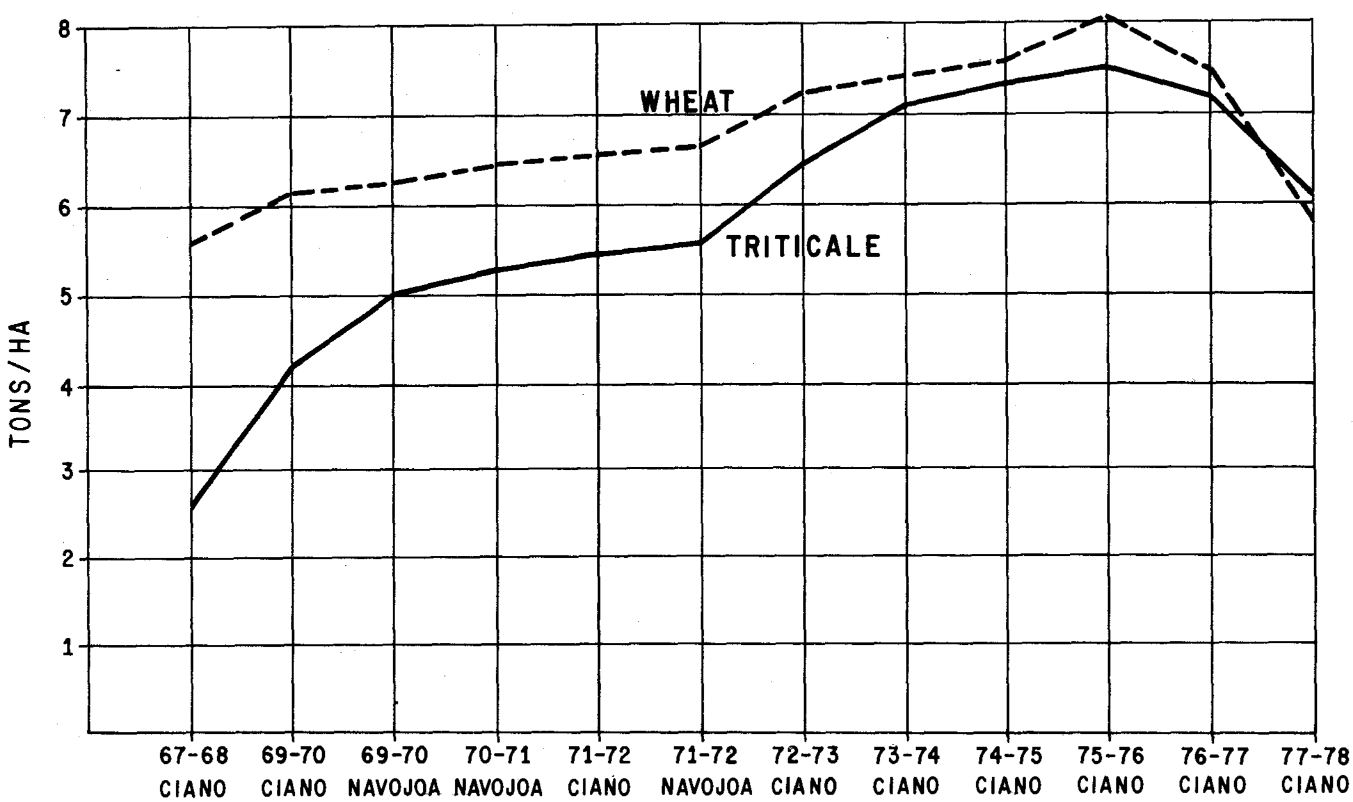


Fig 1. YIELDS OF THE BEST WHEAT AND TRITICALE STRAINS IN THE YAQUI VALLEY, MEXICO 1967-78

Table 1. Yield performance of certain advanced lines from late October planting compared with the check cultivar in the same experiment in Yaqui 1977-78.

Advanced line	Pedigree	Yield kg/ha	Test Weight kg/hl	Check	Yield kg/ha
Drira-Fas 204	X21297	4230	72.2	Beagle	4192
Drira-Fas 204	21298	4615	65.5	Beagle	4500
Drira-Fas 204	X21296	4038	69.5	Beagle	4500
Drira-Fas 204	X21299	4365	67.6	Beagle	3942
M2A-UP301 x Bgl	X16378	4384	69.6	Beagle	4192
M2A-Bgl	X15490	3769	71.5	Beagle	4500
Bgl"S"-Cin"R"	X15674	4000	66.5	Beagle	3942
Bgl-M2A	X15673	4346	66.8	Beagle	4250
Bgl-M2A	X15670	3942	67.2	Beagle	3853
Drira-MA	X15893	4865	72.5	Beagle	4250
Cin-Bgl x Bgl		4057	69.6	Beagle	4250
IA-Kla x Cal/Bgl	B-199	4377	72.7	Beagle	3853
Bgl"S"-M2A x Bgl	B-218	4638	67.0	Beagle	3853
Cin-Cno x Bgl	X16337	4084	67.3	Beagle	3853

Table 2. Yield performance and test weight of certain advanced lines from mid-November planting compared with the best check cultivar in same experiment in Yaqui 1977-78.

Cross	Pedigree	Yield kg/ha	Test Wt. kg/hl	Check variety	Yield kg/ha	Test Wt. kg/hl
M2A-IA	X12677-41Y-1Y-3M-1Y-0M	6485	70.0	Mapache	6313	69.6
M2A-IRA	X11960-6M-1Y-1Y-0M	5817	73.1	Mapache	6463	71.3
M2A-Cml	X10995-27M-2Y-1Y-1M-1Y-2M-0Y	6082	70.0	Mapache	6076	69.0
$M2A^2$-Bgl	X15733-1Y-2B-1N-0M	6122	70.8	Mapache	5753	71.8
$M2A^2$-Bgl	X15733-0M	5823	65.0	Mapache	5753	71.8
Beaguelita	X22551-100Y-4Y-0M	5869	68.7	Mapache	5753	71.8
Beaguelita	X22551-100Y-100Y-9M-0Y	6599	63.7	Mapache	6338	69.0
Bgl"S"-M2A x Cin	X15673-A-1Y-2Y-8M-0Y	6675	69.8	Mapache	6388	69.0
Bgl"S"-M2A x Cin	X1573-A-1Y-2Y-1M-0Y	6438	68.2	Mapache	6338	69.0
Bgl"S"-ITA x M2A	X22585-100Y-1Y-1M-0Y	6376	66.6	Mapache	6338	69.0
Bgl/Ars-Mexipak Mut x Bgl"S"	X22562-101 Y-3Y-2M-0Y	6761	69.4	Mapache	6543	69.0
IA-M2A x Pi62/ Bgl"S"	X16304-107Y-100Y-7M-0Y	6542	71.4	Mapache	6543	69.0
M1A-Bgl"S"	X15552-33M-2Y-2Y-1M-0Y	6540	67.2	Mapache	6104	67.4
RMxBgl"S"-M2A	X22097-100Y-1Y-0M	6182	71.2	Mapache	6104	67.4
IRA-No 66	X14447-B-1Y-4Y-2M-1Y-0M	6185	72.4	Mapache	5988	69.6
IA-Spy	X17117-25Y-3Y-4B-0Y	5651	67.8	Mapache	5655	69.4
Tcl Bulk50-MA	X15684-3Y-2Y-0M	5995	67.3	Mapache	5692	66.6
IA-IRA x Bui	X12257-1N-0M	5942	62.8	Mapache	5692	66.6
Drira-Fas 204	X21298-2M-0M	5986	71.4	Mapache	6231	69.4

Table 3. Average yield performance and test weight of certain advanced lines from the 10th International Triticale Screening Nursery planted in 2 row 2 meter non replicated plots in El Batan and Huamantla. Summer 1978.

Cross	Pedigree	Average yield kg/ha	Average Test Weight kg/hl
M2A	X2802-38N-3M-5N-3M-2Y-0M	6500	63.9
IRA-Cml	X8326-C-1Y-1M-100Y-105B-100Y-1Y-0M	7334	65.0
$M2A^2$	X8504-C-2Y-2M-100Y-103B-107Y-0Y-101M-0Y	7146	67.2
IA-M2A	X11052-C-2M-1Y-1Y-2M-0Y	6709	65.3
IRA^2-$M2A^2$	X11308-B-2M-3Y-2Y-4M-0Y	7625	68.7
$M2A^2$xKla-Bvr	X11433-B-1M-3Y-3Y-6M-2Y-1M-0Y	7667	67.4
Bgl"S"/Ars-Mexi-pak	Mut x Bgl"S" X22562-100Y-100Y-12M-0Y	6542	64.1
Bgl"S"/Ars-Mexi-pak	Mut x Bgl"S" X22562-101Y-3Y-1M-0Y	7560	66.1
M2A-Bgl	X15490-3Y-0M	7084	64.0
M1A-Bgl	X1552-33H-2Y-2Y-1M-0Y	6834	61.5
Tcl Bulk 50-MA	X15684-3Y-2Y-0M	7230	62.4
M2A-Arm"S"xBgl"S"	X15733-1Y-2M-1Y-0M	6729	63.1
M2A-Arm"S"xBgl"S"	X15733-15Y-3M-2Y-1M-0Y	7417	65.3
Drira-MA	X15893-0M	6748	62.9
Buey-Bgl"S"	X16215-103B-101Y-1Y-1M-0Y	8746	65.1
Buey-Bgl"S"	X16215-103B-101Y-1Y-2M-0Y	7976	65.5
Gazelle-Yo"R"	X23963-100Y-0M	7560	66.4
Beagle	(Testigo)	6014	61.7
Mapache "S"	(Testigo)	6824	63.3
Bacum	(Testigo)	5340	64.8

Table 4. The 10 highest yielding entries in the 9th International Triticale Yield Nursery (ITYN) averaged over 41 locations

Rank	Entry No.	Variety or Cross	Average Yield kg/ha
1	25	Local Check	3767
2	6	Mapache	3764
3	21	Beagle	3661
4	13	Maya I-Arm	3648
5	11	F.S. 1897	3621
6	7	Rahum	3606
7	5	Nacozari 76 (Bread Wheat Check)	3495
8	9	Lince	3454
9	4	Bacum	3432
10	12	Octo Bulk-Bush	3381

Table 5. High yielding entries of 9th ITSN appearing frequently in the top 10 percent at 34 locations

Entry No.	Cultivar or Cross	Pedigree	Frequency in top 10%
10	Beagle	X1530A-12M-5N-1M-0Y	18
102	M2A-UP301 x Bgl"S"	X16378-2Y-0B-1Y-0M	17
81	M2A - Bgl	X15490-2Y-4B-1N-0M	14
83	(M2A-Arm"S"-Bgl)	X15733-1N-0M	14
249	Bgl - Cin	X15674-0N	14
50	Nacozari		14
145	IA-IRA x Bui	X12257-2N-0M	12
180	Bgl"S" 552	X1530A-12M-5N-1M-100Y-0M	12
195	Drira - Sorgo	X16020-2Y-1B-2N-0M	12
270	M2A - Bgl	X15491-0N	11
144	IA-IRA x Buitre	X12257-1N-0M	11
172	M2A - Bgl	X15491-1Y-3B-3N-0M	11
47	M2A - IRA	X12581-18Y-1Y06M-0Y	10
189	Bgl x Tob-Arm"S"	X21542-7N-0M	10
240	M2A-UP301 x Bgl	X16378-0N	10
256	Cml-Pato Sel 28		10

Locations: Los Baños (Philippines), Janakpur (Nepal), Karnatka (India), Alajuela (Costa Rica), El Serw (Egypt), Nuevo León (México), Aleppo (Syria), Aragua (Venezuela), Colima (México), Jovedepur (Bangladesh), Jubeihá (Jordan), CIANO (México), Izmir (Turkey), Tessaloniki (Greece), Punjab (India), Indore (India), Delhi (India), Marino (Colombia), Denkow (Poland), Hohenheim (W. Germany), Guelozow (GDR), Beja (Tunisia), California (U.S.A.), Georgia (U.S.A.), Huamantla (México), Cambridgeshire (England), Deir Alla (Jordan), Ancash (Peru), Cajamarca (Peru), Bet Dagan (Israel), U. de Man. (Canada), Chonam (S. Korea), Toluca (México), El Batán (México).

Table 6. Lines with an average test weight greater than 66.0 kg/hl based on observations from Laski and Dankow, Poland, Hohenheim, West Germany; Winnipeg, Canada; Davis, California, U.S.A.; Sonora and Toluca, Mexico; and Stellenbosch, S. Africa.

Cross and Pedigree	Mean	Laski	Dankow	Hohen-heim	Winnipeg	Davis	Toluca	Sonora	Stellen-bosch
Panda"S" X8386-D-2Y-0M-100Y-103B-106Y-0Y	71.6	69.6	69.2	67.0	72.0	74.8	-	75.8	68.5
Panda"S" X8386-D-2Y-0M-100Y-103B-108Y-0Y	70.2	69.8	70.2	67.3	72.0	75.4	60.8	77.0	69.0
M2A-IGA x IA X11286-C-4M-4Y-0Y	69.8	69.8	68.2	63.5	69.0	73.1	-	73.4	71.5
Octo-Hexa x IGA X11239-B-1M-100Y-0M	68.6	68.6	65.2	63.5	70.0	73.9	64.2	74.6	68.5
IRA^2 - $M2A^2$ X11308-B-2M-3Y-2Y-4M-0Y	68.2	65.4	63.0	64.0	69.0	70.8	-	74.6	70.5
Cml-Pato Sel 454	67.7	69.0	61.4	61.8	67.0	74.8	63.7	74.4	70.0
M2A-Kla"S" X12701-9Y-4Y-1M-0Y	67.1	67.8	66.0	64.1	69.0	71.0	56.5	72.6	69.5
IA^2 X8436-H-1Y-4M-1Y-0Y	66.7	65.2	67.4	58.1	69.0	72.9	59.8	74.4	-
IRA^2 X8346-B-1Y-1M-1Y-0Y	67.1	63.8	63.2	57.8	71.0	73.0	60.9	75.2	72.0
Pj62-Polko x Arm"S"	66.4	67.0	64.6	62.7	69.0	71.6	58.6	70.6	67.0
IRA^2 X8392-C-3Y-2M-1Y-0Y	66.6	65.0	65.0	65.0	69.0	70.0	55.4	73.4	70.0
Beagle (Check)	62.0	63.8	60.4	61.4	63.0	65.3	50.9	66.4	65.0
Bacum (Check)	65.2	62.2	61.8	63.0	69.0	70.4	54.6	71.8	68.5
Arabian (Check)	65.0	65.2	63.6	61.8	65.0	70.4	57.9	69.6	66.0
Rahum (Check)	62.4	58.6	61.0	57.7	62.0	69.8	50.2	70.0	66.5
Mapache (Check)	61.4	60.2	59.8	58.1	60.0	70.7	46.6	70.0	66.0

Table 7. Advanced lines from crosses made to combine improved test weight and high yield showing their test weight from Yaqui, El Batan, Toluca and Huamantla and their yield in El Batan and Huamantla in comparison to the parents.

Cross and Pedigree	Test Weight kg/hl				Average Test Weight	Yield kg/ha	
	Yaqui	El Batan	Toluca	Huamantla		El Batan	Huamantla
Setter (Parent)	64.7	62.8	54.4	69.6	62.9	4812	2166
Panda"R" (Parent) X8386-D-2Y-0M-100Y-102B-100Y-1Y-0M	74.8	68.2	66.2	72.4	70.4	5125	3832
Setter-Panda"R" X34530-230H-0Y	75.6	68.2	65.2	72.8	70.5	5521	3915
Setter-Panda"R" X34530-304H-0Y	74.4	69.4	66.0	73.6	70.9	5583	4831
Setter-Panda"R" X34530-441H-0Y	74.6	66.6	67.6	72.4	70.3	5396	4290
Octo-Bulk Bush (Parent)	64.7	65.8	61.8	69.2	65.4	5479	3332
Octo-Bulk Bush x Panda"S" X35781-168H-0Y	75.8	69.2	59.0	72.8	69.2	6187	3041
Octo-Bulk Bush x Panda"S" X35781-175H-0Y	75.4	68.2	58.4	70.8	68.2	6646	3249
Octo-Bulk Bush x Panda"S" X35781-501H-0Y	75.0	67.8	66.8	71.6	70.3	5479	3582
$M2A^2$ (Parent) X8504-C-2Y-2M-100M-104B-102Y-0M	60.7	61.2	59.6	68.0	62.4	3312	1916
$M2A^2$-Panda"R" X35783-379H-0M	75.0	67.0	67.6	71.6	70.3	4312	3374
$M2A^2$-Panda"R" X35783-541H-0M	73.2	66.8	67.8	74.0	70.5	4521	4582
Bacum (Parent)	72.5	65.2	54.2	70.0	65.5	5708	3790
Panda"R"-Bacum X35784-73H-0Y	75.0	68.6	64.8	74.0	70.6	3917	3832
Panda"R"-Bacum X35784-90H-0Y	73.8	68.6	67.2	74.4	71.0	3957	2874
Panda"R"-Bacum X35784-552H-0Y	75.4	67.8	60.8	72.0	69.0	5625	3499
Lince (Parent)	61.9	57.4	51.2	62.8	58.3	4167	3915
Panda"R"-Lince X35786-439H-0Y	74.0	68.0	64.8	73.2	70.0	4479	3749
Panda"R"-Lince X35786-481H-0Y	74.2	70.4	64.6	73.6	70.7	4667	4332
Panda"R"-Lince X35786-631H-0Y	73.6	70.2	65.2	73.2	70.6	4229	4165
Rahum (Parent)	65.9	63.0	53.4	69.6	63.0	6541	3415
Panda"R"-Rahum X36517-43H-0Y	75.4	69.2	64.4	72.8	70.5	5083	3041
Panda"R"-Rahum X36517-248H-0Y	74.8	68.6	65.6	71.2	70.0	5896	2582
Panda"R"-Rahum X36517-1085H-0Y	74.8	67.4	62.4	73.2	69.5	5229	5831
Arabian (Parent)	63.9	62.4	59.6	66.4	63.1	2750	2832
Panda"R"-Arabian X36518-193H-0Y	74.6	70.4	65.6	72.8	70.9	3833	3249
Panda"R"-Arabian X36518-225H-0Y	74.6	65.8	63.6	72.8	69.2	4375	4582
Panda"R"-Arabian X36518-494H-0Y	74.0	66.2	65.2	72.0	69.4	3500	4415
Mapache"R" (Parent)	63.1	63.8	54.0	67.2	62.0	5417	4248
Panda "R"-Mapache"R" X36520-142H-0Y	73.2	69.4	63.0	72.4	69.5	5708	4415
Panda "R"-Mapache"R" X36520-505H-0Y	74.2	70.4	64.0	72.4	70.3	4458	3624
Yoreme Tc75 (Parent)	70.2	64.2	61.8	66.4	65.7	5125	2832
Panda"R"-Yoreme X36521-55H-0Y	75.4	67.4	67.8	72.0	70.7	4687	3415
Panda"R"-Yoreme X36521-162H-0Y	73.1	66.4	64.8	72.0	69.1	4792	2874

Table 8. Advanced triticale lines with high level of resistance to leaf rust, at three locations in Mexico and their reaction to stem and stripe rust, to scab and to Septoria leaf spot.

Row No.	Lines with Immune Reaction	P. graminis Refugio	P. graminis Saltillo	P. graminis Toluca	P. striiformis Toluca	P. recondita Refugio	P. recondita Saltillo	P. recondita Toluca	Fusarium (Scab) Patzcuaro	Septoria Patzcuaro	Origin 10th ITSN
1	M2A X2802-38N-3M-5N-3M-2Y-0M	0	0	0	0	0	0	0	0	3	18
2	M2A-BGC X12764-19Y-1Y-1M-1Y-0M	0	0	0	0	0	0	0	0	3	69
3	M2A-FS 722 X12845-12Y-16Y-1Y-0M	0	0	0	0	0	0	0	0	4	72
4	IRA-No66 X14447-B-1Y-2Y-2M-1Y-0M	0	0	0	0	0	0	0	20	5	94
5	IRA-No 66 X14447-B-1Y-4Y-2M-1Y-0M	0	0	0	0	0	0	0	5	6	95
6	IRA-M2A x IA-M2A X14517-C-1Y-1Y-2Y-0M	0	0	0	0	0	0	0	5	4	99
7	IRA - M1A X15560-3H-5Y-1Y-0M	0	0	0	0	0	0	0	0	5	123
8	IRA-Bgl"S" X15570-100Y-5Y-3M-0Y	0	0	0	0	0	0	0	0	4	124
9	Hexa-from Octo-Hexa x M2A X15685-B-6Y-2M-2Y-0M	0	0	0	0	0	0	0	0	4	136
10	Sheperd"R" X15754-A-1Y-2M-1Y-1M-0Y	0	0	0	0	0	0	0	10	4	149
11	Topo X15893-0M	0	0	0	0	0	0	0	10	4	153
12	M2A-ZA75 X17034-2M-0M	0	0	0	0	0	0	0	5	3	169
13	IA-Spy X17117-25Y-3Y-4B-0Y	0	0	0	0	0	0	0	5	2	174
14	Cml x Cno-Gallo X17077-2M-0Y	0	0	0	0	0	0	0	0	5	179
15	Kiss - Rm"S" X20991-100Y-1M-1Y-5M-0Y	0	0	0	0	0	0	0	T	4	182
16	Bgl"S"/Ars-Mexipak Mut x Bgl"S" X22562-101Y-3Y-3M-0Y	0	0	0	0	0	0	0	5	3	193
17	IRA-Bgl"S" x M2A^2-Cin X22591-100Y-100Y-4M-0Y	0	0	0	0	0	0	0	10	6	195
18	/M2A(Bvr-Tobi"S"xArs/Cin)/Abn X26097-D-100Y-101Y-11M-0Y	0	0	0	0	0	0	0	0	3	201
19	Bgl Corto 108Y-1M-0Y	0	0	0	0	0	0	0	0	5	211
20	IA-M2A X15946-4Y-4M-1Y-0M	0	0	0	0	0	0	0	0	3	217
21	IRA-No 66 X14447-B-3Y-2Y-1Y-1M-0Y	0	0	0	TR-MR	0	0	0	0	4	96
22	Bgl"S" X1530-A-12M-3Y-3M-1Y-0M-3M-0Y	0	0	0	TR-MR	0	0	0	10	4	208
23	M2A-ZA75 X17034-5Y-2Y-0M	0	0	0	TMR	0	0	0	0	3	170
24	Bgl"S" x Tob-Arm"S" X21542-5N-0M	0	0	0	TMR	0	0	0	T	5	185
25	Bgl"S"/Ars-Mexipak Mut x Bgl"S" X22563-101Y-100Y-7M-0Y	0	0	0	10MR	0	0	0	5	5	63
26	Drira-Kang X16648-1Y-1B-1Y-1N-2M-0Y	0	0	0	10S-MS	0	0	0	20	5	168
27	M1A-Bgl"S" X15552-33H-2Y-2Y-1M-0Y	0	0	0	20S	0	0	0	5	4	121
	LINES WITH TR REACTION FOR P. R.										
28	M2A-FS722 X12845-12Y-7Y-2M-1Y-0M	0	0	0	0	0	TR	0	10	4	71
29	Bison X2148-5M-2M-3Y-2M-0Y	0	0	0	0	TR	0	0	T	5	16
30	IA-M2A X11052-C-2M-1Y-1Y-2M-0Y	0	0	0	0	TR	0	0	0	6	43
31	IRA-Cml"S" X13019-A-1Y-1Y-4M-1Y-0M	0	0	0	0	0	TR	0	0	7	76
32	M2A^2 x Cin-Kla X14495-F-3Y-1Y-1Y-0M	0	0	0	0	0	TR	0	0	5	98
33	Tcl E3-Arm"S" x MA X15909-5Y-4Y-2M-0Y	0	0	0	0	TR	0	0	5	4	154
34	M2A-Spy x M2a X16379-5Y-3Y-1M-0Y	0	0	0	0	0	TR	0	10	4	166
35	Cheetah"S" X22473-102Y-100Y-1M-0Y	0	0	0	0	0	TR	0	0	2	187
36	M2A - Spy OM	0	0	-	-	TR	0	-	20	5	236
37	Rahum	0	0	-	-	0	TR	-	5	6	240
38	Panda"R" X8386-D-2Y-0M-100Y-101B	0	0	-	-	0	TR	-	-	-	242
39	Panther"R" X13895-B-100Y-101B-105Y-0Y	0	0	0	0	0	TR	0	5	3	85
40	Panther"R" X13895-B-100Y-101B-100Y-1M-2Y-0M	0	0	0	TR	0	TR	0	5	6	83
41	M2A-BGC X12764-19Y-3Y-2M-2Y-0M	0	0	0	0	0	T-5R	0	T	7	70
42	Beagle	0	0	0	TMS	TR	TR	0	0	3	150
43	Rahum"R" 1Y-0M	0	0	0	10MS-MR	0	TR	0	T	7	14

Table 8. Continued...

44	M2A x UM940"S"-Arm"S"/AZ67 X14928-6Y-1Y-0Y	0	0	0	10S-MS	TR	TR	0	5	6	112
	LINES WITH TR, MR AND TMS REACTION										
45	IRA-M2A x M1A X15559-33Y-1Y-1M-0Y	0	0	0	TR-MR	0	0	TR-MR	T	3	122
46	Ocelot"R" X12677-56Y-1Y-3M-0Y	0	0	0	0	0	0	10R-MR	0	5	67
47	Lince	0	0	0	0	0	0	TMR	T	3	9
48	Tcl Bulk 50-MA X15684-6Y-1M-1Y-0M	0	0	0	0	0	TMR	0	T	4	135
49	M2A^2-IRA x CML/CML"S" X14134-C-5Y-1Y-1Y-0M	0	0	0	0	0	TMR	0	10	5	86
50	Bura X8417-E-1Y-7M-2Y-0Y	0	0	0	0	TMS	TR	TR-MR	10	6	31
51	M2A^2-Cin X7272-42M-1Y-0M	0	0	0	0	0	TMS	TR	0	4	22
52	Drira-Fas 204 X21298-2N-0M	0	0	0	0	TR	TMS	0	T	2	183
53	Lynx"S" X15733-1Y-9M-2Y-2M-0Y	0	0	0	0	TMS	TR	0	0	4	140
54	Gazelle"S"-Yo"R" X23963-100Y-0M	0	0	0	0	0	TR	5MR-MS	20	4	199
55	Cml"S"-Kal X14861-1Y-3M-1Y-2M-100Y-1M-0Y	0	0	0	0	0	TR-MS	0	0	6	109
56	Beagle	0	0	0	0	TMS	0	TR-MR	T	2	10
57	Lynx"S" X15733-0M	0	0	0	TMR	TMS	TMR	0	5	4	137
58	Bison"S" X2148-5N-2M-2Y-2M-0Y-102M-0Y	0	0	0	0	TMS	0	0	T	3	15
59	Ram X12257-1N-0M	0	0	0	0	TMS	0	0	10	5	56
60	Bgl"S"/Ars-Mexipak Mut. x Bgl"S" X22562-100Y-100Y-12M-0Y	0	0	0	0	TMS	0	0	T	2	61
61	M2A-FS 722 X12845-12Y-16Y-3Y-0M	0	0	0	0	TMS	TMS	0	0	7	73
62	IGA-M2A x IA/M2A X14527-D-1Y-3Y-2M-0Y	0	0	0	0	TMS	0	0	T	6	101
63	Shepherd"S" X15754-A-2Y-1M-1Y-1M-0Y	0	0	0	0	TMS	0	0	T	5	151
64	Bgl-IRA X21538-0M	0	0	0	0	TMS	0	0	T	4	184
65	Bgl-IGA X23892-C-101Y-19M-0Y	0	0	-	-	TMS	0	-	T	6	233
66	Panda"S" X8386-D-2Y-0M-100Y-102B-102Y-100Y-3M-0Y	0	0	-	-	0	TMS	-	-	-	241
67	IA-MA X15867-6Y-6M-1Y-0M	0	0	0	TMR	TMS	0	10MS-MR	0	4	152
68	Mapache"S"	0	0	0	30S-MS	TMS	0	10MR-R	5	4	210
	LINES WITH TS REACTION										
69	Cheetah"S" X22473-102Y-100Y-12M-0Y	0	0	0	0	TS	TR	0	0	2	188
70	Gazelle"S"-Yo"R" X23963-100Y-4M-0Y	0	0	0	0	TS	0	0	20	6	198

Table 9. Creation of primary hexa (6x) and octoploid (8x) triticale

Crop cycle	Mexico 1977		Yaqui 1977-78		Mexico 1978	
	6x	8x	6x	8x	6x	8x
Crosses attempted	312	212	208	151	362	350
Embryos extracted	3522	-	1639	-	5721	-
Plant survival	332	663	98	280	652	434
Plants doubled	63	91	23	100		
Crosses doubled	30	44	17	42		
Percentage plants doubled	19	14	23	36		

Table 10. The number of D-genome substitutions in each of 44 triticale lines.

Name and Pedigree	Number of Substitutions
Mapache	1
Rahum	1
Bison	2
Bura X8417-E-1Y-7M-5Y-0Y	2
Delfin "S" X15490-3M-0Y	1
Lynx X15733-15Y-3M-2Y-1M-0Y	1
Panther"S" X13897-B-100Y-103B-103Y-1M-100Y-1M-0Y	1
Serval"S" X16201-100B-101Y-1Y-0M	0
Gopher"S" X16155-100Y-2M-2Y-0M	1
Terrier"S" X8208-G-1Y-2M-3Y-0M	1
Beaguelita X22427-101Y-2M-2Y-0M	0
IRA^2 X8346-B-1Y-1M-1Y-0M	2
Panda"R" X8386-D-2Y-0M-100Y-102B-100Y-1Y-0M	2
Ocelot"S" X12677-56Y-1Y-3M-0Y	2
Fawn"S" X22652-101Y-101Y-0M	2
Impala"S" X11066-E-9M-2Y-0Y	2
Bonito"S" X14920-8Y-1Y-0Y	2

Table 10. Continued.

Yak"S" X11308-B-2M-3Y-2Y-4M-0Y	2
Ram"S" X12257-2N-0M	0
Beagle	0
Beagle"S" X1530-A-12M-3Y-3M-1Y-0M-1Y-0Y	0
Drira	0
Kiss Wint Hung	0
Siskiyou	0
Tcl Wint 1975	0
6TA-487	1
Armadillo"S"	1
Camel-Pato Sel	1
Camel-Pato x 7C	1
Gaviota-Spy	0
Gta "S"-21563 x AA"S"/Spy	1
Rabi"S" - Rye 9	1
Rabi"S" - 31810 x Spy	0
Geier "S"-GS"S" x Fg"S"-Cr"S"/Spy	0
/Emerald	0
Cit"S"-AA"S" x Fg"S"/Spy	0
/Emerald	0
Ato"S" - Plover x Spy	0
D6811 - Garza x Weoszanowslie	0
Gdo V2471-Br"S" x Pg"S"/Merced R-3	0
Kingfisher"S" x Uloszanowskie	0
Ruff-Els 630403-By x Rabi"S"/Spy	0
Gta"S"-Rollelex x Fg"S"/Prolific	0

Table 11. Advanced triticale lines selected for Protein Quality

Y78-79 Var. No.	Cross and Pedigree	YAQUI 1977-78 Protein per cent	YAQUI 1977-78 Q.I.	YAQUI 1977-78 PC # MV 78	HUAMANTLA 1978 Test Weight kg/hl	HUAMANTLA 1978 Protein per cent	HUAMANTLA 1978 Q.I.
1112	FS477-M2A X31338-12Y-3M-0Y	12.2	4.0	17	68.0	14.7	3.9
1208	Drira x Kiss-Arm"S" X21295-0M-2Y-1M-0Y	11.2	3.8	69	71.2	11.9	3.8
1302	FS 3927	14.2	4.1	120	71.2	14.0	4.1
1501	M2A-Spy x M2A X16379-40Y-1Y-2M-7Y-3B-0Y	13.5	4.1	223	61.6	14.3	4.0
1601	FS477-Grajo"S" X32684-3Y-2B-0Y	13.7	4.2	265	63.6	14.8	4.4
1610	(RM/Car 12 x Kal-Bb)Nv"S" X25558-A-1Y-3B-2Y-1B-0Y	13.0	4.5	280	64.8	15.7	4.5
1626	IRA x Bb-Cha/Bgl"S" X25703-P-1Y-1B-3Y-3B-0Y	13.3	4.2	299	67.2	12.4	3.8
1627	IRA x Bb-Cha/Bgl"S" X25703-P-1Y-1B-3Y-4B-0Y	13.7	3.9	300	64.0	13.4	4.0
1628	IRA x Bb-Cha/Bgl"S" X25703-P-1Y-1B-5Y-3B-0Y	14.9	4.3	301	69.2	11.5	3.6
1723	M2A-Coquena X14786-2Y-1Y-3Y-1B-2Y-2B-0Y	13.9	4.2	326	71.2	15.2	4.3
1724	M2A-Coquena X14786-2Y-1Y-3Y-1B-2Y-4B-0Y	13.6	4.3	327	72.8	14.9	4.3
1826	FS 4093 - Sorgo X15987-A-1Y-1Y-1M-1Y-100B-0Y	14.0	4.2	385	71.2	-	-
1903	M2A x Hexa From Octo-Hexa X12805-17Y-1Y-3M-1Y-2M-102Y-101M-0Y	12.9	4.2	391	67.2	14.3	4.1
1713	IRA-Cal X14600-2Y-1Y-1Y-2B-1Y-2B-0Y	16.4	4.8	317	59.2	17.4	4.8
1714	IRA-Cal X14600-2Y-1Y-1Y-2B-1Y-3B-0Y	16.6	4.5	318	59.2	17.5	4.9
1715	IRA-Cal X14600-2Y-1Y-1Y-2B-1Y-5B-0Y	16.0	4.5	319	63.2	16.0	4.6
1716	IRA-Cal X14600-2Y-1Y-1Y-2B-3Y-1B-0Y	15.8	4.7	320	63.6	17.3	5.0
1717	IRA-Cal X14600-2Y-1Y-1Y-2B-3Y-2B-0Y	15.7	4.6	321	59.2	17.2	4.8
1718	IRA-Cal X14600-2Y-1Y-1Y-2B-3Y-3B-0Y	16.0	4.5	322	61.6	17.4	4.8

Q.I. = Quality Index of protein as related to lysine content.

PC # = Number of pure seed small multiplication plot

MV 78 = Toluca Summer, Mexico, 1978

Barley

In 1978, the CIMMYT Barley Breeding Program generated new germ plasm and distributed it to cooperators around the world. There was a demand for better adapted and higher yielding genotypes from different national programs. Seed requests were increased considerably. Much attention was given to breeding for wider adaptation, disease and lodging resistance, yield, nutritional quality, earliness and hull-less types.

The amount of breeding material incorporated into the program has increased during the last two cycles. New entries from regional and national programs have enriched the germ plasm base. In many instances, valuable information has been provided about features and the general performance of these materials under certain conditions in other barley growing areas.

Regional programs such as ICARDA in Syria and the CIMMYT-Andean Program in Ecuador have substantially contributed. Selections made from nurseries sent by these centers are now a component of progenitors in use here.

WIDE ADAPTATION

The experience accumulated over many years in the CIMMYT Wheat Breeding Program has shown that the best way to determine the range of adaptation of a particular line, is to perform multilocation tests. This method has also been adopted by the CIMMYT Barley Program. The extent to which this adaptation can be expanded in the case of barley might not reach the level of that in wheat, but there is no doubt that it can be improved.

By alternating two generations a year at two locations which differ in latitude and environmental conditions, diseases and crop management, it has been possible to select for light insensitive materials which have been proven to have more adaptation.

Superior agronomic types have been selected under the conditions of the Yaqui Valley at Cd. Obregon, Sonora, México, where the crop is grown under irrigation and is relatively free of diseases.

The screening of material against certain diseases has also been made in central Mexico. The lines selected at both locations have been evaluated in yield trials at Cd. Obregon, where the crop can express its maximum yield potential.

Some of the lines which have been selected and tested under these conditions are listed in tables 1A, 1B and 1C.

Every one of the lines tested was multiplied simultaneously in small multiplication plots. The International Barley Observation Nursery (IBON) was assembled from the seed obtained from these plots. This nursery contained 354 entries and was sent to more than 70 places around the world.

On an international basis, the testing of selected material from the preliminary yield trials was made through the Elite Barley Yield Trials (EBYT) which contained 24 lines from the CIMMYT Barley Program and one local check.

In order to make fair comparisons, the lines were divided into covered types and hull-less types. Some of the outstanding lines from the 3rd EBYT (naked) and 1st EBYT (normal) are listed in tables 2A and 2B respectively.

Since the program is involved in the breeding of different types of barleys, viz: naked versus covered types, early versus normal types and combinations among these, the number of nurseries was becoming too big. Therefore, it was decided to reduce these to only one—The International Barley Yield Trial (IBYT). The nursery contained 20 lines and varieties from different programs around the world, four lines from the CIMMYT Barley Program and one local check. Cooperators will continue having access to the rest of the advanced material through the International Barley Observation Nursery (IBON). The IBON contains lines which might not be outstanding under the conditions of selection in Mexico, but they could well have a value under other environmental conditions.

LODGING RESISTANCE

The search has continued for genotypes which carry good lodging resistance under both irrigated and dryland conditions.

New genotypes with good straw and well developed root systems which anchor themselves strongly to the ground have been developed.

A list of some advanced lines with good resistance to lodging is given in table 3. Some of these lines, especially the ones in which the cross involves the lines 11012.2 as parent, can stand high dosages of fertilizer; however these lines are too dwarf to be grown under dryland conditions.

DISEASE RESISTANCE

During the last two cycles much emphasis has been placed on trying to breed genotypes with a higher degree of disease resistance.

Due to a poor data return in our screening nurseries, it was necesary to rely to a large extent on data obtained by CIMMYT staff in several places in Mexico and abroad in order to plan our crosses.

Some regional phytopathological problems have arisen. In Colombia, Ecuador, Peru and Chile for example, the barley yellow dwarf virus has become a major disease. A new race of stripe rust has also threatened the barley crop in Colombia and Ecuador, and has forced breeders there to search for new sources of resistance against this disease.

A series of advanced lines has been screened. They have been found to carry resistance to diseases such as leaf rust, powdery mildew, bacterial stripe and barley yellow dwarf virus.

For a second consecutive year, there was a severe epidemic of leaf rust in Mexico, which allowed both an evaluation of parental material and screening of segregating lines against this disease. Table 4 lists a series of advanced lines which carry resistance to leaf rust.

Screening against powdery mildew and stripe rust was made in the lowland of the State of Guanajuato in central Mexico.

A list of advanced lines carrying resistance to powdery mildew and stripe rust is given in tables 5 and 6 respectively.

Particular interest was put into the screening of advanced materials against barley yellow dwarf virus. Since the infection of this disease is very erratic under the conditions where CIMMYT grows its nurseries in Mexico, reliable testing sites such as in California, U.S.A. and Colombia and Ecuador had to be used.

Some sources of resistance have already been identified under these conditions. However, within CIMMYT's advanced lines, there is not much material which shows resistance to this disease. There are hopes that in the new crosses made using resistant material, it will be possible to select more genotypes which will carry such resistance.

Table 7 lists a series of advanced lines which carry some resistance against barley yellow dwarf virus.

HULL-LESS GRAIN

A great number of crosses have been made to incorporate the hull-less character into CIMMYT's breeding material. This character is now scattered throughout the breeding material.

The evaluation of advanced material carrying the hull-less character has been made in preliminary yield trials grown at Cd. Obregon, Sonora, Mexico. Experiments IX, X and XI in table 1B were assembled using lines which carried the hull-less character. The line "Bichi" (a cross between CM-67 and Dickson-Hiproly) outyielded not only the barley checks but also some of the wheat and triticale checks. These comparisons, however, have to be made with certain caution since the trials received only three irrigations and were fertilized with only 80 kg N and 60 kg P.

The results of these trials clearly confirm that the yield potential of the hull-less barleys can be improved by combining the different yield components in the proper background.

In the past, certain problems have been detected during the threshing process of the hull-less barleys. The embryo protrudes from the endosperm and this makes it more exposed and vulnerable to mechanical damage resulting in a reduction in the germination percentage when the seed is planted in the next cycle.

In order to check for any morphological differences that might exist in the way the embryo is set in the endosperm, a visual examination of the seed of the Barley World Collection was made. It was possible to select more than 100 lines in which the embryo was somewhat protected within the endosperm. These lines are now being grown in small plots at Cd. Obregon. They will be threshed to determine whether the position of the embryo is a feature that can confer resistance to embryo rupturing. The heritability of this character will be investigated in crosses with some other genotypes.

QUALITY

After a number of years of unsuccessfull breeding to try and incorporate quality into CIMMYT lines, the problem of endosperm shrivelling in the high lysine mutant hiproly, has been solved. The gene is now scattered in several genotypes which show a perfectly well developed endosperm. These genotypes are now being used as regular progenitors in the crossing block. In table 8 some advanced lines carrying the high lysine gene are listed. Some of the lines come from head selections made in bulk populations using the short haired rachilla gene as marker in crosses involving hiproly as the high lysine donor. Some lines other than hiproly are also being explored as possible donors of high lysine and high protein.

EARLINESS

The breeding of early types for certain purposes in some areas of the world, has continued. The earliness genes from different sources are now scattered in genotypes which might differ in height, disease resistance, quality, grain type, etc. Some of these lines have been tested in preliminary yield trials at Cd. Obregon.

The results of these trials are given in table 1C. Even though the yields in these trials do not seem very high, they should not be taken as they appear. The comparisons should be made on a day by day grain production basis. In Table 1 for example, the variety 388 in experiment XIII has a high daily production of grain compared to early checks such as Porvenir and Mona, which are early standard commercial varieties.

SPRING X WINTER BARLEY

The need for winter hardiness and facultative types for certain barley growing areas of the world has been recognized. Accordingly, a crossing program has been started using selected winter materials in combination with some of our best spring genotypes.

During the 1976-77 winter cycle, the first winter nursery was grown at Toluca, which has an altitude of 2,800 meters, in the central Mexican highlands. The lines were screened for winter hardiness under these conditions. The selected lines were used as progenitors to make crosses with improved lines from the spring crossing block.

The F_1 seed was sown in 2 meter row plots during the 1977-1978 winter cycle at Cd. Obregon, Sonora, Mexico.

The rows were harvested in bulk, and the resulting seed was assembled in sets and shipped to different cooperators around the world. A total of 567 crosses were sent to countries such as Turkey, Korea, Chile, etc., to be exploited under their conditions.

One set of this nursery was grown in the high plateau of Mexico to make selections towards the spring side.

TABLE 1A. Comparative yields of selected barley lines from experiments grown at Cd. Obregon in 1977-1978 cycle.

Var. No.	Variety or cross and pedigree	Yield kg/ha
	COVERED TYPES	
	Experiment I	
17	Bco.Mr-Mzq CMB-73A-33-2B-1Y-1B-1Y-0B	5008
15	CR115-Por x Bc/Api-CM67 CMB-74-932-A-6Y-1B-1Y-0B	4803
18	Arivat	4757
30	Centinela	4373
1	Ensenada	4380
24	Masurka	4006
12	Apizaco	3749
	Experiment II	
46	Bco.Mr-Mzq CMB-73A-33-3B-1Y-5B-1Y-1B-0Y	5558
48	Ensenada	5463
42	Manker	5113
60	Arivat	4976
36	CM67	4580
54	Tlaxcala	4340

TABLE 1A. continued

Var. No.	Variety or cross and pedigree	Yield kg/ha
	Experiment III	
76	Celaya"S"-8156 x CI7773-U.A1.5040 CMB-73A-1339-B-12B-1Y-1B-1Y-1B-1Y	5869
71	Celaya-CI3909.2 CMB-73A-790-1B-1Y-1B-1Y-1B-0Y	5754
69	Rod 586-11012.2 CMB-73A-6-2-7B-1Y-1B-1Y-1B-0Y	5609
84	Centinela	5445
90	Arivat	4911
78	Ensenada	4625
72	Masurka	4287
	Experiment IV	
115	Minn M11-Gva x Por-Dwarf 2 CMB-72-120-A-10Y-1B-1Y-1B-1Y-0B	6161
92	11012.2-Beacon CMB-73-139-1Y-1B-2Y-0B	5879
112	Tequila"S" CMB-72-189-3Y-1B-2Y-1B-1Y-0B	5628
120	Ensenada	5236
114	CM67	4622
96	Manker	4600
	Experiment V	
140	Traill-1038 x DL70 CMB-74A-432-25B-1Y-1B-1Y-0B	6317
125	Mzq-DL71 CMB-74A-67-1B-1Y-1B-1Y-0B	6148
130	Por-C58.1044070.19 x Bra CMB-74-108-3B-1Y-1B-1Y-0B	6146
150	Avt	5521
126	Centinela	5447
139	Manker	1879

TABLE 1A. continued.

Var. No.	Variety or cross and pedigree	Yield kg/ha
	Experiment VI	
155	Minn.M11-Gva x Por-Dwarf 21/RM 1508 CMB-74-1173-1B-1Y-1B-1Y-0B	5619
151	Api-CM67 x II266/62966.69 CMB-74A-971-2B-1Y-1B-2Y-0B	5439
175	Pro-Gva x 11012.2 CMB-74A-946-3M-1Y-1B-3Y-0B	5358
180	Manker	5124
156	Ensenada	5034
168	Tlaxcala	4916
162	Apizaco	4609
	Experiment VII	
203	CM 67-UM(evans)4098 CMB-74-20-1Y-1B-1Y-1B-2Y-0B	5039
181	Api-CM67 x Manchuria CMB-74A-977-1M-1Y-1B-1Y-0B	4933
202	RM 1508-11012.2 x Bco. Mr CMB-74A-1801-A-1B-1Y-1B-0Y	4865
204	Arivat	4782
186	Tlaxcala	4120
210	Ensenada	4096
	Experiment VIII	
223	CR115-Por x Bc/Api-CM67 CMB-74-932-C-6Y-1B-1Y-1B-2Y-0B	5084
229	Bal 61-Pro x Apam-Dwarf II-1Y/Api-CM67 CMB-74-996-A-1Y-1B-1Y-1B-1Y-0B	4763
233	Mzq-Bal 16/Ds-Apro x Minn 907 CMB74-1085-B-6Y-1B-1Y-1B-1Y-0B	4636
222	Apizaco	4373
216	Ensenada	4080
234	Masurka	3979
228	CM67	3968

TABLE 1B. Comparative yields of selected barley lines from experiments grown at Cd. Obregon in 1977-1978 cycle.

Var. No.	Variety or cross and pedigree	Yield kg/ha
	HULL-LESS TYPES	
	Experiment IX	
270	Bichi CMB-72A-31-6B-7Y-1B-1Y-0B	5223
265	Choya-M64.76 CMB-73-225-1Y-1B-3Y-1B-1Y-0B	4967
267	Ds-Apro.6B x 11016.2 CMB-73-249-3Y-5B-1Y-1B-1Y-0B	4917
258	Pavon (Bread wheat check)	4407
252	Beaqle (Triticale check	2918
246	America (Hull-less barley check)	2918
	Experiment X	
288	Bichi CMB-72A-31-6B-7Y-1B-1Y-0B	5185
279	Ds-Apro x 11016.2 CMB-73A-361-10B-4Y-1B-1Y-1B-0Y	4984
274	Apam-IB65 x Avt CMB-73A-326-1B-1Y-1B-1Y-1B-0Y	4909
290	Iris-Apm(Apro x Pallas^{5}-J5/11016.2) CMB-73A-1229-G-3B-1Y-1B-1Y-1B-0Y	4894
294	Pavon(Bread wheat check)	4262
276	Beagle (Triticale check)	4088
300	America (Hull-less barley check)	2958
	Experiment XI	
318	Bichi CMB-72A-31-6B-7Y-1B-1Y-0B	5430
329	Choya-Galt x 11012.2 CMB-74-972-A-1Y-2B-2Y-1B-1Y-0B	5077
325	M66.85-2080 CMB-74-481-3Y-1B-2Y-1B-1Y-0B	5017
319	Minn 906-Gva CMB-74A-449-1B-1Y-2B-1Y-0B	5016
312	Pavon (Bread wheat check)	4369
330	Beagle (Triticale check)	4338
306	America (Hull-less) barley check	3036

TABLE 1C. Comparative yields of selected barley lines from experiments grown at Cd. Obregon in 1977-78 cycle.

Var. No.	Variety or cross and pedigree	Yield kg/ha	Daily Production of grain
	EARLY TYPES	kg/ha	kg
	Experiment XII		
356	Apam-Hc 1905 x Apam-RL CMB-72-216-C-9Y-1B-0B	5115	46.92
347	Apam-RL x Gas CMB-74A-151-8B-1Y-5M-0Y	4810	42.94
346	(ProxDs-Apro/Bco.Mr-Galt)ER-Por x Bco.Mr-Dz02.391 CMB-73A-1344-A-6B-1Y-1B-1Y-1B-0Y	4577	42.37
360	Porvenir (Barley check)	4343	40.21
348	Mona	2633	28.61
	Experiment XIII		
388	(S.P.(2h)xCR115-Por/CM67)11012.2-Minn906 CMB-74A-15M-0-1B-1Y-1B-2Y-0B	5772	52.00
380	Bamba x Jo-Galt//Api-CM67 x 11012.2 CMB-74-A-1597-E-4B-1Y-1B-1Y-0B	5109	47.30
389	Api-CM67 x Ds-Apro/11016.2-SP.(2h) CMB-74-1190-A-5Y-1B-1Y-1B-1Y-0B	4974	44.81
372	Porvenir	4901	45.37
390	Mona	3413	37.09

TABLE 2A. Average yield of the top 5 yielding lines from the 1st EBYT, naked, at 14 locations.

Var. No.	Cross and pedigree	Yield kg/ha
23	CM67-Pro/Bco.Mr x Ds-Apro CMB-73-456-H-1Y-3B-2Y-1B-1Y-0B	2721
10	(Sht.Wocus-Apro x Woodvale/Apro)Ds-Apro CMB-72A-193-E-4B-2Y-1B-1Y-1B-0Y	2667
8	Ds-Apro x CR115-Por CMB-72A-105-1B-3Y-2B-1Y-1B-0Y	2638
11	Sv. Mona-Emir x Gva CMB-73A-995-H-2B-5Y-1B-2Y-0B	2620
9	CM67-Apam x Gva CMB-72A-122-C-1B-1Y-1B-1Y-1B-0Y	2619
25	Local Check	3020

TABLE 2B. Average yield of the top 5 yielding lines from the 3rd EBYT,normal,at 19 locations.

Var. No.	Cross and pedigree	Yield kg/ha
13	CR115-Por x Beecher/Api-CM67 CMB-74-932-A-6Y-1B-2Y-0B	3102
9	CM67-M66.85 CMB-74A-182-4B-2Y-0B	3068
15	Bal 16-Pro x Apam Dwarf II-1Y/Api-CM67 CMB-74-996-A-11Y-1B-2Y-0B	2995
18	CM67-Bussell CMB-73-37-8Y-3B-1B-1Y-1B-0B	2984
2	CM67 x Ds-Apro CMB-72A-32-5B-3Y-1B-1Y-1B-0Y	2960
25	Local Check	3786

TABLE 3. Advanced lines from the CIMMYT Barley Program with good resistance to lodging.

Cross and pedigree
CR 115-Por x Bc/Api-CM67 CMB 74-932-A-6Y- B-1Y-0B
Celaya "S"-8156 x CI 7773-U.Al.5040 CMB 73A-1339-B-12B-1Y-1B-1Y-1B-0Y
Rod 586-11012.2 CMB 73A-622-7B-1Y-1B-1Y-1B-0Y
Minn M11-Gva x Por-Dwarf 2 CMB 72-120-A-10Y-1B-1Y-1B-1Y-0B
11012.2-Beacon CMB 73-139-1Y-1B-2Y-0B
Mzq-DL 71 CMB 74A-67-1B-1Y-1B-1Y-0B
Api-CM67 x II 266/62966.69 CMB 74A-971-2B-1Y-1B-2Y-0B
Bal 16-Pro x Apam-Dwarf II-1Y/Api-CM67 CMB 74-996A-1Y-1B-1Y-1B-1Y-0B
Choya-M64.76 CMB 73-225-1Y-1B-3Y-1B-1Y-0B
IRIS-Apam (Apro x Pallas^5-J^5/11016.2) CMB 73A-1229-G-3B-2Y-1B-1Y-1B-0Y
Ds-Apro x 11016.2 CMB 73A-361-10B-4Y-1B-1Y-1B-0Y
Choya-Galt x 11012.2 CMB 74-972-A-1Y-2B-2Y-1B-1Y-0B

TABLE 4. Advanced lines from the 6th IBON, resistant to <u>Puccinia hordei</u>

Entry No.	Cross and Pedigree
7	Bco.Mr-Mzq CMB 73A-33-2B-1Y-1B-2Y-0B
17	Maswi-Bamba CMB 74-844-6Y-1B-1Y-0B
48	Cal.Mr.x Ds-Apro CMB 73A-42-16B-4Y-1B-2Y-1B-0Y
52	11016.2-Cal.Mr. CMB 73A-104-1B-2Y-2B-1Y-1B-0Y
109	Vanguard-Julia x Zephyr Kronstad 72-73-89-1B-1Y-1B-1Y-0B
118	Pitayo-RM1508 CMB 74A-96-28B-1Y-1B-1Y-0B
119	Por-C 58.1-4407.19 x Bra CMB 74A-108-3B-1Y-1B-1Y-0B
122	Cadillo-RM 1508 CMB 74A-134-21B-1Y-1B-1Y-0B
124	Egypt 20-DL70 CMB 74A-261-1B-2Y-1B-1Y-0B
136	Api-CM67 x DL71 CMB 74A-961-22B-1Y-1B-1Y-0B
147	Zoapila-CI 3087 CMB 74A-50-3B-1Y-1B-1Y-0B
162	Api-CM67 x HBCCXXVIII CMB 74A-967-14M-1Y-1B-1Y-0B
198	Minn 480-Gva CMB 74-736-2Y-2B-2Y-1B-2Y-0B
209	CR 115-Por x A16/Ds-Apro CMB 74-933-G-2Y-1B-2Y-1B-1Y-0B
215	Mzq-Bal 16/Ds-Apro x Minn 907 CMB 74-1085-B-6Y-1B-1Y-1B-1Y-0B
218	Bal 16-Pro x Choya/Cal.Mr-11012.2 CMB 74-1202-D-2Y-1B-2Y-1B-2Y-0B
233	Apam-IB65 x IRIS CMB 73A-350-1B-1Y-1B-2Y-0B
268	Choya x Ds-Apro.6B CMB 73A-228-19Y-1B-1Y-0B

TABLE 5. Advanced lines from the CIMMYT Barley Program with resistance to Powdery mildew.

Entry No.	Cross and pedigree
51	Coho-Zephyr Kronstad 72-73-39-1B-1Y-1B-1Y-0B
77	Atlas 46-Bco. Mr. CMB-72A-38-7B-1Y-1B-1Y-1B-0Y
78	Bco.Mr-Galt CMB-72A-45-4B-1Y-1B-1Y-1B-0Y
79	Bco.Mr-Manker CMB-72A-47-1B-6Y-3B-1Y-1B-0Y
96	Nepal 842-Apam x CM67-U.Sask-1800 CMB-72A-243-I-6B-1Y-2B-1Y-1B-0Y
98	Volla- Filbecks III Kronstad 72-73-191-4B-1Y-1B-1Y-1B-0Y
111	Pitayo-RM 1508 CMB-74A-96-37B-1Y-0B
113	OB.154.1-70·22425 CMB-74A-407-4B-1Y-0B
114	WI-2274-Benton CMB-74A-729-8B-1Y-0B
118	Nacta-RM-1508 CMB-74A-1183-1B-1Y-0B
123	DL69-Sultan CMB-74A-670-3M-1Y-0B
133	11012.2-Impala x Birence CMB-74A-1697-D-2B-2Y-0B
141	Minn907-RM 1508 CMB-74-506-8Y-2B-1Y
145	CR115-Por x Beecher/Api-CM67 CMB-74-932-C-1Y-1B-1Y-0B
171	Bco.Mr x Ds-Apro CMB-73A-36-1B-3Y-1B-1Y-0B
173	Cal.Mr x Ds-Apro CMB-73A-42-16B-1Y-1B-2Y-0B
189	Apam-IB65 x Emir CMB-73A-330-5B-1Y-3B-1Y-0B
216	Tern-Cal-Mr/Apam-EB1053 x Por-Dwarf 21 CMB-73A-984-C-3B-3B-3Y-2B-2Y-0B
221	P12871-Mzq x Emir CMB-73A-11B-A-5B-1Y-1B-1Y-0B
223	Mona-Tern/DS-Apro 2B x Olli-M64.69 CMB-73A-1203-A-2B-1Y-2B-1Y-0B
246	11012.2-P12900 CMB-73-142-8Y-2B-1Y-1B-1Y-0B
266	CM67-Pro/Bco.Mr x Ds-Apro CMB-73-456-H-1Y-3B-1Y-1B-1Y-0B

TABLE 6. Advanced lines from the CIMMYT Barley Program with resistance to stripe rust.

Entry No.	Cross and Pedigree
51	Coho-Zephyr Kronstad 72-73-39-1B-1Y-1B-1Y-0B
56	Apam-Aths CMB 72-16-40Y-1B-1Y-1B-2Y-0B
58	CM67-Jet CMB 72-29-1Y-1B-1Y-2B-1Y-0B
89	Ds^2-Apro x CM67 (CM67/Apro x Sv 02109-Mari) CMB 72A-190-B-1B-1Y-1B-1Y-1B-0Y
94	Bal 16-CM67 x Ds^2-Apro 3Y CMB 72A-208-F-1B-1Y-1B-1Y-2B-0Y
106	Bussell
107	Mzq-DL71 CMB-74A-67-3B-1Y-0B
115	Api-CM67 x DL71 CMB-74A-961-19B-1Y-0B
135	Apam-5106 CMB 74-4-3Y-1B-1Y-0B
196	Api-CM67/Apm-Kn27 x Dz 02.391 CMB 73A-373-12B-1Y-1B-1Y-0B
207	H 272-11012.2 CMB 73A-423-52-2Y-1B-1Y-0B

TABLE 7. Advanced lines from the CIMMYT Barley Program with resistance to Barley Yellow Dwarf Virus.

Entry No	Cross and Pedigree	Reaction Type
47	CM67 x Ds-Apro CMB 72A-31-6B-7Y-1B-1Y-0B	MR
70	Pro x Ds-Apro CMB 72A-15-4B-4Y-1B-1Y-1B-1Y-0B	MR
154	Por-CM67/Apam-RL x Por-U.Sask-1800 CMB 74-1021-A-1Y-1B-1Y-0B	MR
199	Por-EB1053 x CM67/Nepal CI593 CMB 73A-420-1B-1Y-1B-2Y-0B	MR
234	CM67-P102850 CMB 73-32-2Y-3B-2Y-5B-1Y-0B	R
235	CM67-11016.2 CMB 73-34-29Y-1B-1Y-1B-1Y-0B	MR
267	CM67-Pro/Bco.Mr.x Ds-Apro CMB 73-456-H-1Y-3B-1Y-4B-1Y-0B	R
268	CM67-Pro/Bco.Mr.x Ds-Apro CMB 73-456-H-1Y-3B-2Y-1B-1Y-0B	R
274	69.82-Mona CMB 73-375-2Y-2B-1Y-1B-1Y-0B	MR

TABLE 8. Advanced lines from the CIMMYT Barley Program with good quality.

Cross and pedigree
Nopal CMB-73-704-A-17Y-1B-500Y-0B
Nopal"S" CMB-73-604-A-174-1B-1Y-1B-1Y-0B
Nopal"S" CMB-73-604-A-3Y-1B-1Y-1B-500Y-0B
Nopal x Bco.Mr.-Gva CMB-76-287-500Y -0B
Nopal/Api-CM67 x Mzq CMB-76-288-500Y-500B-0Y
RM1508-Por x CM67-Gva CMB-75A-1151-1B-500Y-0B
<u>Hiproly F3 bulk selection</u>
Hip F_3 bulk 74A-469-1Y-1M-0Y
Hip F_3 bulk 74A-720-1Y-1M-0Y
Hip F_3 bulk 74A-768-1Y-1M-0Y

Pathology

INTRODUCTION*

The search for resistance against pathogens that cause low yields and poor quality of grain is one of the main objectives of the wheat improvement program in CIMMYT. Assessment of resistance in all the genotypes included in the basic nurseries starts at CIMMYT's home base in both the summer and the winter nurseries in Mexico. The germ plasm selected there is then sent through the international nurseries to numerous wheat growing areas of the world, in order to expose it to an array of pathogens as well as to populations of widely different virulence. Collaborators are requested to estimate and report back the kind and amount of disease observed in each entry in these nurseries. In a reciprocal way, CIMMYT assesses wheat, barley and triticale cultivars from elsewhere under Mexican conditions.

According to the environmental conditions, amount of inoculum, susceptibility of hosts, etc., sometimes disease resistance testing is performed under severe epiphytotics, natural or artificial. At other times, the development of diseases is only moderate or scarce, but in any case this is a continuous, never ending process that enables the selection of resistant genotypes which can be incorporated into crosses with high yielding lines or cultivars possessing other desirable traits.

Our goal is to develop advanced germ plasm with a genetic pool of resistance as broad and stable as possible to be used in large geographical areas.

To approach the problem of resistance some priorities have been established regarding the economic importance of diseases. On a world wide basis, rusts cause the greatest losses in production. In the humid, cool or temperate areas leaf blights, head blights and mildew may destroy the crop. Other foliar diseases, smuts, viruses and root rots impair wheat in rather restricted areas of the world.

The reactions of CIMMYT's basic germ plasm to diseases are summarized from the data of some international nurseries, in this chapter. Also presented hereunder is a detailed analysis of leaf rust and stem rust virulences obtained from field observations and greenhouse work in Mexico.

RUSTS

Results of the 10th International Bread Wheat Screening Nursery (10th. IBWSN) have been compiled in table 1 for stem rust *(Puccinia graminis tritici)*, in table 2 for leaf rust *(Puccinia recondita)* and in table 3 for stripe rust *(Puccinia striiformis)*. In all cases, a maximum coefficient of infection of 5.0 was arbitrarily set to group the top resistant genotypes and these are the ones reported. Such a coefficient takes into account the severity and type of reaction, as used to estimate rust infection with Cobb's modified scale.

Most of the experimental stations in South Africa registered high levels of stem rust for the year under report. In southern Brazil, the appearance of virulent biotypes in the previous season forced a shift in the commercial varieties of wheat. In Mexico, a good number of cultivars from CIMMYT's basic nurseries were eliminated at El Refugio, Guanajuato State, in the Central Plateau. This location, detected in 1977, is now a regular site for testing under natural occurrence of the fungus.

According to table 1, Brochis "S" (=Cno–Bb x Cdl (7C/LR64–Inia x Inia–Bb; cross 5872–) was the most oustanding cultivar resistant to stem rust.

No leaf rust epidemic was observed in the commercial wheat crop of Northwestern Mexico. Following the outbreak of the rust which threatened production in the 1976-1977 season, the Ministry of Agriculture authorities in the area substituted Jupateco 73 and recommended a number of resistant varieties such as Torim 73, Mexicali 75 (a durum), Cocoraque 75, Anahuac 75, Pima 76, Hermosillo 76, Nacozari 76, Pavón 76 and Tesopaco 76. It is possible, however, that in view of the wide spectrum of virulent biotypes of leaf rust in the Yaqui Valley, as discussed later in this report, these varieties will also have to be replaced in a few seasons time.

Leaf rust was endemic also in the dry delta of Egypt, in the Sub-continent (India and Bangladesh), and in the Southern Cone of South America. In recent years, leaf rust is more frequently attacking the commercial wheats in some areas of the Middle East (Jordan, Israel).

Among the most resistant lines listed in table 2, are

* The Government of Japan through a grant to CIMMYT supported the resident i.e. core, pathology program.

Hork "S" (= Hopps–Robin x Kalyan, cross CM8874–) and Cgñ x Kal–Bb (cross CM15133–). The Minnesotan variety Chris (row 194) is used extensively by our Basic Germ plasm Program in back-crosses to incorporate resistance to leaf rust (see row numbers 196, 197 and 199 in table 2).

A heavy epidemic of stripe rust in The Netherlands was reported by the experimental stations at Cebeco and Wageningen, due to the presence of a new virulent race. Otherwise, yellow rust was endemic in the high plateaux of Kenya, Central Mexico, Central Turkey and North of the Andean Region.

In table 3, eleven lines of Brochis "S" (Cross CM5872–) highly resistant to the rust are listed. The advanced lines Emu "S" (= Tob "S"–Napo x No66–Era/Bb–Gallo, cross CM8327–) and Moncho "S" (= We–Gto x Kal–Bb, cross CM8288–) are among the top CI=<5.0.

FOLIAR DISEASES

Infection of the leaves by *Septoria tritici and Septoria nodorum* often coincide in the same plant making difficult the identification of specific symptoms of leaf blotch and glume botch respectively. Both fungi cause elongated necrotic lesions; the lesions of *S. tritici* form abundant and visible fruiting bodies (pycnidia).

The pycnidia of *S. nodorum* are less abundant and inconspicuous, and in addition the fungus invades glumes, grain and stem nodes. In the latter case, the plants are badly lodged due to breaking of the stem at the infected nodes, causing almost total losses in yield. This is one important limiting factor for wheat production in Brazil and Paraguay.

Tables 4 and 5 contain the best cultivars for resistance to these *Septoria spp.,* summarized from the 7th International Septoria Nursery (7th ISEPTON). The most oustanding wheat cultivar for resistance to *Septoria tritici* is Kvz–UP301 (cross CM20596–) showing the lowest rate of infection across all 13 locations, (row 238 in table 4). For *S. nodorum,* Ktz M12–Tanori 71 (cross CM14952–) and Moncho "S" (cross CM8288–A–) continue to be highly resistant as reported in previous years.

Brazilian and Kenyan genotypes provide good sources of resistance to *Septoria spp.,* but the plants are tall and rather late.

Two Mexican cultivars seem interesting because of their resistance to both pathogens viz., entry 51, Alondra "S" (= D6301–Nai60 x Wq–RM/Cno^2–Chr, cross CM1683–A–) and entry 53, (Cno–7C x CC–Tob/7C) Cno–Chr x Flr–No66 (cross CM8607–R–).

The geographical distribution of powdery mildew (*Erysiphe graminis*) is restricted to cool and highly humid areas of the world. In such conditions, susceptible varieties can be destroyed if the attack occurs in the early stages of crop development. Resistance to this disease is apparently available in CIMMYT's germ plasm. Cultivars from Mexico and from different countries are highly resistant according to the information in table 6, extracted from the 7th ISEPTON. The advanced lines in entries 55, 56, 57, 181, 182, 183, 238 and 293 involving the Russian winter variety Kavkaz, should be noted.

LOOSE SMUT

The more efficient and economical way of controlling loose smut is the use of resistant varieties. To guide breeders in their crossing programmes, CIMMYT's basic nurseries of bread wheat, durum wheat, triticale and barley were screened in 1978 for resistance to *Ustilago tritici.* Plants were inoculated in CIANO at flowering using a partial vacuum method; kernels harvested from them were seeded a season later in El Batan, where healthy and smutted heads were counted. Intensity of infection is expressed as the percentage of smutted heads relative to total numbers of heads. The most resistant genotypes (less than 1.0 per cent, almost immune) are listed in tables 7, 8, 9, 10 and 11.

The greatest intensity recorded in each of the crops was as follows: 67.0 per cent in bread wheat, entry CB–97, Sajame "S" (cross CM4210–10Y–4M–8Y–2M–0Y); 11.0 per cent in durum wheat, entry CB0141, Gta "S"^{2}–So179 (cross HRL–0Y–1M–0Y); 58.0 per cent in triticale, entry CBTcl–558, IA Bulk E_2 (cross X11065–A–1M–1Y–0Y); and 100.0 per cent in barley, entry Ceb.Misc.351, line Super Precoz (6 rows).

LEAF AND STEM RUST VIRULENCE SURVEY, MEXICO 1977–78

Leaf and stem rust fungi still represent major risks that may offset efforts to stabilize or expand wheat growing areas. They may be regarded as constraints to national goals of increasing food production. Therefrom derives the persistent emphasis of CIMMYT's breeding program to develop rust resistant wheat genotypes. Resistance of CIMMYT's wheat cultivars must be effective against a wide range of rust genotypes to be useful on a global scale as intended.

Although resistance of Mexican selections must be appraised empirically at national or regional levels with local strains of leaf rust or stem rust, a description of the virulence pettern of inocula used in Mexico to select for resistance, may provide a way to predict the usefulness of such a resistance by comparing the array of virulence genes of rust populations in Mexico and those at a given location.

CIMMYT's approach to describe rust populations aims at determining the frequency and combinations of virulence genes. While the presence of a given virulence gene may be detected in field nurseries, assessing the frequency of virulence genes singly or in combinations requires intense greenhouse work.

Major features in leaf and stem rust populations

Virulence shifts in rust populations may be detected in the field by the breakdown of resistance in one or several of the "single resistance gene" carrier lines, or in previously resistant cultivars. Consequently, our uniform rust nurseries comprise lines that carry a single leaf or stem rust resistance gene, advanced resistant CIMMYT lines, and varieties grown commercially in Mexico.

During 1977-1978, these nurseries were planted in the winter at CIANO, Sonora; Los Mochis, Sinaloa; Santiago Ixcuintla, Nayarit; Rio Bravo, Tamaulipas; and Poza Rica, Veracruz. In the summer at Toluca and El Batan, Mexico; Celaya and El Refugio, Guanajuato; Nestipac, Jalisco; and Navidad, Nuevo Leon. Tables 12 and 13 show the severity and type of infections on lines that carry a single resistance gene for leaf rust (Lr) or for stem rust (Sr) respectively, assessed with Cobb's modified scale.

In the leaf rust nursery (table 12), only those lines that carry either Lr9 or Lr19 were consistently rust-free across all planting sites, with an average coefficient of infection of about 0.4. Agent, with Lr24, was resistant except for 20–40MS assessed at El Refugio, Tamaulipas and Nayarit, giving an overall coefficient of about 7.0

Infections on lines with Lr21 ranged from TR at Poza Rica to 50S at Nestipac, with intermediate to high severity and type of reaction at Celaya and El Refugio. The line carrying Lr22 had as much as 30–50 MS at El Refugio, Celaya and Nestipac, and up to 70S at El Batan; at the other sites this line was resistant. Lines with Lr3ka, 10, 16, 17, 18, 23, EG, T, "B", or "1+ " also responded differently across sites and resulted in larger average coefficients of infection. The remaining lines were highly susceptible at most places.

These results indicate that the leaf rust populations in these areas lack virulence genes complementary to Lr9 and Lr19. They indicate also the presence with low frequency/different regional distribution of virulence genes complementary to Lr24, 21, 22, 3ka, T, EG, 16, 23, "1+", 10, 17, 18 and "B", and the common and universal occurrence of virulence genes complementary to Lr1, 2a, 2b, 2c, 3, 12, 13, 14a, 14b, 15, "Exch" and "C".

Parallel analysis for stem rust (table 13) shows that only Sr27 gave in-depth protection at all sites with an average coefficient of infection of 0.08. Agatha, with Sr25, had up to 20MR in Toluca and El Refugio, which is still a low infection type that does not indicate the presence of the complementary virulence gene. Infection on BtSr30Wst averaged 5.13, to which contributed 10MS observed in Nayarit and 50MR at El Refugio. These values fall short of proving unequivocally the presence of a virulence gene complementary to Sr30. Resistance in Agent, which is conferred by Sr24, was highly effective at every place except at Rio Bravo where 60MS was recorded. Similarly, the set of genes present in Gamut (SrGt+) was effective at every place but at Rio Bravo (50MS).

These observations suggest that stem rust virulence genes complementary to Sr24 and Gt+ are present in Mexico in the Rio Bravo area. Virulence for other Sr-genes studied seems to be present with a moderate to high frequency and with differential distribution.

From tables 12 and 13 it may become evident that leaf rust occurred more severely and evenly than stem rust. Average coefficients of infection for locations across lines (table 14) confirm this pattern.

In three of the 11 locations, the occurrence of stem rust was negligible. In the remaining eight, leaf rust infection was more severe than that of stem rust. Locations that resulted in the highest stem rust infection were Rio Bravo (41.6), Santiago Ixcuintla (36.6), El Refugio (31.3), Celaya (28.1) and Toluca (24.2). Similar listing for leaf rust included El Batan (67.7), El Refugio (65.6), Nestipac (64.5), Celaya (56.3), and Rio Bravo (53.2).

The assessment of leaf rust infection on resistant lines and commercial varieties in the leaf rust nursery is given in table 15.

There was no appreciable change in infection type or severity on these lines and varieties, as compared to previous years, except for two lines that changed from moderate to full susceptibility viz., An^E x My64–Ti71 had previously registered up to 5MS–S, and this year it reached 30S in Celaya; Pamir "S" had as much as 10MS–S last year, compared to 60S at Celaya this year.

It may be concluded that no major change has occurred in the leaf rust population in Mexico in the past year, and that Celaya continues to have more complex leaf rust biotypes than other parts of Mexico, as has been reported previously.

The assessment of stem rust infections on resistant lines and commercial varieties in the stem rust nursery is shown in table 16.

Infections in summer nurseries were more intense than in the previous year, but not different enough to indicate new virulence patterns. The only exception was the full susceptibility in Guanajuato of HD1220–Kal^3(10–50S) from insignificant levels of infection a year ago. Most recordings from Rio Bravo are very high on the otherwise resistant lines, and confirm dissimilarities observed between the Rio Bravo epidemiological unit and the rest of Mexico.

Detailed leaf rust population analysis

Two hundred and fifty nine leaf rust samples were collected in 17 sites in Mexico. From them, 568 single pustule isolates were produced and inoculated for study on 18 differential lines, each with a single, different Lr resistance gene. Table 17 shows the proportion of isolates capable of overcoming each of these 18 genes, according to source of samples.

Virulence genes complementary to Lr1, 3, 14a, and 14b, occurred commonly at every sampling site. These results confirm the conclusions drawn from the leaf rust uniform nursery. On the other hand, virulence genes complementary to Lr9 and Lr19 were not found; the results also agree with field data. Virulence for Lr24 occurs at very low frecuency (1.0 per cent in CIANO; 9.0 per cent in Costa de Hermosillo).

Virulence genes complementary to each of the remaining eleven Lr-genes occur with varying frequency— (0—10 per cent to over 80.0 per cent for Lr2a, 2b, 2c, 3ka, 10, T and EG; from 45 per cent or over to 100 per cent for Lr17 and 23; from 0—53 per cent for Lr21; and from 0—21 per cent for Lr16). These 11 resistant genes may be regarded as partially effective against certain segments of the rust population.

In the study of the 568 single pustule isolates, 201 different virulence combinations were found. Many of the combinations, however, reflect trivial differences involving virulence genes of common occurrence. For a more meaningful study, some combinations were selected that involve virulence genes complementary to the 11 partially effective resistance genes (table 18). The frequency of virulence combinations for each row in table 18, results from adding up all isolates which had **at least** the capability of counteracting the set of Lr genes that describe that row.

Thus, 45 out of 180 single pustule isolates from samples collected on bread wheat in CIANO may overcome Lr2a and 2b. However, only 39 isolates meet the condition of overcoming also Lr2c; further down, only 16 isolates could overcome all of Lr2a, 2b, 2c, and 3ka, and just four may overcome also Lr10.

When identical analysis is done with isolates coming from El Refugio and Celaya (table 18), it is clear that the abundance of isolates capable of overcoming a long series of Lr-genes is much greater than at CIANO. The most complex isolate found this year has virulence genes complementary to Lr2a, 2b, 2c, 3ka, 10, 17, 21, 23, T, and EG, plus those complementary to ineffective Lr1, 3, 14a, and 14b. This isolate occurred once out of 180 isolates from bread wheat in CIANO, whereas it occurred 10 times out of 43 isolates from bred wheat samples in El Refugio, and in a similarly high frequency in other samples from the Guanajuato State.

Table 18 also shows that no isolate was found that had put together virulence genes complementary to Lr2a, 2b, 2c, 3ka, 10 and 16; this seems to be the minimal "universally resistance formula" in Mexico while using the 11 partially effective Lr genes.

While the Guanajuato rust population includes the most complex virulence combinations in the country, samples from bread wheat at CIANO during the winter of 1978 resulted in the most assorted set of virulence combinations (107 combinations out of 180 isolates). In very sharp contrast, samples collected in CIANO on spreader rows rusted with naturally occurring inoculum yielded only two virulent combinations, namely, those consisting of the virulence genes complementary to Lr1, 2a, 2b, 2c, 3, 14a, 14b, 17 and 23, and to Lr1, 3, 10, 14a, 14b, 17 and 23.

These combinations may be considered as the core of virulence in Mexico, upon which additional virulence genes may occur to form complex combinations.

This contrast indicates that mixed rust populations found on experimental plots in CIANO may result from the practice of cycling the inoculum through collecting, preserving and spreading it yearly. Insofar as the breeder's selection is concerned, this mixed rust population provides proper testing to the genetic diversity and wide resistance base of CIMMYT germ plasm.

Detailed stem rust population analysis

One hundred and fifty stem rust samples were collected on bread wheat, durum wheat, triticale and barley at five Mexican locations and 366 single pustule isolates were tested on the differential series used at the Cereal Rust Laboratory (CRL) of the U.S. Department of Agriculture, St. Paul, Minnesota, U.S.A. The series consists of 12 lines each with a single, different Sr-gene. Table 19 shows the proportions of isolates that may overcome each of the 12 Sr genes, according to the source of sample.

Virulence genes complementary to Sr 5, 8, 9a, 9d and 11 occurred commonly (36-100 per cent of the isolates), whereas virulence genes complementary to Sr6, 9e, 10 and 13 were less common (0-55 per cent, 0-60 per cent, 0-67 per cent and 0-43 per cent respectively). Frequency of virulence genes for Sr 7b, 9b and Tt-1 ranged from 0-20 per cent to 100 per cent according to the source of sample. These results closely resemble data reported in previous years. A noticeable difference is the more frequent occurrence of the virulence gene for Sr 13; it occurred in 43 per cent of isolates from CIANO and in 29 per cent of isolates from El Refugio in 1978, as compared with 1.8 per cent and 7.1 per cent a year ago, respectively.

In the study of 366 single pustule isolates, 99 different combinations were found. The occurrence and frequency of combinations show geographic variation, a predictable sequel to geographic variation in occurrence and frequency of virulence genes singly. This fact, and the abundance of combinations make it advisable to divide data regarding combinations of virulence genes according to the sampling site.

Table 20 aims at summarizing the percentage of occurrence for every combination at the 5 locations. Following the approach developed by A. P. Roelfs and D. McVey at CRL, the 12 virulence genes are taken as three sets of four genes each; set I consists of virulence genes for Sr 5, 9d, 9e and 7b; Set II of virulence genes for Sr 11, 6, 8 and 9a; and set III of virulence genes for SrTt-1, 9b, 13 and 10.

Complex virulence patterns shown in table 20 (2-4 genes in combination) are limited to the four genes making up any one set. Each virulence pattern shown is accompanied by the CRL code letter, which is used to identify any virulence pattern in a set. Approximate equivalents to standard races are offered with virulence patterns of Set I. It should be made clear however, that these equivalents in no way may be construed as being identical to a precise combination of virulence genes.

Although virulence patterns are limited to combinations within a set, table 20 may be useful to learn about the structures of stem rust populations. Firstly, trends towards simpler or more complex patterns may be evaluated by establishing class limits (e.g. 1-2 genes as "simple"; 3-4 as "complex") and tallying proportions for each class. Following this criterion, virulence patterns for Sr genes in Set I tend towards complexity: letters S, R, K and T represent combinations of at least 3 virulence genes.

These combinations account for 96 per cent of isolates from Navidad, 92 per cent from bread wheat, 100 per cent from durum wheat and 93 per cent from triticale at CIANO, and 85 per cent from bread wheat, 88 per cent from durum wheat and 78 per cent from barley at El Refugio. Since virulence for Sr9e is not too common, it is meaningful to proceed with the analysis and compare the frequency of virulence pattern R, which is complex but does not include virulence for Sr9e, and patterns S, K, and T—also complex but inclusive of virulence for Sr9e.

It may be seen that the latter are major groups only in Navidad and in El Refugio on bread wheat and on durum wheat. Therefore, most isolates tend to be complex (as far as Set I is concerned) but lack virulence for Sr9e.

Identical pattern towards complexity may be observed in Set II; letters P, K, S and T signal combinations of 3-4 genes; these patterns account for 74 per cent of isolates from Navidad, 75-93 per cent of isolates from CIANO, 85 per cent of isolates from bread wheat and 63 per cent from barley at El Refugio, and 50 per cent from triticale at Celaya; however, complex combinations that contain virulence for Sr6 (patterns K, S and T) are major groups only at CIANO (about 50 per cent of isolates) and El Batan (45 per cent).

Set III includes Sr13 and 10, whose complementary virulence genes are not very common. Consequently, complex combinations, i.e. 3-4 virulence genes do not prevail. Only at Navidad and El Refugio do complex combinations represent major groups (65 per cent at Navidad; 41-53 per cent at El Refugio). Patterns P, K and T are the complex combinations that include virulence genes for Sr13 and 10; these patterns are abundant only at Navidad, where they were found in 32 per cent of isolates.

Continued analysis throughout the years and sites may provide information on the stability of trends towards the complexity of virulence pattern in rust populations.

Secondly, table 20 may be used to determine the frequency of specific combinations of virulence genes within each of the three sets. For instance, combinations of virulence genes for Sr10 and 13 occur as virulence patterns F, P, K and T in Set III. The sum of percentages for those patterns is the frequency of that combination, 32 per cent for Navidad, 8 per cent for bread wheat at El Refugio, and so forth.

Virulence combinations are described in full, and their frequency of occurrence are given for each sampling location in tables 21 (Navidad), 22 (CIANO), 23 (El Batan), 24 (El Refugio) and 25 (Celaya). Stem rust isolates from Navidad include the most complex combinations for the country. Formulae with T as initial letter (race 15) are common in that part of Mexico. Virulence formulae RTQ and RPQ still prevail in CIANO (table 22). Some isolates from samples collected on durum wheat at El Batan lacked virulence for Sr5 (formulae with G as initial letter in table 23). Their overall virulence pattern was very simple too.

Samples from El Refugio yielded a long list of combinations (table 24). Formulae with the initial letter T (race 15) or R (races 11, 113) are very common. Rust populations from Celaya (table 25) resulted in a high frequency of isolates whose virulence pattern has a Q as initial letter (race I51). Altogether, stem rust populations of the Celaya-El Refugio area are more mixed that at any other place tested in Mexico (74 combinations out of 99 for the entire country).

LEAF AND STEM RUST POPULATION COMPARISONS, MEXICO, 1978

Some features of the 1978 virulence survey are shown in table 26.

Judging from the total number of virulence combinations, population heterogeneity is greater for leaf rust than for stem rust. However, local differences are of utmost importance. Leaf rust exhibits its maximum variability at CIANO from samples collected in the midst of the growing season (similarly mixed stem rust populations may be found at El Refugio).

Whereas mixed leaf rust populations in CIANO may be validly tracked down to inoculum artificially spread every season, mixed stem rust populations at El Refugio must have other explanations, like the presence of diversified host populations, or of sexual reproduction of the fungus on the alternate host. These alternatives may be studied in the future.

For a more applied viewpoint, results show a wide array of virulence combinations available at CIANO for leaf rust, and at El Refugio for stem rust, to ensure proper selection of resistant wheat germ plasm in Mexico.

To ensure disease epidemics at CIMMYT's Toluca Experiment Station, Mexico, spores of the three rusts are spread onto susceptible rows using a simple sprayer.

Table 1 . Breadwheat genotypes from the 10th. International Breadwheat Screening Nursery most resistant to stem rust in 17 locations*/ (coefficient of infection = 5.0% or less).

Row num	Variety or cross and pedigree	Coefficient of infection
111	(21931/Ch53-An x Gb56)An64 Cd1 CM11243-28Y-4M-3Y-OM	1.4
113	(Cno"s"-Gallo/Son64-Kl.Rend x Bb)UP301 CM11559-K-5Y-8M-1Y-1M-1Y-OY	1.9
52	Brochis"s" CM5872-C-1Y-5M-1Y-2M-OY	3.0
51	Brochis"s" CM5872-C-1Y-5M-1Y-OM	3.2
53	Brochis"s" CM5872-C-1Y-5M-2Y-1M-OY	3.8
54	Brochis"s" CM5872-C-1Y-5M-2Y-2M-OY	3.8
144	Mochis 73-RA^{2}F2 II41593-7R-1R-1R-OM	3.8
69	Emu"s" CM8327-C-9M-1Y-OM	4.3
50	Brochis"s" CM5872-C-1Y-1M-3Y-OM	5.0

*/ 1. El Bajio, Mexico,
2. El Batan, Mexico
3. Ancash, Peru
4. Dos Cerrados, Brazil
5. Rio Grande do Sul, Brazil.
6. Stupice, Czechoslovakia.
7. Ege R.A.R.I., Turkey.
8. Aussefera, Yemen.
9. Giza, Egypt.
10. Sakha, Egypt
11. Kulumsa, Ethiopia.
12. Njoro, Kenya.
13. Bethlehem, So. Africa.
14. Jyerhoch, So. Africa.
15. Makatini, So. Africa.
16. Sensako, So. Africa.
17. Powarkeda, India.

Table 2. Breadwheat genotypes from the 10th. International Breadwheat Screening Nursery most resistant to leaf rust in 30 locations*/ (coefficient of infection = 5.0 or less).

Row num	Variety of cross and pedigree	Coefficient of infection
66	Moncho"s" CM8288-A-3M-6Y-5M-2Y-OM	2.7
197	Chris^5-S948.A1 CMH72A.333-1B-2Y-1B-OY	2.9
61	We x Tob-Cno"s"/Cdl CM8285-T-500M-503Y-OM-501M-OY	3.8
91	Hork"s" CM8874-K-1M-1Y-OM	3.9
103	Chiroca"s" CM8963-A-1M-1Y-1M-3Y-OM	4.0
118	Cgñ x Kal-Bb CM15133-1M-3Y-4M-2Y-OY	4.1
94	Hork"s" CM8874-K-1M-1Y-OM-(1-356Y)-(1-200B)	4.3
139	Nad63-LR64A x Bb"s" II30756-3S-1M-1T-OR	4.3
93	Hork"s" CM8874-K-1M-1Y-OM-(1-356Y)	4.4
194	Chris	4.4
92	Hork"s" CM8874-K-1M-1Y-OM-(1-113Y)	4.5
5	Cocoraque F75	4.5
117	Cgñ x Kal-Bb CM15133-1M-2Y-2M-1Y-OY	4.6
17	Dougga	4.7
59	Napo-Tob"s" x 8156/Kal-Bb CM7806-15M-2Y-2M-1Y-OM	4.7
199	Chris^5-S948.A1 x 8156(B) CMH72A.307-3B-1Y-4B-OY	4.9
196	Chris^5-S948.A1 CMH73.489-2Y-OB	4.9
95	Hork"s" CMH8874-K-1M-1Y-OM-(1-105Y)	5.0

*/ 1. Nebraska, USA
2. El Batan, Mexico.
3. Toluca, Mexico.
4. Monterrey, Mexico.
5. El Bajio, Mexico.
6. Los Mochis, Mexico.
7. CIANO, Mexico.
8. Rio Bravo, Mexico,
9. La Molina, Peru.
10. Ancash, Peru.
11. Dos Cerrados, Brazil.
12. Passo Fundo, Brazil.
13. Criadero Klein, Argentina
14. Ege R.A.R.I. Turkey.
15. Mivhor Farm, Israel.
16. Wadi Jabis, Jordan.
17. El Gemmeiza, Egypt.
18. Giza, Egypt.
19. Sakha, Egypt.
20. Makatini, So. Africa.
21. Sensako, So. Africa.
22. Jyerhoch, So. Africa.
23. Powarkheda, India.
24. New Delhi, India.
25. New Delhi, India.
26. Ludhiana, India.
27. Patnagar, India.
28. Pusa, India.
29. Joydebpur, Bangladesh.
30. Ishurdi, Bangladesh.

Table 3 . Wheat genotypes from the 10th. International Bread Wheat Screening Nursery most resistant to stripe rust in 15 locations*/ (coefficient of infection = 5.0% or less)

Row num	Variety or cross and pedigree	Coefficient of infection
49	Brochis"s" CM5872-C-1Y-1M-3Y-3M-OY	0.6
73	Emu"s" CM8327-C-9M-4Y-3M-OY	0.8
47	Brochis"s" CM5872-C-1Y-1M-1Y-3M-OY	0.9
50	Brochis"s" CM5872-C-1Y-1M-3Y-1M-OY	0.9
53	Brochis"s" CM5872-C-1Y-5M-2Y-1M-OY	1.0
118	Cgñ x Kal-Bb CM15133-1M-3Y-4M-2Y-OY	1.1
45	Brochis"s"(B) CM5872-C-1Y-1M-1Y-1M-OY	1.1
54	Brochis"s" CM5872-C-1Y-5M-2Y-2M-OY	1.6
72	Emu"s" CM8327-C-9M-1Y-5M-1Y-OM	1.7
48	Brochis"s" CM5872-C-1Y-1M-1Y-4M-OY	1.9
44	Brochis"s" CM5872-C-1Y-1M-1Y-1M-OY	2.0
119	Cgñ x Kal-Bb CM15133-1M-3Y-6M-OY	2.1
51	Brochis"s" CM5872-C-1Y-5M-1Y-OM	2.2
98	(Cno^2 x Son-Kl.Rend/Ron)Sx CM8922-H-1M-1Y-3M-2Y-OM	2.2
74	Emu"s" CM8327-C-9M-4Y-8M-OY	2.4
52	Brochis"s" CM5872-C-1Y-5M-1Y-2M-OY	2.7
111	(21931/Ch53-An x Gb56)An64 Cdl CM11243-28Y-4M-3Y-OM	2.9
137	$Y50_E$-7C x Kal II28875-300Y-14M-1Y-1B-OY	3.1
75	Pavon"s" CM8399-D-4M-3Y-OM	3.3
71	Emu"s" CM8327-C-9M-1Y-2M-2Y1M-OY	3.3
128	Tl(La x Fr-KAD/Gb x Fr-KAD/Gb) CM23091-1M-1Y-OY	3.5
70	Emu"s" CM8327-C-9M-1Y-1M-1Y-OM	3.5
146	HD2167	3.5
46	Brochis"s" CM5872-C-1Y-1M-3Y-OM	3.5
106	Chiroca"s" CM8963-A-1M-1Y-1M-5Y-9M-OY	4.1
65	Moncho"s" CM8288-A-3M-6Y-5M-1Y-OM	4.2
117	Cgñ x Kal-Bb CM15133-1M-3Y-4M-2Y-OY	4.4
33	Blue Jay"s" CM5287-J-1Y-2M-1Y-4M-OY-501Y-OB	4.6
66	Moncho"s" CM8288-A-3M-6Y-5M-2Y-OM	4.7
59	Napo-Tob"s" x 8156/Kal-Bb CM7806-15M-2Y-2M-1Y-OM	4.8
147	HD2169	4.9

*/ 1. Oregon, U. S. A.
2. El Batan, Mexico.
3. Toluca, Mexico.
4. Tibaitata, Colombia.
5. Santa Catalina, Ecuador.
6. Carillanca, Chile.
7. Cebeco, The Nederlands.
8. Waageningen, The Nederlands.
9. Adapazari, Turkey.
10. Ege R.A.R.I., Turkey.
11. Mivhor Farm, Israel.
12. Sakha, Egypt.
13. Kulumsa, Ethiopia.
14. Njoro, Kenya.
15. Patnagar, India.

Table 4 . Breadwheat genotypes from the 7th. International Septoria Nursery resistant to *Septoria tritici* in most of 13 locations*/.

Row num	Variety or cross and pedigree	Country of origin	Locations 1	2	3	4	5	6	7	8	9	10	11	12	13
36	Pavon"s" CM8399-D-4M-3Y-OM	Mexico	4	6	3	3	20	T	95	1	5	4	3	2	2
51	Alondra"s" CM11683-A-1Y-1M-2Y-OM	Mexico	3	5	3	2	15	T	100	4	6	4	4	1	3
53	(Cno-7C x CC-Tob/7C)Cno-Chr x Flr-No66 CM8607-R-1M-2Y-5M-2Y-OM	Mexico	2	7	3	3	10	10	95	3	4	1	4	2	5
57	Jar66-Kvz x Yr70 CM20384-A-7Y-501M-502Y-OB	Mexico	6	4	1	5	15	T	100	3	5	4	4	2	3
58	Lee-RL2564 x Fr/IAS54 Br8706-13M-1Y-500M-OY	Brazil-Mexico	3	5	5	2	15	0	95	1	5	3	3	2	3
83	PAT 51	Brazil	3	5	8	2	20	10	90	E	4	2	4	2	5
119	Pch(Kt54A-N10B x Kt54B/Nar59) T2494-14T-4T-1v-OY	Chile	3	7	7	1	20	T	60	2	4	4	3	2	3
134	G139-117033 x Knott#2/Son64^2 x Kl.Pet-Son64 M1116-1-50-76	Egypt	4	8	-	1	30	10	25	1	4	8	4	2	3
145	Piamontes INTA-Gral Roca MAG B629-F8-7881-1-69	Argentina	3	3	6	4	30	-	20	1	3	4	3	1	3
147	IRN 1963, 409	Kenya	3	E	3	1	60	10	40	E	3	7	4	1	3
158	K6106.9	Kenya	3	7	6	1	15	T	90	E	4	3	4	2	3
215	Glea-Tob66 -2Y-OY-1Ptz	Canada	3	8	3	-	15	T	80	2	3	7	3	2	3
217	Glea-Tob66 -2Y-OY-1Ptz	Canada	4	4	8	T	20	T	80	2	3	7	4	2	3
238	Kvz-UP301 CM20596-12Y-1M-1Y-OY-3Ptz	Mexico	2	4	3	1	10	T	10	1	-	3	4	2	3
319	PF7182 -2Ptz	Brazil	1	6	3	T	10	T	30	E	4	7	2	2	5
321	Colonias -1Ptz	Brazil	3	5	4	T	10	20	20	E	4	8	2	1	5
322	Purple Straw (SN3805) -Ptz	Brazil	3	5	5	1	30	T	60	E	4	3	4	2	5
323	PF70216 -1Ptz	Brazil	3	E	3	3	10	T	40	E	5	2	3	2	3
324	PF70216 -2Ptz	Brazil	2	E	2	2	10	20	40	E	4	3	3	2	3

*/ Locations and scale used in each.

1. Patzcuaro, Mexico (0-9).
2. Indiana, USA (0-9).
3. Oregon, USA (0-9).
4. Cruz Alta, RS, Brazil (1-5).
5. Ponta Grossa, Parana, Brazil (%).
6. Caacupe, Paraguay (%).
7. Colonia, Uruguay (%).
8. Carillanca, Chile (0-9).
9. Elvas, Portugal (0-9).
10. Holetta, Shoa, Ethiopia (0-9).
11. Elsinburg, Cape, So. Africa (0-9).
12. Outiniqua, Cape, So. Africa (0-9).
13. Roseworthy, So.Austr., Australia (0-9).

Table 5 . Breadwheat genotypes from the 7th. International Septoria Nursery resistant to Septoria nodorum in most of 9 locations*/.

Row num	Variety or cross and pedigree	Country of origin	1	2	3	4	5	6	7**/	8	9
5	Cigüeña"s" 21406-62-300Y-301M-OY-500M-OY	Mexico	80	2	40	5	3	3	7	0	1
32	Moncho"s" CM8288-A-3M-6Y-5M-8Y-OM	Mexico	65	1	40	5	3	2	7	2	1
46	Bb-Kalyan CM9160-11M-5Y-4M-1Y-OM	Mexico	60	4	40	4	2	2	7	0	1
51	Alondra"s" CM11683-A-1Y-1M-2Y-OM	Mexico	50	4	20	4	1	2	7	0	0
53	(Cno-7C x CC-Tob/7C)Cno-Chr x x Flr-No66 CM8607-R-1M-2Y-5M-2Y-OM	Mexico	60	1	40	3	4	1	8	0	1
86	PAT 72617	Brazil	60	1	20	8	3	1	9	1	1
88	IAS-63	Brazil	50	-	50	5	2	1	8	1	1
94	B-15	Brazil	40	1	40	3	3	1	8	0	1
98	Veranopolis = FN.35	Brazil	50	2	40	2	5	1	9	0	0
135	Fn-K58 x N(Fr-KAD x Gb)^2 II14239-5t-1B-1t-2B-OY	Mexico-Colombia	80	1	40	4	3	3	7	0	2
150	Romany x Gabo-Gamenya	Kenya	60	-	30	3	3	2	8	2	2
159	Zg 751.21	Yugoslavia	50	1	80	3	2	2	7	0	1
183	Tzpp-Son64/Cno-Jar x Kvz CM20707-A-1Y-8M-1Y-OY-4Ptz	Mexico	70	2	30	T	1	2	8	1	1
187	Ktz M12-Tanori 71 CM14952-64M-5Y-5M-OY-4Ptz	Mexico	60	1	40	5	2	2	8	1	1
188	Pak 20-Calidad CM15264-1M-4Y-5M-4Y-OY-1Ptz	Mexico	60	1	30	7	3	1	8	1	1
189	Pak 20-Calidad CM15264-1M-4Y-5M-4Y-OY-2Ptz	Mexico	60	2	30	7	3	2	8	1	1
190	Pak 20-Calidad	Mexico	50	2	30	3	4	2	8	1	1

*/ Localities and scale used in each.

1. Alabama, USA (%)
2. Cruz Alta, RS, Brazil (1-5)
3. Ponta Grossa, Parana, Brazil (%)
4. Versailles, France (0-9)
5. Weibullsholm, Sweden (0-10)
6. Bavaria, West Germany (1-9)
7. Bohemia, Czechoslovakia (9-0)
8. Elsinbourgh, Cape, So. Africa (0-5)
9. Outiniqua, Cape, So. Africa (0-5)

**/ Scale used in Czechoslovakia represents: 9 = most resistant; 0 = most susceptible.

Table 6. Breadwheat genotypes from the 7th. International Septoria Nursery highly resistant to powdery mildew in 5 locations*/.

Row num	Variety or cross and pedigree	Country of origin	1	2	3	4	5
2	UQ105 = Condor"s"	Australia	5	2	4	3	10
5	Cigüeña"s" 21406-62-300Y-301M-0Y-500M-OY	Mexico	5	4	1	2	0
54	CC-Kal(Az67 x Nad-LR64/Bb) CM11663-E-1Y-1M-2Y-OM	Mexico	5	3	1	2	T
55	Lee-Kvz/CC x Ron-Cha CM16780-J-1M-2Y-500M-OY	Mexico	3	0	2	2	0
56	Lee-Kvz/CC x Ron-Cha CM16780-J-1M-2Y-501M-OY	Mexico	1	0	2	2	0
57	Jar66-Kvz x Yr CM20834-A-7Y-501M-502Y-OB	Mexico	1	0	3	2	0
72	Tito"s" CM8212-C-1M-5Y-1M-13Y-500M-OY	Mexico	3	4	3	3	0
77	IAS57	Brazil	3	2	1	2	10
87	PAT72195	Brazil	5	4	3	2	0
96	B.1701	Brazil	5	4	3	2	20
117	Pb^2-Mq_E RL-4219	Canada	4	2	2	2	5
122	Bon-AfM^2 13022-9B01t-2B-1t-1B-OY	Colombia	3	4	4	2	10
125	CI13654 x II60.105-II64.20	USA	5	3	4	2	5
130	K4500.4	Kenya	3	0	0	2	T
131	Pb-Mq_E RL-4219	Canada	4	1	1	2	T
148	On-TR135 x Cdl 31230-Tu-1MB-5BJ	Tunisia	4	0	1	2	0
152	Kafue PI314909	Kenya	4	3	3	3	0
157	S12.B8-Pj62 B549-101C-102C-OC-2M-OY	Brazil	4	2	0	4	0
158	K6106.9	Kenya	4	2	0	2	0
162	(Jar/Lee-Sk x Mara)Pato(B) Inia"s" -Cal x Inia"s"-CC/Cj71 CM21079-A-6Y-9M-2Y-OY-2Ptz	Mexico	3	3	3	2	0
171	Ulucak #2 = Cno"s"-Gallo 27829-19Y-2M-3Y-OM-2Ptz	Mexico-Turkey	3	0	2	2	15
181	Tzpp-Son/Cno-Jar x Kvz CM20707-A-1Y-8M-1Y-OY-1Ptz	Mexico	5	T	1	2	0
182	Id CM20707-A-1Y-8M-1Y-OY-2Ptz	Mexico	3	T	1	2	0
183	Id CM20707-A-1Y-8M-1Y-0Y-3Ptz	Mexico	3	T	2	2	0
238	Kvz-UP301 CM20596-12Y-1M-1Y-OY-3Ptz	Mexico	4	T	1	2	0
256	Cardenal II27105-2M-300Y-9Y-OU-1Ptz	Mexico	4	0	0	2	0
258	Brochis"s" CM5872-C-1Y-5M-2Y-2M-OY-1Ptz	Mexico	3	4	2	2	0
293	$Tzpp^2$-An_E x Inia/Cno-Jar x Kvz CM1335-C-9Y-3M-1Y-OY-3Ptz	Mexico	3	0	5	3	5

*/ Localities and scale used in each.
1. Oregon, USA (0-9)
2. Ponta Grossa, RS, Brazil (0-9)
3. Weibullsholm, Sweden (0-10)
4. Bavaria, West Germany (1-9)
5. Outiniqua, Cape, So. Africa (%).

Table 7. Breadwheat genotypes most resistant (less than 1.0% smutted heads) to *Ustilago nuda* under artificial inoculations in the field. Yaqui Valley, Sonora, Mexico 1977-1978.

CROSSING BLOCK Y.77-78

Row num	Variety or cross and pedigree
2	Cocoraque 75
5	Tanori 71 (Reseleccion)
19	Tezopaco 76 Br69-1Y-3M-3Y-OM
21	Sapsucker"s" Br69-1Y-3M-7Y-OM
28	Bulbul"s" Pak2858-7a-3a-4a-0a
32	Y50$_E$-Kal^3 II35188-5M(F1)-31Y-OM-2M-OY
33	Soltane
52	Alondra"s" CM11683-A-1Y-1M-3Y-OM
61	HD.2182
64	Glenlea
95	Cno"s"-Inia"s" x Lfn6Tob x Kl.Pet-Raf CM2281-13M-1Y-3M-1Y-1M-OY
109	Cal x Cno-Son64(Cno x Nad-Chris"s"/ Son-Kl.Rend x Bb) CM5774-A-8Y-1M-1Y-4M-OY
155	Inia"s"-Napo x Tob66 II27078-8M-1Y-1M-OY
174	3221/76
210	Rq"s"-Pal#2/Kl.Pet-Raf x Sx II30724-K-2C-OC-500M-500Y
221	Cno"s"-Pj62 x On-II.60.147/Bb-Gallo CM31026-Q-1Y-1M-4Y-1M-OY
260	Kvz/Cno-Chris x On SE375-12S-3S-OS-OY
258	IAS 58
305	IAS 20 x Wt^3_E-Nar59 CMH-74A.654-2B-2Y-1B-500Y-OM
310	Pel 73280-Arthur 71

CROSSING BLOCK Y.77-78

Row num	Variety or cross and pedigree
22	Sapsucker"s" Br69-1Y-3M-2Y-1M-OY
60	Yecorato"s" II40041-12M-7R-OM
75	T4-C306 P32.9.4
142	Jar66-Kvz x Yr70 = Pamir"s" CM20834-A-7Y-501M-502Y-OB
283	PAT 7219

MISCELLANEOUS BREADWHEATS Y 77-78

Row num	Variety or cross and pedigree
65	Cno-7C x CC-Tob/SD648.5-8156(R) = Como"s" CM4756-12Y-1M-3Y-3M-OY
81	Tob66-Cno"s" 24908-30M-3Y-3M-OY-1SK
87	Tob"s"-8156 x Y50$_E$-Kal^3 CM15624-4S-5S-0S
120	H.212.70-Cameltooth CMH72A.235-2B-2Y-1B-1Y
123	UM530/CB100 Material de Briggs
126	Yt 28
129	PF69129
184	P.I.225466
50	S948.A1-SE^5 H567.71-6Y-1B-1Y-1B-OY
70	Bage
83	Ska-Lfn CM6347-5S-5S-0S

Table 8. Durum wheat genotypes from the Crossing Block Durum Y.77-78, most resistant (1.0% or less smutted heads) to Ustilago nuda under artificial inoculations in the field. Yaqui Valley, Sonora, Mexico 1977-1978.

Row num	Variety or cross and pedigree
1	Barrigon Yaqui
5	Jori C-69
6	Cocorit 71
7	Mexicali 75
20	Maghreb 72
22	Anhinga"s" D22234-52M-3Y-1M-OY
24	JNK
29	Mallard"s" Cd1894-3Y-OY-OM
30	Mexi"s"-Fg"s" CD1895-12Y-Oy-OM
31	Mexi"s"-Fg"s" CD1895-12Y-OY-4E-OB
32	Tc60-Cit"s" x Rabi"s" CD4360-A-3Y-1M-1Y-OM
33	Bittern"s" CM9799-126M-1M-4Y-OY
35	Snipe"s" CM13414-1Y-2M-OY
36	Snipe"s" CM13414-3M-OY
37	Goose"s" CM10143-19M-2Y-1M-1Y-OY
40	Plc"s"-Ibis"s" x Gta"s"-Rtte CM17904-B-3M-1Y-1Y-OY
41	Ibis"s"-Gta"s" CM18577-11Y-9Y-OY
42	Gull"s" D27606-4M-1Y-OM
43	S15-Cr"s" D33312-7Y-2M-1Y-OM
44	Mexi"s"-Fg"s" CD1895-12Y-OY-3E-OB
45	Coot"s"-Mexi"w" CD3857-2Y-OY
47	S15-Cr"s" CD7469-2Y-5M-OY
60	Lds Mut-Ptl"s" CM17583-20M-1Y-1Y-1Y-OM
61	Lds Mut-Gta"s" CM18347-500Y-4Y-OM
64	Coot"s" CM225-10M-1Y-OM-1Y-OY
68	Gta"s" D31725-3M-8Y-OM
79	Erpel"s" CD1247-D-6Y-2Y-OY
81	Mexi"s"-Gta"s" CD1896-1Y-3Y-OY
82	Mallard"s" x Magh"s"-AA"s" CD5057-D-4Y-OM
84	Grebe"s" CD14432-C-1Y-3M-1Y-OM
89	Mexi"s"-Kiwi"s" CD537-2M-1Y-OY
91	Gta"s"-6517 x Fg"s" CM17728-C-4M-4Y-OY
92	Flamingo"s" D27582-8M-13Y-2M-OY
93	Jori"s"-Crane"s" D27591-5M-3Y-1M-OY
95	Rabi"s"-31810 CM10172-37M-OY-2Y-OY
98	65-150 x Lds
101	Gta"s"-Mexi"s" CD771-17Y-OY
102	(Gr"s"-Fg"s"/21563-Gs"s" x Cit"s")P66/270 CD1074-1Y-3Y-OM
103	Cit"s"-Fg"s" CD3568-8Y-OM
105	Mexi"s"-21563 x AA"s" CD3935-4Y-3M-OY
106	Gta"s"-Fg"s" CM10145-15M-1Y-1M-3Y-OY
107	GdoVZ.471-Br"s" x Pg"s" CM13919-11Y-2Y-OY
111	21563-AA"s" D27625-5M-2Y-2M-1Y-1M-OY-OM
112	Avetoro"s" D32864-6Y-1M-3Y-OM
115	Gdo VZ.469-Plc"s" CM373-3M-2Y-1M-OY
116	Gdo VZ.471-Br"s" x Pg"s" CM13919-11Y-2M-2Y-OY
117	Tern"s" CM17835-B-2M-6Y-OM
118	Gaviota"s" D31725-3M-12Y-2M-OY
122	Goose"s" CM10143-6M-3Y-1M-2Oy-OY
129	Colonias
142	Ptl"s" x S15-Cr"s" CD2686-A-1Y-1Y-OY
145	Mallard"s"-Rabi"s" CD4502-U-4Y-7M-OY
146	Cano 2111-AA"s" x Plc"s"-Cr"s" CD4755-A-2Y-1M-OY
147	Cit"s"-MCa"s"(Pg"s"/Gll"s" x Lds-56.1) CM14662-I-500Y-1M-3Y-1Y-OY
148	It CM14662-I-500Y-1M-3Y-2Y-OY
153	Ato"s" x AA"s"-Plc"s" CD1859-1B-500B-OY
154	Vo1658-Mexi"s" x Ruff"s" CD4389-A-1Y-1M-OY
155	Boyeros"s" CD4404-B-9Y-3M-OY
156	Mallard"s"-Pg"s" CD4501-N-4Y-9M-OY
158	Gdo VZ.471-Br"s" x Pg"s" CM13919-34Y-4Y-3Y-OY
159	Lds Mut-Gta"s" CM18347-500Y-1Y-OY
160	Ruff"s" x Jori"s"-Cr"s" CM18537-1Y-OY
161	Mario"s" D31750-1M-2Y-1M-OY
87	21563/61.130 x Lds D26844-18Y-4M-OY

Table 9 . Triticale genotypes from the Crossing Block Triticale Y.77-78 highly resistant (immune, almost no smutted heads) to *Ustilago nuda* under artificial inoculations in the field. Yaqui Valley, Sonora, Mexico 1977-1978.

Row Num	Variety or cross and pedigree
504	Cinnamon"R"
505	Camel"s"
516	Rahum"s"
519	Yoco"R" 100M-0Y
521	Beagle"s"
523	Navojoa"s" X2802-38N-3M-6N-4M-OY
524	Navojoa"R" X2802-38N-3M-6N-6M-OY-2B-OY
525	Arabian"R" X2802-38N-5M-6N-6M-1Y-1M-OY
526	Bacum"s" X2832-24N-3M-8N-1M-1Y-1M-2Y-OM
528	Koala"s" X2091-100Y-101B-2N-2M-4Y-1M-OY
530	Beagle 510 X1530-A-12M-5Y-1M-1Y-100M-OY
531	Beagle"s" 330 X1530-A-12M-3Y-3M-1Y-OM-1M-OY
538	M2A^2.610 X12514-6M-100Y-OM
544	IRA^2 670 X8319-A-3Y-1M-OY
545	IRA^2 321 X8292-C-3Y-2M-1Y-OY
547	M2A-IRA 720 X11799-7M-2Y-OY
550	M2A-Fs 722 X12845-5Y-4Y-1M-100Y-OM
551	M2A-WW15 X17045-1Y-1M-OY
552	M2A-Beagle X15490-3M-OY
553	M2A-Arm"s" x Bgl X15733-15Y-3M-2Y-1M-OY
556	Cml"s"-Kal X14861-2Y-1Y-1Y-2B-OY
557	Cml"s"-Pato 454
560	Tob-Cno"s" x M2A X14455-B-101Y-100B-102Y-OY
561	Tejon-IRA 101 X13895-B-100Y-100B-103Y-1M--100Y-1M-OY
562	FW 121-Prol x Cin 272 X7267-27M-2Y-3M-OY
571	Bgc-IA x Bb/M2A-Cin X16375-102Y-OY-100M-OY
577	Octo OC-Agrotr. X7224-10M-1Y-100M-OY
578	IRA-Cml 122 X8326-C-1Y-1M-100Y-106B-107Y-1Y--2M-2Y-OM
580	M2A 921 X2802-9N-2M-3N-1M-3Y-1M-1Y-OM
585	Tejon-IRA 120 X13895-B-100Y-100B-1M-2Y-OM
588	IA-Bush X7254-29M-1Y-OM
591	M2A-IRA 172 X8417-E-1Y-7M-2Y-OY
593	M2A-Canada X8208-G-1Y-2M-3Y-OY
595	M2A-Camel 100 X8155-C-1Y-1M-1Y-OY
596	M2A-Camel 112 X8157-B-1Y-1M-2Y-OY
597	IRA-Camel 431 X8308-B-4Y-3M-1Y-OY
599	M2A-IRA x M2A/Cin X11319-B-yM-1Y-OY
600	Koala^2 X8828-A-1Y-6M-1Y-OY
601	IRA-Camel X8305-C-3Y-1M-1Y-OY
604	UM.2038 -1M-OY
606	70HN470-Koala X13393-19Y-100B-100Y-2Y-4M-OY
609	Bgl"s"/ARS-Mexipak Muti x Beagle"s" X22473-102Y-100Y-6M-OY
611	Octo-Hexa x IRA X16723-6Y-1Y-1M-OY
615	Bgl"s"^{2}x ITA-LEO X22427-101Y-2M-2Y-OM
616	Camel-Pato 155 X8064-13M-1Y-2M-Oy-2B-OY-100M-OY
625	Arabian"s" X2802-38N-5M-6N-5M-OY
627	Beagle"s"-Cinnamon"s" X21535-6M-OY
628	DRIRA-IA X16641-103B-101Y-1Y-2M-OY

Table 9 . Cont........

Row num	Variety or cross and pedigree
565	Jo-Cent.Bulk x IA X16201-100B-101Y-1Y-OM
567	IRA-M2A 114 X12937-B-1Y-1Y-4M-OY
633	M2A-Camel 251 X8386-D-2Y-OM-100Y-102B-105Y-1M--1Y-OM
634	M2A-Camel 360 X8386-D-2Y-OM-100Y-103B-106Y-OY
635	M1A-Camel 380 X8386-D-2Y-OM-100Y-103B-108Y-OY
636	FS381-FS477 X17014-A-100Y-100Y-3M-OY
637	Chapala-Snoopy x M2A X22652-100Y-101Y-OM
639	Beagle-IGA 11 X23892-C-101Y-11M-OY
640	IA-M2A X11060-D-2M-1Y-OY
642	M2A-Cal X17063-2N-OM
643	IRA^2 X8346-B-1Y-1M-1Y-OY
644	M2A-IA 130 X12677-56Y-1Y-3M-OY
645	Rahum"s"-IRA x Fs477 X26115-E-1Y-2M-102Y-OY
647	$M2A^2$ 351 X12514-35Y-1Y-1M-OY
648	M2A-IRA 401 X12629-40Y-1Y-1M-OY
649	M2A-IRA 120 X12577-32Y-1Y-2M-OY
650	M2A-Koala"s" X12701-20Y-1Y-2M-OY
651	M2A-Fs722 X12845-11Y-2Y-1M-OY
652	Camel-Pato 567
655	M2A-IRA 321 X8229-D-3Y-2M-2Y-OY
660	IRA-Camel 112 X8305-B-1Y-1M-1Y-1Y-2M-100Y-OM
665	Cinnamon M2A X11100-A-2M-100Y-0Y
666	IRA-Penjamo 62 X10488-A-2Y-2M-1Y-OY
671	M2A-Cinnamon X12545-19Y-1Y-2M-OY
672	M2A-Camel 132 X8399-C-1Y-3M-2Y-OY
631	M2A-Camel 202 X8386-D-2Y-OM-100Y-102B-100Y-1Y-OM
632	M2A-Camel 203 X8386-D-2Y-OM-100Y-102B-103Y-OY
679	$M2A^2$-Koala X10895-B-3M-2Y-1Y-1M-OY
683	Cinnamon-Potam 70-IA X14082-A-1Y-4Y-1M-OY
685	IRA-Fs3854 X7555-13M-2Y-100M-OY-100Y-3M-0Y
686	Mapache"s" X2802-F-12M-1N-2M-OY
688	Koala x Octo-Hexa X7203-3M-1Y-1M-OY
689	Cinnamon-PI251923 x Pato X8061-2M-1Y-1M-3Y-2B-ON
691	M2A-UP301 x Beagle"s" X16378-2Y-OB-1Y-OM
692	$M2A^2$-Beagle X15733-1N-OM
693	Cinnamon-Ciano x Beagle X16337-2N-OM
695	M2A-Koala"s" X12701-25Y-4Y-1M-OM
696	M2A-Camel 211 X8386-A-2Y-1M-1Y-1Y-4M-100Y-1M-OY
697	$M2A^2$-Snoopy X16379-10Y-1Y-2M-OY
698	Tobi-Armadillo"s" -54N-1B-OY
699	UM940"s"-Mayo 64 X1039-14M-1Y-16M-1Y-OM
700	UM940"s"-Mayo 64 x IRA X15663-OY-1BV-OY
701	BGA 20 X23892-C-101Y-2M-OY
702	Neagle"s"-Cinnamon X8378-F-3Y-2M-1Y-2Y-1Y-1M-OY
703	Aries-Calidad X8144-5M-1Y-1M-2Y-2Y-1M-100Y-1M-OY
704	Beagle-Tanori 71 X14536-26Y-100Y-12M-OY
705	M2A 371 X2802-37N-1M-4N-2M-2Y-2M-1Y-OM
710	M2A-IRA 110 X8516-E-1Y-1M-OY
711	M2A-IRA 812 X12566-8Y-1Y-2M-2Y-OM
712	M2A-Fs 722 X12845-11Y-1Y-1Y-1M-OY

Table 9 . Cont ......

Row num	Variety or cross and pedigree	Row num	Variety or Cross and pedigree
673	M2A-Leo"s" X12736-28Y-1Y-1M-OY	713	$M2A^2$-Snoopy X16379-5Y-3Y-1M-OY
674	M2A-IA 220 X12677-44Y-2Y-2M-OY	714	IA-Cinnamon X11193-A-100M-0Y-100M-0Y
675	M2A-IA 160 X12665-14Y-1Y-6M-OY	718	$M2A^2$-IRA X17156-B-1Y-1M-2Y-OM
721	Beagle"s"^{2}-Coyote X22482-100Y-1Y-1M-0Y	750	$M2A^2$-UM94-"s" x ITA X11327-B-4M-1Y-1Y-4M-0Y
727	IGA-IRA X8430-A-2Y-1M-2Y-OY	752	M2A-Tanori 71 X14679-15Y-1Y-OY
728	M2A-Cinnamon X8286-B-2Y-1M-OY	757	$M2A^2$-A-1Y-1Y-4M-OY X14120-A-1Y-1Y-4M-0Y
733	Jupateco-Sarde V	758	IRA-M2A 350 X12937-B-1Y-3Y-5M-OY
735	$M2A^2$ 421 X8266-H-4Y-2M-1Y-OY	759	IA-IRA x Bui X12257-2N-OM
736	$M2A^2$ 422 X8266-H-4Y-2M-2Y-OY	760	IA^2 X8436-H-3Y-10M-1Y-OY
738	IRA^2 272 X8327-H-3Y-3M-1Y-OY	582	M2A x Koala-Bruin"s" X10892-A-1M-1Y-OY
741	Beagle"s" 552	589	Maya-Armadillo"s" 105
743	IRA-Beagle"s" X15570-3Y-2B-ON	725	M2A-Camel 311 X8534-A-3Y-1M-1Y-OY
748	Beagle"s"-Bulk E2 X11066-E-9M-2Y-OY		
749	M2A-IA 130 X12677-56Y-1Y-3M-OY		

Table 10. Barley genotypes from the Crossing Block Y.77-78 most resistant (less than 1.0% smutted heads) to Ustilago nuda under artificial inoculations in the field. Yaqui Valley, Sonora, Mexico 1977-1978.

Row num	Variety or cross and pedigree
8	Bathim 10
24	Benton
25	Gaines
28	Godiva
35	Cq-UN6, UN3
36	Bonanza-2.23 SS-2152
37	TRA-UTAH Hulless Sel 6395.66
53	C-63
54	Heines Standard
61	MOR-BURF 9 x Pro/Toll-Api XV-1836-1M-1Y-4M-2Y
64	Cer/Por x Tra-Api XV-2508-3R-3C-1R-OM
65	M9313A/M2/GAS XV-4560-1R-3M-2R-OM
71	C.I.3909.2 502Y-500B-501Y-OB
72	M65.95 500Y-501B-500Y-OB
79	Bco. Mr-Gva CMB72-121A-500Y-500B-501B- -503Y-OY
82	Apam-EB 1053 x Pro-Dwarf 21 CMB72-212C-12Y-500B-500Y-500B-OY
89	M65.95-M66.123 x BGS.0252 CMB73-364-27B-500Y-500B-OY
90	CM67-U.Sask 1800 x Pro-CM67 CMB.72A-160-I-1B-7Y-500B-OY
98	Tequila CMB72-189-11Y-3B-1Y-OB
100	Api-CM67 x Mzq CMB73A-367-500B-500Y-OB
101	Bal.16-Manker x Choya CMB73-977-A-500B-501Y-500B-OY
107	Apam-IB65 x Gva CMB-73A-349-12B-500Y-OB
116	M69.77-Shi-r-KCI No.87 CMB.73-2Y-4B-500Y-502B-OY
126	Tokak Mutant - GAS CMB.74A-883-500M-OY
143	Apam-ATHS x 10985.1-Apam CMB.73A-1338-B-9B-1Y-500B-OY
183	C.I.1237-Manker/Ds-Apro x 11016.2 CMB.74-1254-A-2Y-5B-500Y-OB
189	Cal-Mr x Ds-Apro CMB.73A-42-12B-2Y-3B-500Y-OB
207	OC.640-Mari CMB.73-336-500B-500Y-OB
221	P.71318
223	W.W. Wing
227	WI.2198
228	Weeah
229	Noyep
233	NWCL
234	Abyin
238	Universe
241	Maris Dingo
249	N.S.36
250	Nacta 501Y-502B-500Y-OB
303	CM67-U.Sask 1800 x Pro-CM67/Ben CMB.75-522-4Y-500B-OY
304	Cambrinus-B1 CMB.74A-811 6M-1Y-500B-OY
305	Api-CM67 x HBCC XXVIII CMB 74A-967-6M-1Y-500B-OY
311	F3 Bulk 645-1Y-2M-OY
81	Apam-Dwarf II-1Y x Por-Kn27 CMB.72-207-A-501Y-501B-500Y-OB
91	Gizeh 134-Apam CMB.72-127-7Y-1B-2Y-500B-OY
96	CM67-U.Sask 1744 CMB.72-45-19Y-2B-2Y-OB
136	Api-CM67 x Bus/Bco.Mr x Ds-Apro CMB.74-1187-C-2Y-500B-OY
184	69.82 x Ds-Apro CMB.73A-472-19Y-2B-500Y-OB
300	C.I.3909.2 x M66.151-Manker CMB.73A-287-5B-2Y-1B-500Y-500B-OY

Table 11. Barley genotypes from the Miscelaneous Barley Y.77-78 most resistant (less than 1.0% smutted heads) to Ustilago nuda under artificial inoculations in the field. Yaqui Valley, Sonora, Mexico 1977-1978.

Row num	Variety or cross and pedigree	Row num	Variety or cross and pedigree
1	Tulelake collection	194	Liberty C.I.9549
2	Aurore-Experance	199	Keystone C.I.10877
10	Row 906/73	207	C.I.12125
11	Row 924/73	235	Forezzia x 1087-2L
16	P.I.2325	237	(Fun-H45 x P.I.3604-Fun/Aut.Nor x Bz Winn/Cer/Poo^2 x Tol I XV1856)Aths 4L
37	Pot^2-LoR XV-3704-1C-1R-2M-OR	242	Promesa-B.140 CMB.72A-11-1L-1B
50	Atlas-Kindred	270	Hokudo
52	Por-TP x Cq-Api XV-3696-1C-2R-1M-1B	304	DL-75
54	CL.7207-Olli 10-W-268/21/2-1Y-1B	305	DL-73-14
		342	Porvenir
69	Mat.Rass-209-1Y-1B	354	5106 1B-501Y-500B-500Y-OB
72	Mat.Helm-1524-1Y-1B		
82	Abyssinian-2	357	Api-CM67 CMB.7260-500Y-500B-504Y-OB
83	Jet		
84	Abyssinian-3	365	H.269 1Y-1B-2Y-500B-OY
85	Abyssinian-4	367	Ore"s" CMB.72A-243-H-500B-506Y-500B-OY
95	C.I.5823		
98	C.I.16141	370	Apam-MC 1905 B4.72A-4B-1Y-1B-2Y-OB
100	C.I.16151		
101	C.I.16153	387	Larker
108	Asse-Nackta 6399/3002-1B-1Y-1B	389	Beacon
		392	Conquest
129	Desnuda Precoz 1Y-1B	397	Minn.906
		404	Hembar
130	Desnuda Sueca 1Y-1B	452	Dijon-3-5-2
141	Psaknon E.1973	458	13906-Nv x NKD-1
		489	Karl
143	SM.4142 E.1974	490	Baladi 16 C.I.11187
159	Belle	496	11012-2
165	8-Cr 254/22/2 C.I.4977 - Giza 117	502	11012.2-CM67 x Por-U.Sask 1800 CMB-73A-1116-A-500B-500Y-OB
171	Bolivia C.I.1257	503	Chamizo CMB.73-141-6Y-1B-500Y-OB
172	Kitchin C.I.1296	515	CM67-Centeno x Celaya CMH.76A-1014-1B
176	Abyssinian C.I.3940	540	M16-OC.634 CMH.76-1377-3Y-1B
181	Dickson 452 C.I.5802	552	Dorada (2h)
190	Feebar C.I.7260	91	Nigrinudum

TABLE 12 . Assessment of leaf rust infection on Thatcher-backcross lines each with a single resistance gene in the 1978 uniform leaf rust nursery from 11 locations in Mexico.

		L O C A T I O N S											
		W I N T E R 1 9 7 7 - 1 9 7 8					S U M M E R 1 9 7 8						
Source of resistance	Leaf rust resistance gene(Lr-)	Ciano Sonora	Los Mochis Sinaloa	Sgo Ixcuintla Nayarit	Rio Bravo Tamaulipas	Poza Rica Veracruz	Toluca Mexico	El Batan Mexico	Celaya Guanajuato	El Refugio Guanajuato	Nestipac Jalisco	Navidad Nuevo Leon	Average Coefficient of infection
Centenario	1	40S	5S	70S	90S	60S	50S	80S	80S	80S	80S	70S	64.09
Webster	2a	30S	5MR	80S	80S	60S	80MS	90S	80S	80S	90S	80S	66.91
Carina	2b	30S	20MR	80S	80S	60S	80S	70S	70S	80S	90S	80S	66.18
Loros	2c	40MS	30MS	80S	80S	50S	70S	90S	80S	80S	90S	80S	68.73
Democrat	3	40S	50MR	80S	90S	80S	80S	90S	100S	80S	90S	80S	77.27
Aniversario	3ka	40R	40MS	20MS	50MR	TR	TMR	70S	70MS	60MS	40MR	20R	24.60
Transfer	9	0	TR	TS	TR	TR	0	TR	TR	5MR	0	TR	.38
Exchange	10	10S	20MS	TMS	80S	40S	30S	80S	40MS	80S	30MS	50MS	39.35
Exchange	12	30S	40S	-	70X	40S	50MS	80S	80S	100S	80S	90S	66.00
Manitou	13	20MR	30MR	TMS	60S	10MS	70MS	90S	70S	70S	90S	70S	48.62
Selkirk	14a	50S	40MS	80S	90S	50S	70S	80S	90S	80S	90S	80S	72.00
Maria Escobar	14b	20S	60MS	80S	80MS	40S	50MS	80S	80S	80MS	60MS	30R	51.82
W183	15	50S	60S	80S	90S	50MS	60S	80S	40MS	90S	90S	100S	70.18
Exchange	16	40MS	50MS	-	60MR	40MS	50MS	90S	60MS	90MS	70S	30MR	46.00
Klein Lucero	17	10MS	50S	40S	60MS	20MR	70S	70S	80S	80S	80S	40MR	50.00
Africa 43	18	10MR	30R	TR	60MS	40S	40MS	100S	80S	80S	100S	70S	50.93
T4	19	0	0	TR	TR	TR	0	5MR	TMS	TMR	0	TR	.36
RL 5406	21	5MR	20MR	10S	30MR	TR	TMS	10MR	40MS	40MS	50S	5R	14.91
RL 5404	22	5MR	5MR	TS	40R	TR	TMR	70S	50MS	30MS	40MS	5MR	16.51
Lee 310	23	TMS	50MR	TMR	80MS	10MS	50MS	90S	60MS	70S	60S	30S	39.20
Agent	24	0	0	40MS	30MS	TR	0	TR	20R	20MS	0	TMR	6.98
El Gaucho	"EG"	10MR	60MS	TMR	60MS	20MS	TR	50S	70MS	70MS	90S	30S	36.24
Terenzio	"T"	20MS	10MR	80S	40MS	5MR	30MS	30S	50MR	40MS	40MR	TMR	23.31
Carina	"B.	60S	60S	20MR	80S	-	5MS	80S	70S	90S	100S	90S	64.20
Exchange	"Exch"	40MS	-	-	70MS	10MR	10MS	90S	70S	90S	90S	90S	58.89
PI 58548	"1+"	10MS	50MR	-	50MS	20MS	20MS	70S	60MS	30S	70S	40MR	38.40
PI 263816	"C"	40MR	70S	40S	60MS	20MS	40MS	80S	60MS	80S	90S	80S	54.55
Thatcher	-	40S	50S	100S	90S	50S	40MS	90S	80S	100S	80S	90S	72.91

TABLE 13. Assessment of stem rust infection on wheat lines each with a single resistance gene in the 1978 uniform stem rust nursery, from 8 locations in Mexico.

Line or Cultivar	Stem rust resistance gene(Sr-)	LOCATIONS: WINTER 1977 - 1978			SUMMER 1978					Average coefficient of infection
		Ciano Sonora	Sgo. Ixcuintla Nayarit	Rio Bravo Tamaulipas	Toluca Mexico	El Batan Mexico	Celaya Guanajuato	El Refugio Guanajuato	Navidad Nuevo Leon	
Pre^6-Rel	5	40S	30MS	90S	80S	60MS	80S	80MS	40S	58.25
CI-14165	7b	10S	80S	-	50S	20S	30S	40S	30S	51.43
CI-14167	8	5MS	80S	5MR	60S	20S	50S	80S	60S	44.50
CI-14169	9a	5S	80S	TR	70S	10S	10S	70S	40S	35.65
CI-17386	9b	10S	80S	80S	-	-	-	-	-	56.67[a]
CI-14177	9d	5S	80S	50MS	70S	10S	50S	70S	50S	46.88
Vernstein	9e	0	20MS	80S	0	0	80S	50MS	0	27.00
CI- 17388	10	0	40S	60S	0	10MR	10R	10S	5MR	14.75
Line AG	11	10S	40S	90S	-	-	-	-	-	46.67[a]
$ChSp^5$-Tc3b	12	30S	60S	TMR	50S	TS	80S	40MS	20MS	33.68
CI-17387	13	5MS	20MS	50MS	10MR	TS	40MS	30S	5MS	16.38
Line A	14	5MS	30S	60MS	40S	5S	TMR	20MS	10MS	18.93
Line AB	15	40S	10S	90S	70S	50MS	60S	80MS	60MS	52.75
I Sr16 Ra	16	10S	90S	TR	40S	20S	60S	60S	10MS	36.03
LC17 KH	17	TMS	80S	50MS	30MR	10S	80S	30MS	5MS	31.35
Mq^6 x St-RL5244	22	0	30MS	50MS	0	TR	TR	5MR	TR	8.33
Exchange	23	0	30S	20MR	-	-	-	-	-	12.67[a]
Agent	24	0	TS	60MS	0	TR	TMR	TMR	0	6.25
Agatha	25	0	TMR	TR	20MR	0	0	20MR	0	2.08
Eagle	26	0	30S	50S	TR	0	TMR	10MR	5R	10.70
CI-14441	27	0	TMR	0	0	0	TR	0	0	.08
Pusa-Et.Choisy	29	0	TR	-	5MR	0	20S	70S	10MS	14.31
Bt Sr30 Wst	30	0	10MS	20MR	0	0	10MR	50MR	5R	5.13
CI-17385	Tt-1	0	-	80MS	5R	0	5S	20MS	10MR	12.86
W3563-Tt2	Tt-2	0	10MS	80S	0	0	TMS	0	0	11.10
Gamut	Gt^+	0	10MS	50MS	0	-	TR	TR	0	6.91

a/ Coefficient of infection reflects only winter planted nurseries.

TABLE 14 . Comparison among 8 Mexican locations for stem rust and 11 locations for leaf rust by average coefficient of rust infection in lines that carry a single resistance gene in the 1978 uniform rust nurseries.

Disease	L O C A T I O N S										
	Ciano a/ Sonora	Los Mochis Sinaloa	Sgo Ixcuintla Nayarit	Rio Bravo Tamaulipas	Poza Rica Veracruz	Toluca a/ Mexico	El Batan a/ Mexico	Celaya Guanajuato	El Refugio Guanajuato	Nestipac Jalisco	Navidad Nuevo Leon
Stem rust b/	6.7	- c/	36.6	41.6	- c/	24.2	8.6	28.1	31.3	- c/	14.1
Leaf rust d/	20.5	25.1	40.0	53.2	26.7	37.4	67.7	56.3	65.6	64.5	46.7

a/ Locations where inoculum was released intensely on experimental plots and may have reached uniform nurseries.

b/ Average of 26 lines for stem rust.

c/ Very low and erratic occurence.

d/ Average of 28 lines for leaf rust.

TABLE 15 . Assessment of wheat leaf rust infection on previously resistant advanced lines and on commercial varieties in the 1978 uniform leaf rust nursery from 10 locations in Mexico.

Line or variety	L O C A T I O N S									
	W I N T E R 1 9 7 7 - 1 9 7 8				S U M M E R 1 9 7 8					
	Ciano Sonora	Los Mochis Sinaloa	Rio Bravo Tamaulipas	Poza Rica Veracruz	Toluca Mexico	El Batan Mexico	Celaya Guanajuato	El Refugio Guanajuato	Nestipac Jalisco	Navidad Nuevo Leon
(Tob-B.Man x Bb/Cdl)Sx CM-8972-F-9M-1Y-1M-1Y-0M	TR	0	TR	0	0	TMR	TMS	TMR	TR	TR
An$_E$-My64 x Ti71 CM-15928-3M-1Y-500M-0Y	TR	20MR	TR	0	5MR	0	30S	20MS	0	TR
Pamir"S"	TR	TS	TR	0	TR	TMR	60S	5MS	5R	TMR
Toquifen"S"	0	0	30MR	5R	20MS	30MS	10MS	20MR	0	5R
Hork"S"	5S	TMR	TR	0	TR	0	TMR	10S	TR	TMR
Huacamayo"S"	TMS	TMS	TR	0	5MS	TMR	20MR	10MR	TMR	TR
Brochis"S"	TR	0	10MS	0	TMR	5MR	5MS	TMS	0	TMR
Chiroca	TMR	10MR	TMR	0	10MS	TMR	TMR	TMR	TR	TMR
Era	0	TR	TR	0	0	0	10MR	5R	0	TMR
Tobari 66	TS	20MR	5MS	20S	40S	20MS	40MS	70MS	10MS	TR
Anahuac 75	10X	20X	20MR	0	10MR	50MS	30MS	20MR	50MS	10MR
Mexicali 75	TMR	20MS	TR	20S	TMS	TMR	30MS	20MS	-	5MS
Nacozari 76	10S	5R	30MS	40S	30S	10MR	60MS	40MS	0	0
Pavon 76	0	TMR	20R	0	TR	5MR	30MS	5MR	TR	TR
Tesopaco 76	5S	10MR	TMS	TS	30MS	50MS	70MS	40MS	30MS	TMR
Hermosillo 77	10S	20MR	30MS	5S	50MS	30S	70MS	60S	TR	TMR
Pima 77	TMS	10MS	10MS	70S	10MS	10MS	70MS	50S	10MS	TR
Cocoraque 75	TMR	TMR	5MR	0	20MS	5MR	40MS	TMR	TMS	0

TABLE 16 . Assessment of stem rust infection on commercial cultivars, varieties of common occurrence as progenitors, and previously resistant advanced lines, in the 1978 uniform stem rust nursery from 8 locations in Mexico.

	L O C A T I O N S							
	WINTER 1977 - 1978			SUMMER 1978				
Variety or line	Ciano Sonora	Sgo. Ixcuintla Nayarit	Rio Bravo Tamaulipas	Toluca Mexico	El Batan Mexico	Celaya Guanajuato	El Refugio Guanajuato	Navidad Nuevo Leon
Mexicali 75	0	-	TMS	0	0	0	TMS	0
Anahuac 75	-	-	20MR	0	TR	5MS	5S	0
Zaragoza 75	0	0	40MS	0	5MS	TR	5MS	10MS
Nacozari 76	0	-	30MS	0	0	TR	10S	0
Pavon 76	0	-	0	0	0	TR	0	0
Tesopaco 76	0	-	20MR	TMR	TS	TR	5S	0
Hermosillo 77	-	-	20MS	5R	0	0	TR	0
Pima 77	-	TMS	20S	TR	0	TMS	-	0
Leeds	0	-	TR	0	0	0	0	0
Waldron	0	TMS	TR	0	0	TR	TR	0
Samaca	0	-	40R	0	0	TMR	TMR	TR
África Mayo	0	-	40R	0	0	TR	TMR	0
Hopps	0	0	TR	0	0	TR	TS	TMR
Pato (R)	0	-	0	TR	0	TR	5MR	TMR
Chris	0	0	20MS	TR	0	TR	10S	TMR
Yaqui 50	0	5S	20S	0	0	5MS	TMR	TR
Bonza 55	TMS	10S	30MS	0	0	TR	TMR	TR
Inia 66	0	-	50S	0	20MR	0	TR	5R
Azteca 67	0	-	30MS	0	0	TMS	5MR	TR
Ciano 67	0	10S	50S	0	0	-	TS	0
Yecora 70	0	TMR	40S	TR	TR	TR	TMR	0
Torim 73	0	-	10MS	0	0	-	5MR	0
Cajeme"S"(B)	0	TR	40MS	5MR	TR	TR	5MR	TR
Ron-Cha x Bb-Nor CM-5484-F-5Y-4M-1Y-1M-1Y-0M	0	TR	40MS	5R	0	-	5MR	0
Cno-7C x Bb-Inia 66 CM-7551-30M-2Y-500M-501Y-2B-0Y	0	-	30MR	0	0	TR	5S	TR
Napo-Tob"S" x 8156/Kal-Bb CM-7806-15M-2Y-2M-1Y-0M	0	-	10MS	0	0	TR	TMS	0
CC-Inia x Bb/Cno-7C CM-8252-G-1M-1Y-5M-5Y-1M-0Y	0	-	10MR	0	0	TR	5S	0
Cno"S"-7C x Cno-Inia/Tob CM-8380-A-1Y-8M-1Y-0M	0	-	20S	5R	0	-	-	0
Huacamayo"S" CM-8671-B-1M-1Y-1M-1Y-1M-0Y	0	-	TMR	0	TR	TR	TR	0
Bb-Cno x Inia-Soty(Kal-Bb/Inia-Cal x Inia-CC) CM-11780-J-1Y-2M-1Y-2M-0Y	0	-	TR	0	0	TR	TMR	TR
Cno"S"-Gll x Nar59-On/Nad63-LR64 x Bb CM-11870-B-3Y-1M-1Y-12M-0Y	0	-	20MS	TR	0	TR	TMR	0
Cgñ x Kal-Bb CM-15133-1M-1Y-1M-0Y	0	TMS	30MS	0	0	TR	TR	0
HD-1220-Kal^3 72L19	0	20S	20MR	0	0	50S	10S	5MS

TABLE 17 . Percentage of single-pustule isolates of leaf rust from different sampling sites in Mexico that carry virulence genes complementary to each of 18 selected resistance genes.

Resistance gene (Lr-)	Ciano Sonora 1977-78 BW[1]	Ciano Sonora 1977-78 TCL	Campo Viejo Winter 1978 BW	Milpillas Summer 1978 BW	Costa de Hermosillo Winter-78 BW	Caborca Sonora Winter 1978 BW	San Luis Potosi SLP Winter-78 BW	El Refugio Guanajuato Summer-78 BW	El Refugio Guanajuato Summer-78 DW	El Refugio Guanajuato Summer-78 TCL	Roque Guanajuato Summer-78 BW	Roque Guanajuato Summer-78 DW	Roque Guanajuato Summer-78 TCL	El Batan Mexico Summer 78 TCL	Patzcuaro Mich. Summer-78 BW	Tepatitlan Jalisco Summer-78 BW	Ciano Sonora 1978-79 BW
1	97	78	95	100	100	100	100	100	100	100	94	100	100	55	100	100	100
2a	37	54	7	16	0	0	100	95	100	100	97	100	100	45	100	100	56
2b	30	44	9	14	27	25	100	95	100	100	100	100	100	50	100	100	56
2c	34	41	12	4	27	44	100	93	100	93	97	100	100	95	100	100	56
3	90	90	93	98	100	94	100	98	67	93	97	90	100	36	100	100	100
3ka	45	6	0	80	45	56	9	58	100	87	45	60	43	5	0	8	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	47	54	88	96	91	50	9	60	100	93	55	70	57	55	20	0	44
14a	95	96	95	100	91	100	100	100	100	100	100	90	100	100	100	100	100
14b	94	98	91	100	100	94	100	100	100	100	100	90	100	91	100	83	100
16	21	2	0	2	18	6	0	0	0	0	0	0	0	5	0	0	0
17	66	56	86	95	91	75	91	88	100	100	79	80	71	59	60	92	100
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	18	4	0	29	18	13	0	30	33	53	33	40	14	9	0	0	0
23	66	46	49	96	55	63	100	100	100	100	94	80	86	45	100	100	100
24	1	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0
T	24	7	2	57	27	13	0	58	100	100	39	60	14	9	0	0	0
EG	26	13	9	46	9	0	0	49	83	87	36	60	14	0	0	0	0
No of Isolates tested	180	82	43	56	11	16	11	43	6	15	33	10	7	22	5	12	16

1/ BW= bread wheat; DW= durum wheat; TCL= triticale

TABLE 18 . Regional distribution of leaf rust isolates with virulence genes complementary to selected combinations of resistance genes, from samples studied in Mexico during 1978.

Virulence genes overcoming at least (Lr genes)	Ciano 1977-78 BW	Ciano 1977-78 TCL	Campo Viejo BW	Milpillas BW	Costa de Hermosillo BW	Caborca BW	San Luis Potosi BW	El Refugio BW	El Refugio DW	El Refugio TCL	Roque BW	Roque DW	Roque TCL	Batan TCL	Patzcuaro BW	Tepatitlan BW	Ciano 78-79 BW
	SOURCE OF SAMPLES 1/ (NUMBER OF ISOLATES)																
2a 2b	45	35	3	8			11	41	6	15	32	10	7	10	5	12	9
2a 2b 2c	39	28		2			11	39	6	14	31	9	7	10	5	12	9
2a 2b 2c 3ka	16						1	24	6	13	15	6	3	1		1	
2a 2b 2c 3ka 10	4							22	6	12	13	5	3				
3ka 10	4							22	6	12	13	5	3				
2a 2b 2c 3ka 10 17	1							20	4	12	13	5	3				
10 16	19			1	2	1											
17 21 23	24	2		14	1	1		11	2	8	11	3	1	1			
3ka 17 21 23	22	1		14	1	1		11	2	7	11	3	1				
3ka T EG	28			17	1			14	5	12	12	6	1				
3ka 17 21 23 T EG	17			8	1			11	2	6	10	3	1				
2a 2b 2c 3ka 10 17 21 23 T EG	1							10	1	6	10	3	1				
2a 2b 2c 3ka 16	3																
2a 2b 2c 3ka 10 16																	
Total number of isolates tested	180	82	43	56	11	16	11	43	6	15	33	10	7	22	5	12	16

1/ Ciano, Cd. Obregon, Sonora, Winter 1977-1978.
Campo Viejo Cd. Obregon, Sonora, Winter 1977-1978.
Milpillas, Chihuahuan Sierra, Summer 1978.
Costa de Hermosillo, Sonora, Winter 1977-1978.
Caborca, Sonora, Winter 1977-1978.
San Luis Potosí, SLP, Summer, 1978.
El Refugio, Guanajuato, Summer, 1978.
Roque, Guanajuato, Summer, 1978.
El Batan, Mexico, Summer 1978.
Patzcuaro, Michoacan, Summer, 1978.
Tepatitlán, Jalisco, Summer 1978.
Ciano, Winter 1978-79.

BW= Bread wheat
DW= Durum wheat
TCL= Triticale

TABLE 19. Percentage of single-pustule isolates of stem rust from 5 Mexican locations that carry virulence genes complementary to each of 12 selected resistance genes.

Resistance gene	Navidad N.L. BW	Ciano Sonora BW	Ciano Sonora DW	Ciano Sonora TCL	El Batan Mexico BW	El Refugio Guanajuato BW	El Refugio Guanajuato DW	El Refugio Guanajuato BA	Celaya Guanajuato BW	Celaya Guanajuato DW	Celaya Guanajuato TCL
	Source of inoculum: Location and crop 1/										
Sr 5	100	100	100	100	45	100	97	96	100	100	100
6	16	55	50	50	45	41	12	21	17	0	17
7b	96	92	100	92	36	78	82	78	19	25	33
8	100	100	100	100	100	97	100	95	91	91	100
9a	86	100	75	79	100	80	62	81	82	91	83
9b	94	95	75	54	100	83	85	86	26	16	67
9d	100	99	100	100	100	100	100	100	98	100	100
9e	54	1	25	33	0	60	59	29	10	8	0
10	60	3	25	49	0	42	56	25	35	25	67
11	86	85	100	100	36	87	70	81	37	41	50
13	43	10	0	4	0	27	15	29	14	8	0
Tt-1	79	76	100	87	36	93	91	9	16	24	0
No. of Isolates tested	69	74	12	24	11	53	34	28	43	12	6

1/ BW= Bread wheat; DW= Durum wheat; TCL= Triticale; BA= Barley.

TABLE 20. Percentage of stem rust single pustule isolates derived from samples collected on bread wheat (BW), durum wheat (DW), triticale (TCL), and barley (BA) at 5 locations in Mexico that exhibit different patterns of virulence representing combinations of virulence genes complementary to Sr genes included in each of the 3 sets of the Cereal Rust Laboratory (CRL) differential series.

CRL code letter	Virulence against Sr genes	Standard race approximate equivalents[1]	Source of inoculum: location and crop										
			Navidad	Ciano			Batan	El Refugio			Celaya		
			BW	BW	DW	TCL	DW	BW	DW	BA	BW	DW	TCL
SET I													
L	5	33									2		
G	9d	48					55						
Q	5 9d	151	4	7			9	15	9	18	74	75	67
M	5 7b	56, 155		1									
H	9d 7b	17, 29							3				
S	5 9d 9e	83, 89		1		8		7	9	4	5		
R	5 9d 7b	11, 113	42	91	75	67	36	25	29	53	14	17	33
K	9d 9e 7b	116, 270								4			
T	5 9d 9e 7b	15	54		25	25		53	50	21	5	8	
SET II													
L	11							4		4	2		
D	8							2			2		17
C	9a										5	8	
N	11 8		14		25	21		6	38	14	9	8	
F	8 9a		12	7			55	6	21	18	51	50	33
M	11 9a										2		
P	11 8 9a		58	38	25	29		42	29	42	12	33	33
K	6 8 9a		2	8			9	6	9		5		
S	11 6 8							9			5		
T	11 6 8 9a		14	47	50	50	36	26	3	21	7		17
SET III													
B				1				2	3	4	47	42	33
L	Tt-1							4		4	2	8	
G	9b			9			64		3		2	8	
Q	Tt-1 9b		28	76	75	50	36	34	26	43	5	8	
D	13										7	8	
N	Tt-1 13		1					4		4	2		
J	9b 13			9					3				
S	Tt-1 9b 13		10					15	9	21			
C	10			1		8		2			14	17	
M	Tt-1 10		4		25	33		4	12	4	2	8	
H	9b 10		1	1				2			9		67
F	13 10			1		4							
R	Tt-1 9b 10		23			4		26	41	18	5		
P	Tt-1 13 10							2					
K	9b 13 10		19					2		4	5		
T	Tt-1 9b 13 10		13					4	3				

[1] Race equivalents may be derived from Set I only.

TABLE 21. Description and frequency of stem rust virulence formulae in Mexico as determined from 69 single pustule isolates of samples collected on bread wheat at Navidad, N.L. during 1978.

Coded Formula	Effective/ineffective resistance genes	Frequency (No. isolates)
QFQ	6, 7b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-2/ 5, 8, 9a, 9b, 9d, Tt-1	1
QPQ	6, 7b, 9e, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 8, 9a, 9b, 9d, 11, Tt-1	1
RFQ	6, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-2/5, 7b, 8, 9a, 9b, 9d, Tt1	3
RFS	6, 9e, 10, 11, 24, 25, 26, 30, Tt-2/5, 7b, 8, 9a, 9b, 9d, 13, Tt-1	2
TFQ	6, 10, 11, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 9e, Tt-1	1
RKQ	9e, 10, 11, 13, 24, 25, 26, 30, Tt-2/5, 6, 7b, 8, 9a, 9b, 9d, Tt1	1
RPQ	6, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, Tt-1	8
RPR	6, 9e, 13, 24, 25, 26, 30, Tt-2/5, 7b, 8, 9a, 9b, 9d, 10, 11, Tt-1	1
RPS	6, 9e, 10, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 11, 13, Tt-1	1
RPK	6, 9e, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 10, 11, 13,	4
TNK	6, 9a, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 7b, 8, 9b, 9d, 9e, 10, 11, 13	2
TNM	6, 9a, 9b, 13, 24, 25, 26, 30, Tt2/ 5, 7b, 8, 9d, 9e, 10, 11, Tt1	3
TNR	6, 9a, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9b, 9d, 9e, 10, 11, Tt-1	5
TPH	6, 13, 24, 25, 26, 30, Tt-1, Tt-2/5, 7b, 8, 9a, 9b, 9d, 9e, 10, 11	1
TPN	6, 9b, 10, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9d, 9e, 11, 13, Tt-1	1
TPQ	6, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 9e, 11, Tt-1	3
RTQ	9e, 10, 13, 24, 25, 26, 30, Tt2/ 5, 6, 7b, 8, 9a, 9b, 9d, 11, Tt-1	1
QPT	6, 7b, 9e, 24, 25, 26, 30, Tt-2/ 5, 8, 9a, 9b, 9d, 10, 11, 13, Tt-1	1
TFS	6, 10, 11, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 9e, 13, Tt-1	1
TPS	6, 10, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 9e, 11, 13, Tt-1	3
TPK	6, 24, 25, 26, 30, Tt1, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, 13	3
TPR	6, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, Tt-1	8
RPT	6, 9e, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 10, 11, 13, Tt-1	4
TPT	6, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, 13, Tt-1	1
TTR	13, 24, 25, 26, 30, Tt-2/5, 6, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, Tt-1	2
TTK	24, 25, 26, 30, Tt1, Tt2/ 5, 6, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, 13	1
RTK	9e, 24, 25, 26, 30, Tt1, Tt-2/ 5, 6, 7b, 8, 9a, 9b, 9d, 10, 11, 13	3
RTT	9e, 24, 25, 26, 30, Tt2/ 5, 6, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, 13, Tt1	1
TTT	24, 25, 26, 30, Tt2/ 5, 6, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, 13, Tt-1	2
	Total	69

TABLE 22. Description and relative frequency of stem rust virulence formulae in Mexico as determined from 110 single pustule isolates of samples collected on bread wheat (BW), durum wheat (DW) and triticale (TCL), at Ciano, Sonora, during 1978.

Coded Formula	Effective/ineffective resistance genes	Frequency (%) BW	DW	TCL
QFJ	6, 7b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-2/ 5, 8, 9a, 9b, 9d	1		
QFG	6, 7b, 9e, 10, 11, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 8, 9a, 9b, 9d, 13	5		
RPB	6, 9b, 9e, 10, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 7b, 8, 9a, 9d, 11	1		
RPG	6, 9e, 10, 13, 24, 25, 26, 30, Tt1, Tt2/ 5, 7b, 8, 9a, 9b, 9d, 11	3		
RPC	6, 9b, 9e, 13, 24, 25, 26, 30, Tt1, Tt-2/5, 7b, 8, 9a, 9d, 10, 11	1		8
RPF	6, 9b, 9e, 24, 25, 26, 30, Tt1, Tt-2/ 5, 7b, 8, 9a, 9d, 10, 11, 13,	1		4
RPQ	6, 9e, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 11, Tt1	30	25	
SPQ	6, 7b, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 8, 9a, 9b, 9d, 9e, 11, Tt1	1		
SPM	6, 7b, 9b, 13, 24, 25, 26, 30, Tt-2/ 5, 8, 9a, 9d, 9e, 10, 11, Tt-1			8
TNM	6, 9a, 9b, 13, 24, 25, 26, 30, Tt2/ 5, 7b, 8, 9d, 9e, 10, 11, Tt1		25	21
TPM	6, 9b, 13, 24, 25, 26, 30, Tt2/ 5, 7b, 8, 9a, 9d, 9e, 10, 11, Tt1			4
RPR	6, 9e, 13, 24, 25, 26, 30, Tt2/5, 7b, 8, 9a, 9b, 9d, 10, 11, Tt-1			4
RKG	9e, 10, 11, 13, 24, 25, 26, 30, Tt1, Tt2/5, 6, 7b, 8, 9a, 9b, 9d	3		
RKJ	9e, 10, 11, 24, 25, 26, 30, Tt-1, Tt2/ 5, 6, 7b, 8, 9a, 9b, 9d, 13	1		
RKQ	9e, 10, 11, 13, 24, 25, 26, 30, Tt2/ 5, 6, 7b, 8, 9a, 9b, 9d, Tt1	4		
RTG	9e, 10, 13, 24, 25, 26, 30, Tt1, Tt-2/ 5, 6, 7b, 8, 9a, 9b, 9d, 11	3		
RTJ	9e, 10, 24, 25, 26, 30, Tt1, Tt2/5, 6, 7b, 8, 9a, 9b, 9d, 11, 13	3		
RTH	9e, 13, 24, 25, 26, 30, Tt-1, Tt2/ 5, 6, 8, 9a, 9b, 9d, 10, 11	1		
MTQ	9d, 9e, 10, 13, 24, 25, 26, 30, Tt2/, 5, 6, 7b, 8, 9a, 9b, 11, Tt1	1		
RTQ	9e, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 6, 7b, 8, 9a, 9b, 9d, 11, Tt-1	39	50	50

TABLE 23. Description and frequency of stem rust virulence formulae in Mexico as determined from 11 single pustule isolates of samples collected on durum wheat at El Batan, Mexico during 1978.

Coded Formula	Effective/ineffective resistance genes	Frequency (No of isolates)
GFG	5, 6, 7b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 8, 9a, 9b, 9d	5
QFG	6, 7b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 8, 9a, 9b, 9d	1
GKG	5, 7b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 6, 8, 9a, 9b, 9d	1
RTQ	9e, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 6, 7b, 8, 9a, 9b, 9d, 11, Tt-1	4

TABLE 24. Description and relative frequency of stem rust virulence formulae in Mexico as determine from 115 single pustule isolates of samples collected on bread wheat (BW), durum wheat (DW) and barley (BA) at El Refugio, Guanajuato during 1978.

Coded Formula	Effective/ineffective resistance genes	Frequency (%)		
		BW	DW	BA
QFB	6, 7b, 9b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 8, 9a, 9d	2	3	4
HFG	5, 6, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 7b, 8, 9a, 9b, 9d		3	
QNC	6, 7b, 9a, 9b, 9e, 13, 24, 25, 26, 30, Tt1, Tt-2/ 5, 8, 9d, 10, 11	2		
SLN	6, 7b, 8, 9a, 9b, 10, 24, 25, 26, 30, Tt-2/ 5, 9d, 9e, 11, 13, Tt1	2		
QDS	6, 7b, 9a, 9e, 10, 11, 24, 25, 26, 30, Tt2/ 5, 8, 9b, 9d, 13, Tt-1	2		
QFJ	6, 7b, 9e, 10, 11, 24, 25, 26, 30, Tt1, Tt-2/ 5, 8, 9a, 9b, 9d, 13		3	
QFQ	6, 7b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-2/ 5, 8, 9a, 9b, 9d, Tt-1	2		4
RPL	6, 9b, 9e, 10, 13, 24, 25, 26, 30, Tt2/ 5, 7b, 8, 9a, 9d, 11, Tt-1	2		4
RFQ	6, 9e, 10, 11, 13, 24, 25, 26, 30, Tt2/ 5, 7b, 8, 9a, 9b, 9d, Tt1	2	9	4
RFN	6, 9b, 9e, 10, 11, 24, 25, 26, 30, Tt2/ 5, 7b, 8, 9a, 9d,13, Tt1			4
QFS	6, 7b, 9e, 10, 11, 24, 25, 26, 30, Tt2/ 5, 8, 9a, 9b, 9d, 13, Tt1		3	
QSR	7b, 9a, 9e, 13, 24, 25, 26, 30, Tt-2/ 5, 6, 8, 9b, 9d, 10, 11, Tt1	2		
QSH	7b, 9a, 9e, 13, 24, 25, 26, 30, Tt1, Tt-2/ 5, 6, 8, 9b, 9d, 10, 11	2		
SLR	6, 7b, 8, 9a, 13, 24, 25, 26, 30, Tt2/ 5, 9b, 9d, 9e, 10, 11, Tt1			4
SNM	6, 7b, 9a, 9b, 13, 24, 25, 26, 30, Tt-2/ 5, 8, 9d, 9e, 10, 11, Tt1		3	
RPQ	6, 9e, 10, 13, 24, 25, 26, 30, Tt2/ 5, 7b, 8, 9a, 9b, 9d, 11, Tt1	4	9	17
RFS	6, 9e, 10, 11, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 13, Tt-1			4

Table 24. Cont ....

Coded Formula	Effective/ineffective resistance genes	Frequency (%)		
		BW	DW	BA
RKQ	9e, 10, 11, 13, 24, 25, 26, 30, Tt-2/ 5, 6, 7b, 8, 9a, 9b, 9d, Tt1	6	3	
TNM	6, 9a, 9b, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9d, 9e, 10, 11, Tt1		9	4
TLR	6, 8, 9a, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 9b, 9d, 9e, 10, 11, Tt-1	2		
QPS	6, 7b, 9e, 10, 24, 25, 26, 30, Tt-2/ 5, 8, 9a, 9b, 9d, 11, 13, Tt1	2		
QTQ	7b, 9e, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 6, 8, 9a, 9b, 9d, 11, Tt-1			4
SNR	6, 7b, 9a, 13, 24, 25, 26, 30, Tt2/ 5, 8, 9b, 9d, 9e, 10, 11, Tt1		6	
SPQ	6, 7b, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 8, 9a, 9b, 9d, 9e, 11, Tt-1	2		
KNR	5, 6, 9a, 13, 24, 25, 26, 30, Tt-2/ 7b, 8, 9b, 9d, 9e, 10, 11, Tt1			4
RPS	6, 9e, 10, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 11, 13, Tt1	2	6	10
RTQ	9e, 10, 13, 24, 25, 26, 30, Tt2/ 5, 6, 7b, 8, 9a, 9b, 9d, 11, Tt1	4		10
TNR	6, 9a, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9b, 9d, 9e, 10, 11, Tt-1	4	21	4
TNK	6, 9a, 24, 25, 26, 30, Tt1, Tt-2/ 5, 7b, 8, 9b, 9d, 9e, 10, 11, 13			4
TPQ	6, 10, 13, 24, 25, 26, 30, Tt2/ 5, 7b, 8, 9a, 9b, 9d, 9e, 11, Tt1	4		4
TPM	6, 9b, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9d, 9e, 10, 11, Tt-1	2		
TSN	9a, 9b, 10, 24, 25, 26, 30, Tt-2/ 5, 6, 7b, 8, 9d, 9e, 11, 13, Tt1	2		
TSM	9a, 9b, 13, 24, 25, 26, 30, Tt2/ 5, 6, 7b, 8, 9d, 9e, 10, 11, Tt-1	2		
TTL	9b, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 6, 7b, 8, 9a, 9d, 9e, 11, Tt-1	2		
TKQ	10, 11, 13, 24, 25, 26, 30, Tt-2/ 5, 6, 7b, 8, 9a, 9b, 9d, 9e, Tt1		6	
QTK	7b, 9e, 24, 25, 26, 30, Tt-1, Tt2/ 5, 6, 8, 9a, 9b, 9d, 10, 11, 13	2		
QTS	7b, 9e, 10, 24, 25, 26, 30, Tt2/ 5, 6, 8, 9a, 9b, 9d, 11, 13, Tt1			7
SPS	6, 7b, 10, 24, 25, 26, 30, Tt2/ 5, 8, 9a, 9b, 9d, 9e, 11, 13, Tt1	2		
SPR	6, 7b, 13, 24, 25, 26, 30, Tt-2/ 5, 8, 9a, 9b, 9d, 9e, 10, 11, Tt1	2		
RTR	9e, 13, 24, 25, 26, 30, Tt-2/ 5, 6, 7b, 8, 9a, 9b, 9d, 10, 11, Tt1	2		
RPR	6, 9e, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 10, 11, Tt-1		3	
RTP	9b, 9e, 24, 25, 26, 30, Tt2/ 5, 6, 7b, 8, 9a, 9d, 10, 11, 13, Tt-1	2		
TPR	6, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, Tt-1	12	9	7
TPS	6, 10, 24, 25, 26, 30, Tt2/ 5, 7b, 8, 9a, 9b, 9d, 9e, 11, 13, Tt-1	6		
TTQ	10, 13, 24, 25, 26, 30, Tt-2/ 5, 6, 7b, 8, 9a, 9b, 9d, 9e, 11, Tt1	10		
TSR	9a, 13, 24, 25, 26, 30, Tt-2/ 5, 6, 7b, 8, 9b, 9d, 9e, 10, 11, Tt-1	2		
RTT	9e, 24, 25, 26, 30, Tt-2/ 5, 6, 7b, 8, 9a, 9b, 9d, 10, 11, 13, Tt1	2		
TTR	13, 24, 25, 26, 30, Tt-2/ 5, 6, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, Tt-1		3	
TTS	10, 24, 25, 26, 30, Tt2/ 5, 6, 7b, 8, 9a, 9b, 9d, 9e, 11, 13, Tt-1	2		
TPT	6, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, 13, Tt-1	2	3	

TABLE 25. Description and relative frequency of stem rust virulence formulae in Mexico as determined from 61 single pustule isolates of samples collected on bread wheat (BW), durum wheat (DW) and triticale (TCL) at Celaya, Guanajuato during 1978.

Coded Formula	Effective/ineffective resistance genes	Frequency (%)		
		BW	DW	TCL
LLB	6, 7b, 8, 9a, 9b, 9d, 9e, 10, 13, 24, 25, 26, 30, Tt1, Tt-2/ 5, 11	2		
QCB	6, 7b, 8, 9b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 9a, 9d	2		
QFB	6, 7b, 9b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-1, Tt2/5, 8, 9a, 9d	37	42	17
RDB	6, 9a, 9b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 7b, 8, 9d			17
QCD	6, 7b, 8, 9b, 9e, 10, 11, 24, 25, 26, 30, Tt1, Tt2/ 5, 9a, 9d, 13	2		
QDC	6, 7b, 9a, 9b, 9e, 11, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 8, 9d, 10	2		
QFC	6, 7b, 9b, 9e, 11, 13, 24, 25, 26, 30, Tt1, Tt-2/ 5, 8, 9a, 9d, 10	7		
QFG	6, 7b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 8, 9a, 9b, 9d	2	8	
QFL	6, 7b, 9b, 9e, 10, 11, 13, 24, 25, 26, 30, Tt2/ 5, 8, 9a, 9d, Tt-1	2		
QPB	6, 7b, 9b, 9e, 10, 13, 24, 25, 26, 30, Tt1, Tt-2/ 5, 8, 9a, 9d, 11	2		
QCQ	6, 7b, 8, 9e, 10, 11, 13, 24, 25, 26, 30, Tt-2/ 5, 9a, 9b, 9d, Tt-2		8	
QNC	6, 7b, 9a, 9b, 9e, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 8, 9d, 10, 11	2	8	
QFH	6, 7b, 9e, 11, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 8, 9a, 9b, 9d, 10			17
QPC	6, 7b, 9b, 9e, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 8, 9a, 9d, 10, 11		8	
QMQ	6, 7b, 8, 9e, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 9a, 9b, 9d, 11, Tt-1	2		
SFC	6, 7b, 9b, 11, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 8, 9a, 9d, 9e, 10	2		
QPH	6, 7b, 9e, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 8, 9a, 9b, 9d, 10, 11	2		33
QSH	7b, 9a, 9e, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 6, 8, 9b, 9d, 10, 11	5		
QNK	6, 7b, 9a, 9e, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 8, 9b, 9d, 10, 11, 13	2		
RTB	9b, 9e, 10, 13, 24, 25, 26, 30, Tt-1, Tt2/ 5, 6, 7b, 8, 9a, 9d, 11	2		
RPD	6, 9b, 9e, 10, 24, 25, 26, 30, Tt-1, Tt-2/5, 7b, 8, 9a, 9d, 11, 13		8	
RKD	9b, 9e, 10, 11, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 6, 7b, 8, 9a, 9d, 13	5		
QPR	6, 7b, 9e, 13, 24, 25, 26, 30, Tt-2/ 5, 8, 9a, 9b, 10, 11, Tt-1	2		
RPN	6, 9b, 9e, 10, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9d, 11, 13, Tt-1	2		
RPQ	6, 9e, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9b, 9d, 11, Tt1	2		
RPM	6, 9b, 9e, 13, 24, 25, 26, 30, Tt-2/5, 7b, 8, 9a, 9d, 10, 11, Tt-1		8	
TNM	6, 9a, 9b, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9d, 9e, 10, 11, Tt-1	2		
TPL	6, 9b, 10, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9a, 9d, 9e, 11, Tt1		8	
RTH	9e, 13, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 6, 7b, 8, 9a, 9b, 9d, 10, 11	2		17
TNR	6, 9a, 13, 24, 25, 26, 30, Tt-2/ 5, 7b, 8, 9b, 9d, 9e, 10, 11, Tt-1	2		
STK	7b, 24, 25, 26, 30, Tt-1, Tt-2/ 5, 6, 8, 9a, 9b, 9d, 9e, 10, 11, 13	2		

TABLE 26. Comparison of population structure of leaf and stem rust fungi in Mexico during 1978.

Source of sample			Leaf rust[1]		Stem rust[2]	
Location	Crop[3]	Season	No. of isolates	No. of combinations	No. of isolates	No. of combinations
Cd. Obregón, Sonora	BW, TCL	Winter, 1978	305	145		
do.	BW, DW, TCL	do			110	20
El Refugio, Guanajuato	do.	Summer, 1978	64	21		
do.	BW, DW, BA	do.			115	50
Celaya, Guanajuato	DW, DW, TCL	do.	50	15	61	31
Navidad, Nuevo León	BW	do.			69	29
El Batán, Mexico	DW	do.			11	4
do.	TCL	do.	22	17		
Tepatitlán, Jalisco	BW	do.	12	5		
Milpillas, Chihuahuan Sierra	BW	do.	56	22		
Caborca, Sonora	BW	Winter, 1978	16	12		
Ciano, Sonora	BW	Winter, 1979	16	2		

[1] Total number of leaf rust isolates are 541 which yielded a total of 197 virulence combinations.

[2] Total number of stem rust isolates are 366 which yielded a total of 99 virulence combinations.

[3] BW= Bread wheat; DW= Durum wheat; TCL= Triticale; BA= Barley.

Agronomy

Weed control studies in Mexico were continued at El Batan and Toluca in a continued search for effective weed control programs for the breeding nurseries at these sites. The trials are not designed to relate to farmers' requirements in these areas, as the conditions encountered in breeding nurseries and farmers' fields are completely different. Because the nurseries are planted at wide spacings, herbicides which achieve control by dwarfing weeds temporarily so that the crop gains a competitive advantage, are not useful, and short weeds that would not normally be a problem in a commercial crop, become important in a nursery. Also, because of the range of maturity of the material, hormonal herbicides cannot normally be used due to the probability of differential phytotoxicity.

EL BATAN

The main weeds encountered at this site are *Amaranthus hybridus, Galansoga ciliata, Tithonia tabaeformis, Portulaca oleracea, Eleusine tristachya* (gramineous) and *Eragrostis mexicana* (gramineous). Also to be found are *Cyperus esculentis, Ipomoea purpurea, Anoda hastata, Lopezia racemoza and Commelina celestis,* although only the first two are important in the weed control effort on the station.

Three main trials, one of which included three species, were conducted at El Batan using three herbicides. Treatments, yields and phytotoxicity data from these trials are presented in tables 1, 2 and 3. One other trial was conducted later in the season to answer specific questions related to the trials and to the weed control in this season at El Batan. Because of the late planting, weed populations were small in number and therefore results are not tabulated. Observations arising from this trial are included in the comments on the various herbicides used.

Tribunil (methabenzthiasuron) when used as a pre-emergence application showed variable results, varying from very little to moderate control of broadleaf weeds at 1.0 kg/ha a.i. and slightly better control at 2.0 kg/ha a.i. Grass control was also moderate, with better control of *Eragrostis* than *Eleusine.* Its best application time appeared to be 7-14 days after emergence when complete broadleaf control was obtained with moderate control of the grasses. Some control (+ 50 per cent) of *Portulaca* was also noted with these applications. This control was better at 2.0 kg/ha Tribunil, but this also increased phytotoxicity, especially on the durum wheat. Later applications gave excellent control of *Galansoga ciliata,* but control of *Amaranthus hybridus* dropped off from 14 days after emergence.

Bromoxynil gave effective broadleaf weed control up to approximately three weeks after crop emergence. After this stage the bigger plants were damaged, but not killed. At El Batan broadleaf weeds continue emerging for 3-4 weeks after sowing. Two applications of broadleaf herbicides are therefore necessary for complete broadleaf control. Once again there was evidence of synergism between Bromoxynil and Tribunil especially in some of the nursery applications, where the mixture gave complete control of broadleaf and grass weeds. Tribunil alone is not so effective on grass weeds, and Bromoxynil alone has no effect on them.

Illoxan (diclofop) gave perfect (100 per cent) control of both grass species with applications of 1.0 kg/ha a.i. from pre-emergence to approximately 25 days after emergence. Even at 30 days after emergence, control of the grasses was excellent. In most cases 0.5 kg/ha gave comparable results, but occasionally not all grass plants were controlled. This is a very promising herbicide for use in the bread wheat, durum wheat and triticale nurseries and it will replace Tribunil in these nurseries. The only phytotoxicity that has been observed with rates up to 2.0 kg/ha on these species is a slight temporary yellowing of the tips of the leaves.

Illoxan apparently acts on grass weeds by restricting adventitious root growth, whilst reduction in root growth of wheat in the field appears unaffected. Root growth of barley, however, is reduced and has led to increased lodging in the field, and therefore Illoxan will not be used in the barley nurseries.

Studies with plants grown in nutrient solutions to which the herbicide was added, demonstrate the effect on the roots clearly, (see plate 1). These effects are far more severe than those noted in the field, presumably because the roots in the nutrient solutions cannot escape the herbicide, whilst in the field once they have penetrated the soil layer where the herbicide is present, growth is normal.

Basagran (bentazon), although not included in the trial results presented here, was used in the late planted trial and in some of the nurseries for its control of *Portulaca oleracea.* At 1.0 kg/ha a.i., complete control of small (2-3 cm diam.) plants was obtained and bigger plants (6-10 cm diam.) were effectively controlled by 1.5 kg/ha a.i.. Observations were also made of its effectiveness against yellow nutsedge *(Cyperus esculentis).* At 1.5 kg/ha, complete control was obtained of 3-leaf plants grown from seed. Control of 5 and 6-leaf plants was excellent, but not complete.

The effects of 2,4-D and Bromoxynil in control of broadleaf and grass weeds were compared in a further trial. Four dates of application of the recommended dose of each product were used, and results are presented in table 4. As expected, Bromoxynil gave its best control of broad-leafed weeds with the earlier (7 and 14 days post-emergence) applications, and had no effect on the grass weeds. 2,4-D showed best control of broadleaf weeds between 28 and 35 days after emergence. (spike initial ± 2 cm above ground, first stem node slightly swollen). However, the most surprising observation was the level of grass control attained by 2,4-D, which was up to 90 per cent control with the 28 day application. The first signs of control were a break-down of tissue at the crown of the plant.

The last dates of application of 2,4-D resulted in a significantly lower yield than the handweeded control, probably because of a longer period of weed competition during the early part of the season, as no phytotoxicity was evident in the crop.

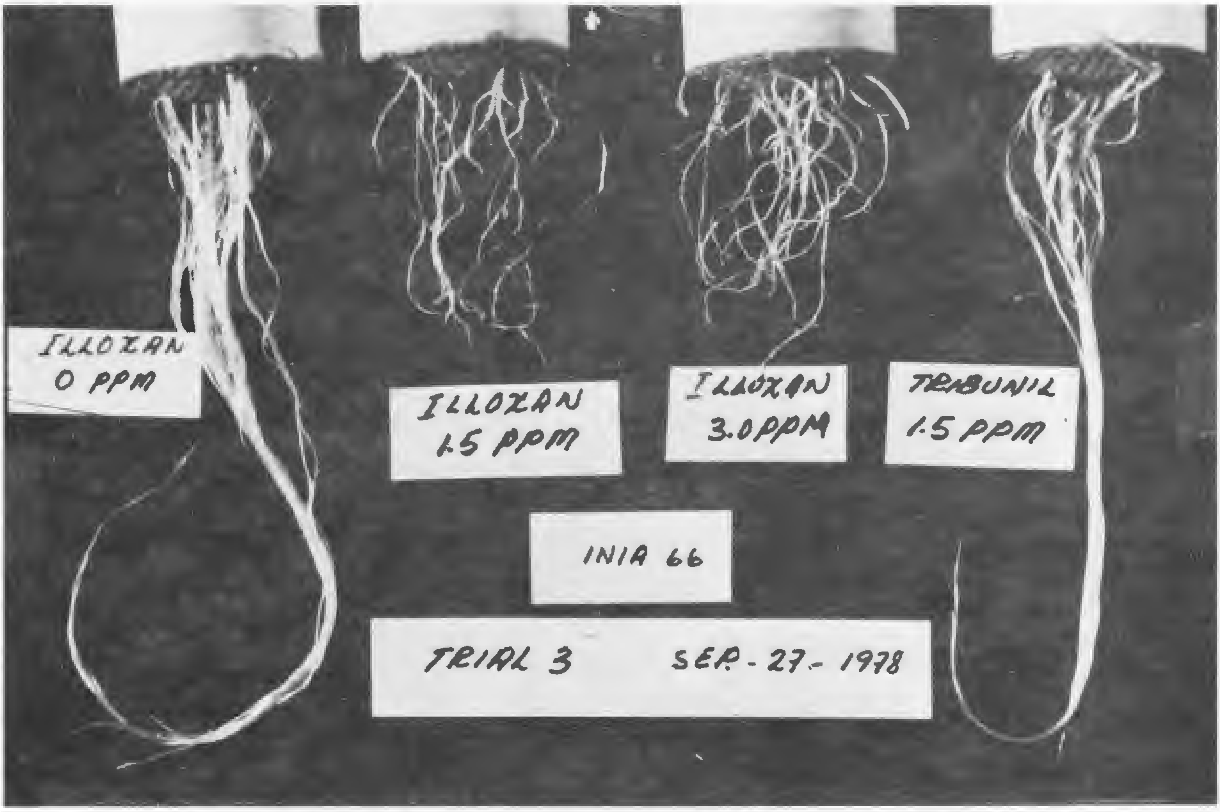
TOLUCA

The main weeds encountered in the trials at the Toluca Station were *Commelina celestis, Galansoga ciliata, Brassica spp., Cucumis sativus* and *Poa annua.* Two trials were conducted on the control of these weeds, but yield results are not presented due to excessive lodging of the trial plots. Weed control and phytotoxicity data from one of these trials are shown in table 5. Observations from the other trial on the effect of Bromoxynil after pre-emergence applications of Tribunil are included in the comments on the herbicides.

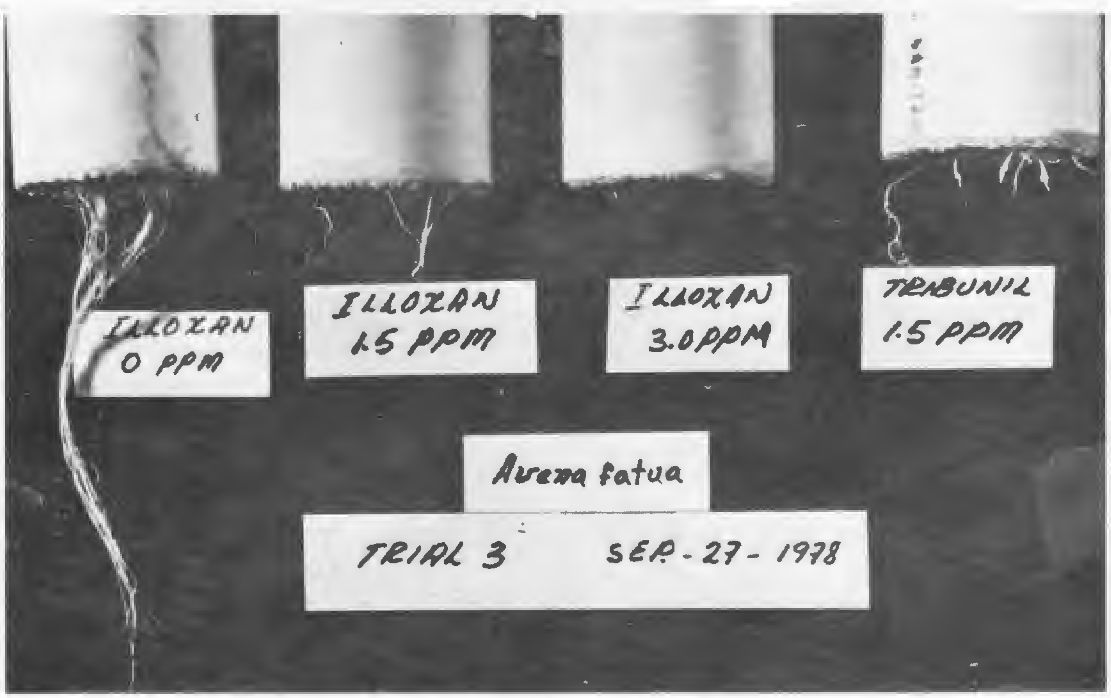
Early applications of Tribunil (from pre-emergence to 10 days post-emergence) gave good control of *Poa,* especially in a post-emerge mixture with Bromoxynil. However, phytotoxicity, especially in the durum wheat was increased by this treatment. A Tribunil pre-emerge application with a Bromoxynil application 10 days post-emerge gave excellent control of *Poa,* and of all other weeds, and did not show the phytotoxicity on the durum wheat. Tribunil alone gave very good control of the broadleaf weeds at seven days after emergence, but with later applications, control of *Galansoga* was poorer. Pre-emerge application did not give good control of *Commelina.*

Bromoxynil, after a pre-emerge Tribunil treatment (1.0 kg/ha a.i.) did not give good control of *Commelina* with an early (7 days post-emergence) application of 0.24 kg/ha a.i. (normal rate). A double rate improved the control of *Commelina* slightly but not markedly. Control of all broadleafed weeds was very good with applications between 14 and 28 days. Applications of 0.48 kg/ha showed little advantage over 0.24 kg/ha a.i.

The effects of Illoxan and Tribunil herbicides on the root growth of INIA 66, a bread wheat (upper illustration) and on wild oats, Avena fatua, (lower illustration) when grown in nutrient solutions to which herbicides were added. The seeds rest on gauze at the base of the plastic tubes.



Bread Wheat—Inia 66



Wild Oats—Avena fatua

TABLE 1. YIELDS AND PHYTOTOXICITY READINGS (10 DAYS AFTER APPLICATION) OF THREE CULTIVARS AFTER DIFFERENT HERBICIDE TREATMENTS. EL BATAN BV 78.

HERBICIDE TREATMENT	Rate kg/ha A. I.	Time of application	Yield Ton/ha Pavon	Yoreme	Mexicali	Mean	Phytotoxicity [x] Pavon	Yoreme	Mexicali	Weed control 14 dys [+] Broadleaf	Grasses
1. Control Non-weeded			2.28	0.84	1.40	1.51	-			-	-
2. Check Hand-weeded			6.12	4.36	5.10	5.19	-			-	-
3. Illoxan+Tribunil Brominal	1.0 + 1.0 0.24	Pre-emerge 30 DAE*	5.99	5.20	4.28	5.21	0	0	1.0	7.0	10.0
4. Illoxan+Tribunil Brominal	2.0 + 1.0 0.24	Pre-emerge 30 DAE	5.94	5.36	5.08	5.46	0	0	1.0	6.1	10.0
5. Illoxan+Tribunil Brominal	1.0 + 2.0 0.24	Pre-emerge 30 DAE	6.56	5.68	4.49	5.58	0.2	0	3.0	9.4	10.0
6. Illoxan+Tribunil Brominal	2.0 + 2.0 0.24	Pre-emerge 30 DAE	6.75	5.13	4.76	5.54	0	0	3.0	8.1	10.0
7. Illoxan+Tribunil	1.0 + 2.0	Pre-emerge	5.01	4.67	3.98	4.55	0	0.5	3.0	9.3	10.0
8. Tribunil Illoxan	2.0 1.0	Pre-emerge 7 DAE	5.54	4.83	3.61	4.66	0	0	3.0	8.7	10.0
9. Tribunil Illoxan + Brominal	1.0 1.0 + 0.24	Pre-emerge 7 DAE	5.38	5.59	4.77	5.25	0	0.5	1.0	8.5	10.0
10. Tribunil Illoxan + Brominal	1.0 1.0 + 0.24	Pre-emerge 30 DAE	6.28	5.07	4.86	5.40	0	0	1.0	8.0	8.7
11. Tribunil Brominal	2.0 0.24	Pre-emerge 30 DAE	6.65	4.91	4.91	5.49	0	0	3.0	8.7	7.0
12. Tribunil Tribunil	1.0 1.0	Pre-emerge 30 DAE	5.19	4.47	2.70	4.12	0	0	2.0	6.0	3.7
13. Tribunil Tribunil	2.0 1.0	Pre-emerge 30 DAE	7.26	5.04	3.64	5.31	0.2	0	3.0	9.0	8.7
14. Tribunil	2.0	Pre-emerge	5.45	5.08	3.26	4.60	0.2	0.5	3.0	9.2	7.3
15. Illoxan + Brominal	1.0 + 0.24	7 DAE	5.66	5.01	4.88	5.18	0	0	0	9.9	10.0
16. Illoxan + Tribunil + Brominal	1.0 + 1.0 + 0.24	7 DAE 7 DAE	5.81	4.87	3.49	4.72	0.5	0	0.2	10.0	10.0
MEAN			5.74	4.76	4.07						
LSD 5%				1.43							
CV%				18.3%							

* DAE = Days after emergence   BV 78 = Verano (Summer), Mexico, 1978

\+ Brominal treatments at 30 DAE gave crop little control of broad-leafed weeds.

x 0 = no phytotoxicity   10 = complete kill

TABLE 2. GRAIN YIELDS OF PAVON 76, WEED CONTROL AND CROP PHYTOTOXICITY AFTER DIFFERENT TRIBUNIL TREATMENTS, IN THE ABSENCE OF GRASS WEEDS. EL BATAN.

TREATMENT	Time of Application	Grain yield Ton/ha	Phyto-toxicity	WEED CONTROL Amaranthus	Galansoga	Portulaca
1. Non-weeded control		4.93				
2. Hand-weeded control		5.55				
3. Tribunil 1.0 kg/ha a.i.	Pre-emerge	5.02	0	0	0	1.0
4. Tribunil 2.0 kg/ha a.i.	Pre-emerge	5.13	0	3.5	4.0	2.0
5. Tribunil 1.0 kg/ha a.i.	7 DAE	5.36	0	9.5	9.5	3.5
6. Tribunil 2.0 kg/ha a.i.	7 DAE	5.31	1.0	10.0	10.0	10.0
7. Tribunil 1.0 kg/ha a.i.	14 DAE	5.76	0	10.0	10.0	5.0
8. Tribunil 2.0 kg/ha a.i.	14 DAE	5.44	0.5	10.0	10.0	5.0
9. Tribunil 1.0 kg/ha a.i.	21 DAE	5.09	1.0	8.5	10.0	4.0
10. Tribunil 2.0 kg/ha a.i.	21 DAE	5.78	1.0	8.5	10.0	4.0
11. Tribunil 1.0 kg/ha a.i.	28 DAE	5.33	1.5	3.0	10.0	3.0
12. Tribunil 2.0 kg/ha a.i.	28 DAE	5.74	1.5	8.5	10.0	3.5
MEAN		5.37				
5% LSD		1.19				
CV %		12.4				

TABLE 3. GRAIN YIELDS, PHYTOTOXICITY AND WEED CONTROL AFTER VARIOUS HERBICIDE TREATMENTS WITH AND WITHOUT A SURFACTANT. EL BATAN.

HERBICIDES	Rates kg/ha a.i.	Time of Application	Surfac-tant	Grain yield Ton/ha	Phyto-toxicity	WEED CONTROL Grasses	Broadleaf	P. oleracea
Non-weeded control				4.58				
Hand-weeded control				5.90				
Illoxan + Brominal	0.5 + 0.24	7 DAE	+	5.50	0.1	10.0	9.5	0.0
Illoxan + Brominal	1.0 + 0.24	7 DAE	+	5.59	0.3	10.0	9.5	0.0
Illoxan + Brominal	0.5 + 0.24	21 DAE	+	5.59	0.1	9.8	6.0	0.0
Illoxan + Brominal	1.0 + 0.24	21 DAE	+	5.48	0.3	10.0	9.5	0.0
Illoxan + Tribunil + Brominal	0.5 + 0.5 + 0.24	7 DAE	+	5.49	0.1	10.0	9.0	5.0
Illoxan + Tribunil + Brominal	1.0 + 1.0 + 0.24	7 DAE	+	5.44	1.0	10.0	10.0	7.5
Illoxan + Tribunil + Brominal	0.5 + 0.5 + 0.24	21 DAE	+	5.94	0.3	10.0	10.0	5.0
Illoxan + Tribunil + Brominal	1.0 + 1.0 + 0.24	21 DAE	+	5.76	0.5	10.0	10.0	4.0
Illoxan + Brominal	1.0 + 0.24	7 DAE	-	5.43	0.5	10.0	8.0	0.0
Illoxan + Tribunil + Brominal	0.5 + 0.5 + 0.24	7 DAE	-	5.47	0.5	10.0	9.5	0.0
MEAN				5.52				
5% LSD				0.62				
CV %				6.6				

TABLE 4. COMPARATIVE EFFECTS OF BROMOXYNIL AND 2,4-D ON CROP YIELD, PHYTOTOXICITY AND WEED CONTROL. EL BATAN.

TREATMENT	Rate kg/ha a.i.	Time of Application	Grain yield Ton/ha	Phytotoxicity	WEED CONTROL Broadleaf	Grass
1. Non-weeded control			4.59			
2. Hand-weeded control			6.11			
3. Bromoxynil	0.24	7 DAE	5.24	0.0	10.0	0.0
4. Bromoxynil	0.24	14 DAE	5.76	0.0	10.0	0.0
5. Bromoxynil	0.24	21 DAE	5.27	0.0	9.5	0.0
6. Bromoxynil	0.24	28 DAE	5.21	0.0	8.5	0.0
7. 2,4-D	1.0	21 DAE	5.70	2.0	8.0	8.0
8. 2,4-D	1.0	28 DAE	5.10	1.0	10.0	9.0
9. 2,4-D	1.0	35 DAE	4.83	0.0	10.0	6.5
10. 2,4-D	1.0	42 DAE	4.14	0.0	4.0	0.0
MEAN			5.20			
5% LSD			1.31			
CV%			14.7			

TABLE 5. EFFECT OF TRIBUNIL AND BROMOXYNIL IN VARIOUS COMBINATIONS ON THESE WEED SPECIES AND THESE CROP SPECIES - TOLUCA, MEXICO.

TREATMENT	Rates kg/ha a.i.	Time of Application	PHYTOTOXICITY BW	D	T	WEED CONTROL Poa	Commelina	Galansoga Cucumis
1. Tribunil	1.0	7 DAE	0.0	1.0	0.1	9.0	9.0	9.5
2. Tribunil	2.0	7 DAE	0.1	1.5	0.5	9.9	9.3	10.0
3. Tribunil	1.0	21 DAE	0.1	1.0	0.1	2.5	9.5	7.5
4. Tribunil	2.0	21 DAE	0.1	2.0	0.5	9.5	9.9	9.3
5. Tribunil	1.0	Pre-emerge	0.0	0.0	0.0	8.0	5.0	10.0
6. Tribunil	2.0	Pre-emerge	0.0	0.5	0.0	9.5	3.0	10.0
7. Tribunil + Bromoxynil	1.0 + 0.24	10 DAE	0.3	3.0	0.5	10.0	10.0	10.0
8. Tribunil - Bromoxynil	1.0 - 0.24	Pre*-10 DAE	0.0	0.0	0.0	10.0	10.0	10.0
9. Tribunil - Bromoxynil	1.0 - 0.24	Pre -20 DAE	0.0	0.0	0.0	8.0	10.0	9.5
10. Tribunil - Tribunil	1.0 - 1.0	Pre -30 DAE	0.0	0.0	0.0	7.5	3.0	7.0

BW = Bread Wheat - Jupateco

D = Durum Wheat - Mexicali

T = Triticale - Yoreme

* PRE-EMERGE

Physiology

INTRODUCTION

During the 1977-78 winter season, work was continued on five topics: the assessment of yield potential of new varieties and advanced lines, the effect of radiation on yield potential, selection methodology for high yield potential, the behaviour of varietal mixtures, and row spacing and density effects on the yield of distinctive genotypes.

The most notable features of the climate during the season were the high temperatures of December and January. The mean maximum of 28.3°C and 25.4°C for these months respectively were well above the long term means (table 1) and the highest values during the past twenty years. These high temperatures during the early part of the season hastened flowering—Yecora 70 flowered 12 days earlier than normal—and possibly reduced yields due to the more rapid development.

1. ASSESSMENT OF YIELD POTENTIAL

As in previous seasons, new advanced lines from the bread wheat, durum wheat and triticale breeding programs were grown under optimum agronomic conditions (i.e. abundant fertilizer and moisture, absence of disease, weeds and lodging) to compare their yield potential with current and check varieties. The interesting feature of this years trial was the superiority of the durum wheats (table 2). Out of the eleven durums in the trial, seven were amongst the ten highest yielders.

It is evident from the components of yield that high yield can be attained in many ways. However, within a species, yield normally appears far more dependent on the numbers of grains per unit area, than on kernel weight. In 1977-78 this was true for the bread wheats where yield showed a highly significant correlation with grains per square meter ($r = 0.57^{**}$), but the correlation with kernel weight ($r = 0.21$) was not significant. However, amongst the durums and the triticales, neither component was significantly correlated with yield. When data from similar trials during the past three seasons are pooled, thereby including both genotypic and environment effects, the relationship between yield and grain numbers per unit area, as evidenced by figure 1, is very strong. The correlation coefficients of 0.79, 0.82 and 0.78 between yield and grains per unit area for the bread wheats, durums and triticales respectively contrast strongly with their correlation coefficients between yield and kernel weight of 0.22, 0.15 and 0.17 respectively, of which only the first is significant.

These data confirm previous studies which have shown the importance of 'sink' or grain number in yield determination in this environment. For this reason, research on limitations to yield has been concentrated on the inmediate pre-anthesis phase, when spike numbers and grain numbers per spike are determined.

Trials over the past year have allowed an assessment of the advances being made by the breeding programs, especially the bread wheat program, in terms of yield potential. Using Siete Cerros, released in 1966, as a base, some varieties and lines, including Zaragoza 75, Pavon 76 and Kal-Bb, have shown consistently higher yields than Siete Cerros. The amount of this increase varies somewhat from season to season, but taken as a mean over the past three seasons is 10-15 per cent, representing an advance in yield potential of approximately one per cent per year.

2. RADIATION EFFECTS ON YIELD

Over recent years, research has been conducted on the limitations to yield potential in the high yield environment of the Yaqui Valley. Published work (Fischer, R.A.) has shown that in most seasons the component which limits yield is the number of grains set per unit area, as evidenced by figure 1. Manipulation of the environment had its greatest effect during the month inmediately prior to flowering.

Work has continued on this aspect of physiology in order to try and define yield limitations that could be overcome by breeders. In 1977-78, an intensive study was made on the effects of shading on Yecora 70. The dry matter and soluble sugar accumulation of the component parts were measured at flowering, at the end of the shading period (anthesis +7 days) and at the end of the season, both for the crop as a whole and for the main stem and each tiller separately.

Contrary to initial expectations, the effect of shade was observed on all stems, and not just the later tillers as had been hypothesized (table 3). The interaction between stem position and shade with respect to yield was therefore not, significant. The first, and largest, tiller appeared to be slightly less affected by shade than the main stem or the other tillers. Due to the timing of the shade, the component of yield affected was the number of grains per spike. The number of spikelets with grain was reduced markedly by shade, with more sterile spikelets at the base of the spike in shaded treatments.

A full review of this work and its implications is being prepared at present and will be published shortly.

3. SELECTION METHODOLOGY FOR HIGH YIELD POTENTIAL

(1) Selection Criteria

Early segregating populations are sown at CIMMYT, and in many breeding programs world-wide, as spaced plants, to facilitate appraisal of disease reaction and other characters of each individual plant. However, numerous studies have shown that there is little, if any, relationship between the yield of a space-planted wheat plant and its yield under the competitive conditions prevailing at commercial densities. For this reason, a visual appraisal of the yield potential of the progeny of a spaced-plant is, at best, extremely difficult.

Three years ago a study of possible selection criteria which could be used on F_2 spaced plants was initiated. The following porometers were measured or visually assessed on each of 150 randomly selected plants from each of ten bread wheat populations: Early leaf size, leaf angle, flag leaf length, flag leaf width, flag leaf area, overall plant leafiness, leaf permeability (mass-flow porometer), leaf firing, days to ear emergence, breeders estimate of yield, spikelet number, number of sterile basal spikelets, tiller uniformity, plant habit (compactness), plant height, penduncle length, spike number, number of late tillers, spike length, plant grain yield, plant total dry matter, harvest index, kernel weight, grains per central spikelet, grains per plant and grains per main spike.

At the end of the initial season (1975-76), all plants flowering later than 115 days, taller than 115 cm or with susceptible disease reactions were discarded, leaving approximately 80 plants per population. These were grown in F_3 lines and all uniform lines together with those showing tolerant levels of segregation for height or maturity, were bulked and sown in F_4 yield tests in 1976-77. From the remaining lines showing considerable segregation in the F_3, five random plants were taken, grown in F_4 lines, and those exhibiting sufficient uniformity in the F_4 were bulked and sown in F_5 yield tests in 1977-78.

Last year the initial results (from the F_4 yield tests) were presented in this report and showed that the best predictor of F_4 yield over all populations was leaf permeability when measured 112 days after sowing (approximately 3 weeks after flowering), ($r= 0.41^{***}$, $n= 411$). Other F_2 traits which showed significant correlations with F_4 yield were plant height ($r=-0.35^{**}$), harvest index ($r= 0.25^{**}$), leaf fire ($r=-0.25^{**}$), kernel weight ($r=-0.24^{**}$), leaf permeability 98 days ($r= 0.22^{*}$), flag leaf width ($r= 0.21^{*}$) and kernels per main spike ($r= 0.20^{*}$).

The F_5 yield tests were not replicated due to the large number of lines (2017) to be tested. However, one plot of a check variety (Pavon) was sown for every five F_5 plots and yields adjusted to the mean yield of Pavon on the basis of the two closest check plots. The data recorded on each plot included yield, disease incidence, height, days to flowering, lodging and scores of bird damage.

At this stage, data analysis has taken the form of running correlations between F_5 adjusted yields and F_2 plant characters. Plots with severe disease incidence and bird damage were not included in the analysis. Correlations were first made between F_2 characters and F_5 yield for all remaining entries and then between F_2 characters and the F_5 yield of the best progeny selected from that plant. The data were then screened again, and results from all plots showing segregation for height or maturity, any disease or lodging were removed from the set and the same correlation procedures carried out. The F_2 plant characters that achieved significant correlations with yield in one or more of these cases are shown in table 4 together with the correlation coefficients.

Once again, leaf permeability measured at 112 days showed the best overall correlations with F_5 yield. Mean leaf permeability appeared slightly better in some cases but it is not a practical selection method as it would involve the keeping of records on each plant during the season. The fact that the visual assessment of yield potential made by a breeder in the F_2 was not significantly correlated with yield bears out the point made initially that F_2 yield characteristics on a spaced plant bear little relationship to yield under competitive conditions. The breeders estimate of yield was very highly correlated with F_2 yield ($r= 0.40^{***}$) but F_2 yield was not significantly correlated with F_5 yield ($r= 0.11$). Likewise F_2 plant yield was very highly correlated with F_2 total dry matter ($r= 0.94^{***}$), spike number ($r= 0.79^{***}$) and grains per main spike ($r= 0.93^{***}$), but these did not prove useful selection criteria because F_2 plant yield did not reflect the potential of the progeny at commercial densities.

Some further work has been initiated to test the usefulness of leaf permeability as a selection criterian in early segregating generations. However this is unlikely to be conclusive and further studies are encouraged in the light of the importance of this problem.

(2) Interplot Competition in Yield Tests

For practical purposes the yield trials of advanced lines at CIMMYT, and in many other breeding programmes, are harvested without removing the edges of the plots. The question has been asked recently whether the error that is incurred by this procedure is not as big as the yield differences normally expected or achieved in these trials. Two trials were conducted in 1977-78 to investigate this problem.

In one trial, all material was of approximately the same height (90-100cm) representing a breeder's normal yield trial, and in the other, height variation was greater (55-90cm). Two planting patterns were employed:- the normal four rows used by the breeding programs, with a space equivalent to one unplanted row between plots, and an alternative pattern where five rows were planted and no space left between plots. The southernmost row of the five row plots was discarded prior to harvest, thus removing a border from the side closest to the sun's path. Each plot was harvested in several parts so that the effect of all edges on yield could be assessed separately.

Part of the results from the normal four row plots are shown in table 5, where the yields, as proportions of the mean, are shown for the net plot (two center rows with 50cm removed from each end) together with the yields from the total plot, including all borders, with yields calculated on the basis of five rows (as is the common practice). Although the actual ranking of cultivars with the different harvest techniques varied, the changes in rank of any one particular cultivar were normally acceptable (changes in rank of three or less), and correlations between the net and total plot yields were highly significant ($r = 0.68$ and 0.76 for the two trials).

The effect of the border areas did cause notable differences in the apparent yield of some cultivars. In the first trial (tall cultivars), entry 9 appeared better when the whole plot was considered because of one replication where the plot was on the outer edge of the trial, whilst the whole plot yield of entry 11 was considerably better than the net plot yield because the southern row did not lodge, whilst considerable lodging was recorded in the rest of the plot. This is a common feature of lodged plots as the southern row is normally considerably stronger than the other rows. When the height of the cultivars in the trial was variable, (Trial 2), the taller cultivars moved up in the yield rankings from the net plot to the whole plot, whilst the shorter cultivars moved down. This result was as had been hypothesized and it stresses the need to continue grouping cultivars in yield trials based on their height.

Because the southern row did not appear to have a large effect on the yield ranking when height was constant, the five-row plot treatments, where the southernmost row was removed prior to harvest, did not seem to have any advantage in stabilizing the yield rankings between yields based on the net plot and those based on the whole of the four row plot.

4. YIELD OF VARIETAL MIXTURE

The concept of the multiline variety has achieved some importance in the CIMMYT bread wheat breeding program. Because the individual lines of a multiline mixture are phenotypically similar, it is extremely difficult to identify the component lines in the crop. Therefore in order to study the behaviour of a mixture, three varieties that could be easily distinguished, and yet are similar in height and maturity, were studied separately and in mixtures.

A similar study was conducted in 1976-77. In 1977-78, seed from the mixture harvested the previous season was sown as one treatment. In 1976-77, the relative yield of the cultivars in a pure stand and the mixture was reversed, such that Pavon 76 was the highest yield in a pure stand, but contributed least to the yield of the mixture, and Siete Cerros 66, which was the lowest yielder in the pure stand was the highest yielder in the mixture. Tesopaco 76 was intermediate in both respects, and the yield of the mixture was very close to, and not significantly different from, the mean yield of the varieties in pure stands.

Once again the yields of the mixtures did not differ significantly from the mean of the yield of the three varieties in pure stands (table 6), although in both cases the yield of the mixture was slightly lower than the mean. Siete Cerros 66, again the lowest yielder in a pure stand, fared better in the mixtures and outyielded the other two varieties. Pavon, the highest yielder in pure stands, did not show the same poor competitiveness as in the previous season, and in the crop seeded from last year mixture, showed a far higher yield than expected from the proportions of seed sown. Tesopaco, which was the most stable component last year, did not compete well with the other cultivars and it gave lower proportions of yield in the mixtures than its proportion of seed in the planted mixture.

Because of high temperatures in the early part of the season, flowering was sooner than normal, and Pavon, which in 1976-77 flowered seven days later than Siete Cerros, flowered at the same time in 1977-78. For this reason it probably yielded better in the mixture. Later flowering of one variety in the mixture would lead to shading of that variety by the others during the critical spike growth phase prior to flowering.

Although there was inconsistency in the behaviour of Pavon and Tesopaco in the two seasons, Siete Cerros continued to assume more importance in the mixture. On top of its more competitive nature in the mixture, yield in this variety is made up of a large number of smallish kernels, so that the proportion of seed in the harvested mixture is even higher than the proportion of yield of the variety.

5. ROW SPACING AND DENSITY STUDIES

Between-row Spacing

Generally, spacing studies show that there is a wide range of spacings from very close rows up to 45 cm or more between rows where maximum yields are obtained. In the present study, twelve diverse genotypes were included in a trial using 10 cm, 20 cm, and 30 cm, between row spacings to determine whether some of the newer short, erect-leaved and compact lines need closer spacings because of their growth habit.

The results (table 7) showed a highly significant overall effect of spacing on yield, with the closest spacing giving the highest yields. The trend was evident in many of the entries, including some where 100 per cent ground cover was achieved at 30 cm spacing before flowering, but was significant in only six of the cultivars. In Zaragoza 75, the leafiest variety in the trial, the trend to higher yields at closer spacings was not evident.

These results show that closer spacings do benefit the very short lines, very compact habit lines and very erect-leafed lines. It is possible that the high temperature at the start of the season accentuated the effect by limiting tillering, but only in Erect RGA were there significantly fewer spikes per unit area at 30 cm than at 10 cm spacing.

Lodging was observed only in Siete Cerros 66, where there was considerably more lodging at closer (10 cm) spacing than at the wide (30 cm) spacing.

Seeding Density

As with row spacing, numerous studies conducted in many parts of the world have shown that using good seed and with good seed-bed preparation, maximum yields may be obtained from a wide range of densities as low as 10 kg/ha seed and up to 200 kg/ha or more. In various parts of the world including Yugoslavia, China and Senegal very high seed rates (+ 300 kg/ha) are used. Higher yields are reported with these seed rates than with more conventional levels (+ 100 kg/ha).

The effect of four seed rates (50, 100, 200 and 300 kg/ha) on six contrasting genotypes was studied in 1977-78. As evidenced in table 8, overall there were no significant differences in yield between seeding densities. Spike numbers were directly proportional to seed density, but this was offset by smaller spikes, both in terms of spikelet numbers and grains per spikelet, so that overall, the number of grains per unit area was stable.

In two cultivars, significant differences were apparent. In Kal-Bb, yields were increased by densities up to 200 kg/ha, due to both increased kernel weight and grains per unit area, whilst in Maya 74, yield was markedly reduced by the 300 kg/ha seed rate, although there was little change in yield from 50-200 kg/ha. Although there was more lodging in this variety at the highest seed rate, the lowest yields were recorded in replications where no lodging occurred. Lodging is likely to be a greater problem at higher densities, as there are a larger number of stems. These are likely to be weaker that at lower densities, leading to increased lodging with taller varieties.

One advantage of high seed rates is in weed competition. Leaf area increases very rapidly (figure 2) at high seed rates and this gives the crop a competitive advantage over the weeds.

It would appear that in this environment, there is no advantage in going to very high seed rates, unless weeds are a problem, and in this case, high densities should only be considered for very lodging resistant varieties.

CONCLUSION

The physiology program of the CIMMYT wheat program has now been terminated, and work will not be continued on selection criteria for high yield potential and the limitations to yield potential. However, there are much data still to be analysed, which will be published when summarized.

Figure 1. GRAIN YIELDS AND GRAINS/SQUARE METERS OF DIVERSE GENOTYPES OF THREE SPECIES. TRIALS IA, IB, IC.

▲ = BREAD WHEATS $r = 0.785^{**}$ ○ = DURUM WHEATS $r = 0.814^{**}$ □ = TRITICALES $r = 0.781^{**}$

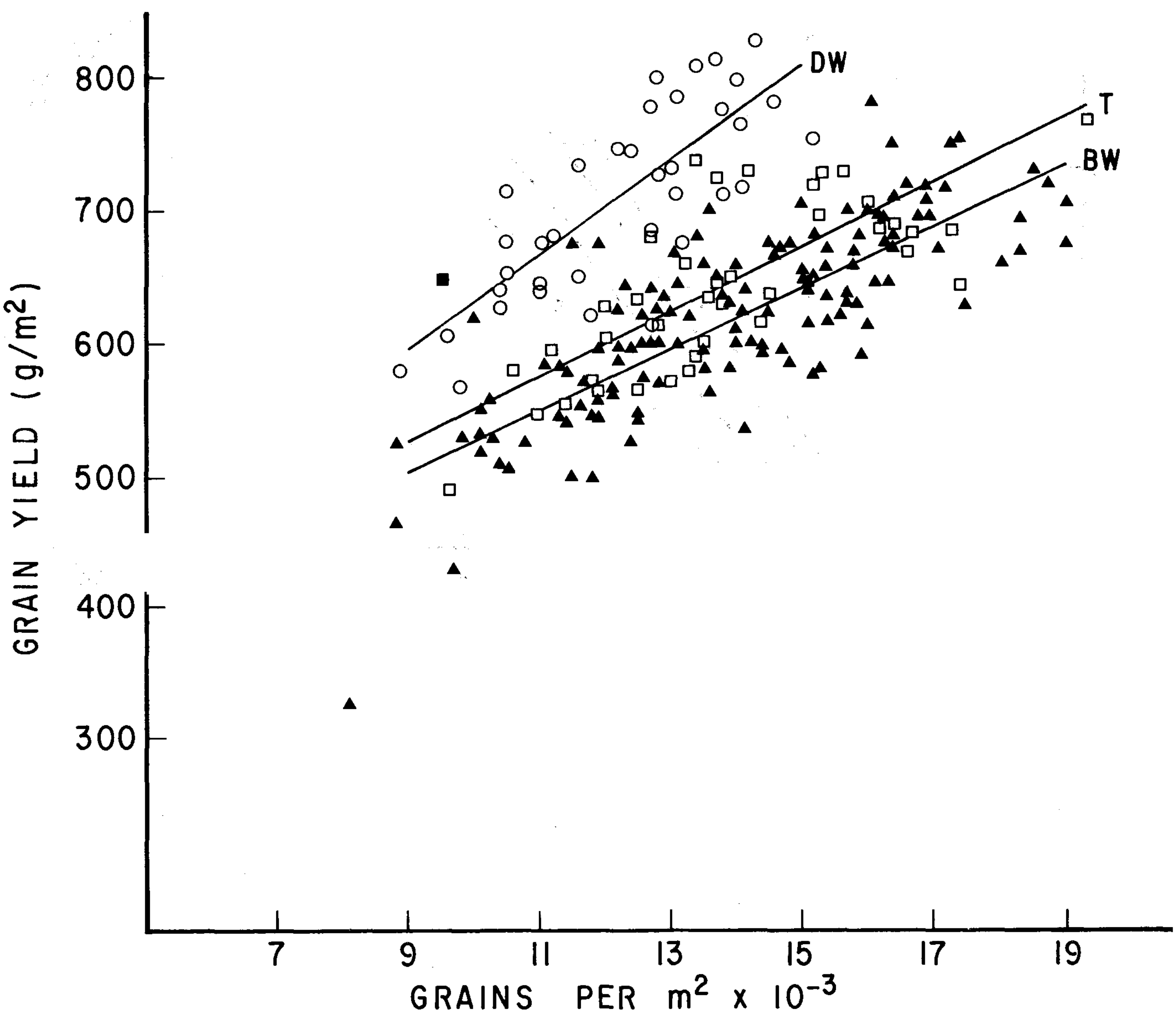


Figure 2. CHANGE IN LEAF AREA INDEX (LAI) OVER TIME AT FOUR SEEDING DENSITIES.

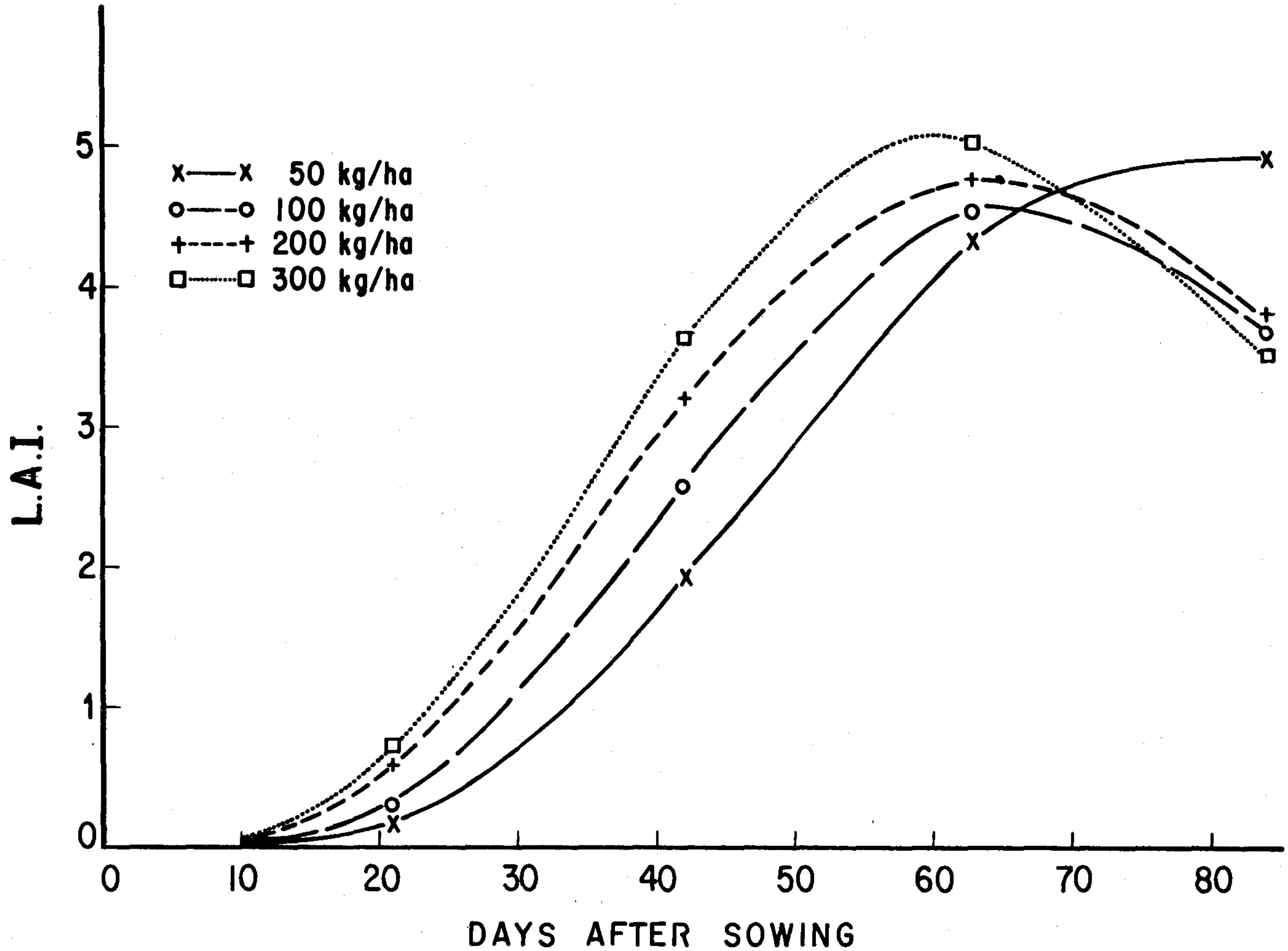


TABLE 1. MEAN MONTHLY WEATHER MEANS FOR CIANO. WHEAT PHYSIOLOGY METEOROLOGICAL STATION.

MONTH	Temp. Max. °C		Temp. Min. °C		Radiation cal/cm^2/day		Evaporation mm/day	
	1977-78	L. T. Mean*	1977-78	L. T. Mean	1977-78	L. T. Mean	1977-78	L. T. Mean
December	28.3	24.4	10.6	8.5	283	284	4.33	3.62
January	25.4	23.4	8.5	6.8	291	305	3.46	3.17
February	25.0	24.9	7.1	6.8	387	399	3.94	3.88
March	29.0	27.1	10.8	8.2	451	497	5.47	5.27
April	32.1	31.2	9.5	10.3	543	581	8.14	7.67

* LONG-TERM - 19 YRS FOR TEMPERATURE, 8 YRS FOR RADIATION AND EVAPORATION.

TABLE 2. YIELDS AND PRINCIPAL COMPONENTS OF 48 CULTIVARS OF THREE SPECIES UNDER NON-LIMITING AGRONOMIC CONDITIONS - 1977-78. (YIELDS AT 12.5% MOISTURE).

	Grain yield kg/ha	Grains per $m^2 \times 10^{-3}$	Grains per spike	Spikes per m^2	Kernel wt. (mg)
Mexi 'S' CD 1895-12Y-OY-1E	8285	14.29	43	329	51
Mexi 'S' - Chap 21563 CD 1894-3Y-OY-2E	8105	13.44	38	351	53
Mexicali 75	7850	13.14	32	408	53
Kvz-Buho 'S' x Kal-Bb CM 33027-F-15M-500Y-OM	7816	16.14	45	358	43
Bittern 'S' CM 9799-126M-1M-5Y-OY	7815	14.61	39	373	47
Mallard 'S' CD 1894-3Y-OY-1E	7785	12.68	27	487	54
Bittern 'S' CM 9799-126M-1M-4Y-OY	7767	13.76	38	365	50
IRA2 X 8319-A-3Y-1M-OY	7694	19.29	53	363	35
Mexi 'S' - Fg 'S' CD 1895-12Y-OY-2E	7654	14.11	35	404	48
Pavon 'S' CM 8399-D-4M-3Y-3M-1Y-OM	7561	17.35	44	397	38
Yellowlegs 'S' CD 17142-8M-3Y-1Y-OY	7554	15.21	37	418	44
Kal - Bb	7319	18.53	41	454	35
Goose 'S CM 10143-6M-3Y-1M-2Y-OY	7289	12.84	35	372	50

TABLE 2. CONTINUATION .....

	Grain yield kg/ha	Grains per $m^2 \times 10^{-3}$	Grains per spike	Spikes per m^2	Kernel wt. (mg)
IRA - M^2A X 12937-B-1Y-3Y-5M-OY	7285	14.17	52	275	45
Beagle	7284	15.32	57	274	42
Zaragoza 75	7218	18.69	44	429	34
Pavon 76	7209	16.59	38	443	38
Pg 'S' x Jo 'S' - Cr 'S' CM 13102-10M-1Y-OM	7191	14.09	32	447	45
Nacozari 76	7179	17.16	45	381	37
Buckbuck 'S' CM 31678-R-4Y-2M-21Y-OM	7076	16.94	43	394	37
Magpie 'S' CM 20668-D-4Y-4M-1Y-OY	7032	15.98	45	358	39
IA - IRA x Bgl X 12257-1N-OM	6995	15.26	61	251	40
Bluejay 'S' CM 5287-J-1Y-2M-1Y-4M- OY-501Y-OB	6974	16.91	44	384	36
Pavon 'S' CM 8399-D-4M-3Y-OM-OB	6949	16.24	40	408	38
Flicker 'S' CM 8954-B-7M-1Y-1M-1Y-OM- 2PTZ-OY	6939	18.28	43	424	33
Kla - M^2A X 8816-3Y-3M-2Y-OY	6901	16.42	49	337	37
Mapache	6880	16.19	50	325	38
M^2A - IA X 12677-56Y-1Y-3M-OY	6862	17.31	57	303	35

TABLE 2. CONTINUATION

	Grain yield kg/ha	Grains per $m^2 \times 10^{-3}$	Grains per spike	Spikes per m^2	Kernel wt. (mg)
M^1A X 2148-5N-2M-3Y-2M-OY	6843	16.71	52	324	36
Cocorit 71	6839	12.73	32	404	47
Cno'S'-Pj62xGallo/Bb-Cha CM 25995-1Y-2Y-OY	6831	13.43	32	428	45
Fiserect 3	6751	18.89	47	411	32
(Pl/Inia-CnoxCal)Bluejay'S' CM 30136-3Y-1Y-OM	6708	18.33	47	393	32
M^2A - Bgl X 15490-3M-OY	6704	16.61	53	316	36
Siete Cerros 66	6699	16.35	41	399	36
Mapache 'S'	6492	15.13	51	296	38
Cgn/Pato x Bb-Cno CM 10712-1Y-1M-6Y-1M-1Y-OY	6460	16.26	39	424	35
Choli	6432	17.36	44	401	33
Jupateco 73	6415	15.13	36	421	37
Yecora 70	6355	13.83	32	437	40
Gallo - Torim 73 x Pavon'S' CM 33489-E-3M-1Y-OM	6325	15.66	34	458	36
55-1744xKal-Bb/Siskin'S' CM 33155-G-5M-2Y-OY	6258	17.46	36	482	32
Cal-Kvz x Torim 73 CM 30831-D-4Y-2M-1Y-OM	6231	15.61	37	431	35
Tesopaco 76	6163	13.96	34	415	39

TABLE 2. CONTINUATION

	Grain yield kg/ha	Grains per $m^2 \times 10^{-3}$	Grains per spike	Spikes per m^2	Kernel wt. (mg)
Inia 66	6010	12.79	38	338	41
Inia-7CxMaya'S'/Pci'S'x Bb-Inia CM 31630-I-1Y-2M-5Y-OM	5981	14.72	44	336	36
Yr Resel(B)-Trifon'S'xRsk-Torim 73 CM 36064-A-1M-5Y-OM	5824	13.93	28	504	37
Kite	5808	15.28	36	425	33
Mean	6971	15.65	42	387	40
5% LSD	585	1.40	5	53	2
CV%	6.1	6.4	9.2	9.9	3.8

TABLE 3. YIELD AND COMPONENTS OF MAIN STEM AND TILLERS OF YECORA 70 FOLLOWING SHADING OVER THE FLOWERING PERIOD. 50% ANTHESIS = 74 DAYS.

Shade level 59-79 days	Stem	Grain yield g/m^2	% of total yld. Red.	Grains/ $m^2 x10^{-3}$	Grains + per spike	Kernel + Wt. (mg)	Fertile + spikelets	Sterile + Basal Spkts.
0 = Control	Main stem	316		6.45	43	43	17.9	1.6
	Tiller 1	194		4.39	34	39	16.1	2.6
	Tiller 2	106		2.59	27	36	15.1	3.7
	Other tillers	39		1.06	28	32	13.6	4.3
	TOTAL	655		14.49	37	41	16.3	2.6
35%	Main stem	304	33	6.36	42	42	17.6	1.9
	Tiller 1	195	-4	4.60	33	37	15.9	2.9
	Tiller 2	93	38	2.19	22	37	13.8	4.6
	Other tillers	27	32	0.66	16	36	10.5	7.4
	TOTAL	620		13.81	34	42	15.5	3.4
63%	Main stem	287	37	5.55	37	45	17.2	2.0
	Tiller 1	183	14	3.96	30	41	15.2	3.4
	Tiller 2	90	21	1.99	26	40	14.6	4.3
	Other tillers	16	29	0.36	12	38	9.0	7.7
	TOTAL	576		11.86	31	43	15.3	3.4

PF Main (shade)	*
PF Shade x Stem	N.S.
5% LSD Shade	12
CV%	13.8

+ In these columns, means appear instead of totals.

TABLE 4. CORRELATION COEFFICIENTS BETWEEN F2 PLANT CHARACTERS AND F5 YIELD. ONLY CHARACTERS SIGNIFICANT IN AT LEAST ONE DATA SET ARE TABULATED.

F2 Characters	All acceptable F5 lines [1]: All progeny [1] n = 1132	All acceptable F5 lines [1]: Best progeny [1] n = 267	Only good agronomic types [1]: All progeny n = 906	Only good agronomic types [1]: Best progeny n = 219
L.P.[2] 111 days	0.21 *	0.31***	0.23**	0.32***
Mean LP. 5 occasions	0.23**	0.31***	0.21*	0.29**
Plant height	-0.09 N.S.[3]	-0.18*	-0.07 N.S.	-0.12 N.S.
Grains/main spike	0.19*	0.14 N.S.	0.20*	0.11 N.S.
LP 92 days	0.16 N.S.	0.24**	0.15 N.S.	0.25**

1. See text for definitions
2. Leaf permeability
3. Not significant at 5% level

TABLE 5. YIELDS OF BREEDER-TYPE PLOTS BASED ON TWO CENTRE ROWS WITH ENDS REMOVED (NET PLOT) AND ALL FOUR ROWS INCLUDING PLOT ENDS (TOTAL PLOT). YIELDS EXPRESSED AS PROPORTIONS OF MEAN YIELD.

UNIFORM HEIGHT						VARIABLE HEIGHT					
Entry No.	Height cm	Net Plot Yield	Net Plot Rank	Total Plot Yield	Total Plot Rank	Entry No.	Height cm	Net Plot Yield	Net Plot Rank	Total Plot Yield	Total Plot Rank
1	100	0.930	14	0.915	15	1	55	1.104	2	1.036	5
2	100	0.983	9	0.949	13	2	70	0.926	14	0.844	15
3	90	0.974	10	0.968	10	3	70	0.928	13	0.949	11
4	100	1.028	6	1.064	3	4	55	0.968	10	0.931	13
5	100	0.941	13	0.920	14	5	85	0.935	12	0.981	9
6	90	1.047	4	1.072	1	6	90	0.955	11	0.989	7
7	90	1.047	3	1.019	7	7	70	0.998	9	1.032	6
8	100	0.986	8	0.953	12	8	55	1.035	4	0.932	12
9	100	0.955	12	0.993	9	9	65	1.001	8	0.986	8
10	90	1.076	2	1.072	2	10	60	1.035	5	0.974	10
11	100	0.919	15	1.042	5	11	70	0.870	15	0.868	14
12	90	1.107	1	1.046	4	12	80	1.021	6	1.125	3
13	100	0.958	11	0.954	11	13	85	1.005	7	1.041	4
14	100	1.039	5	1.010	8	14	90	1.078	3	1.139	2
15	95	1.011	7	1.020	6	15	85	1.140	1	1.173	1
LSD	5%	0.103		0.081				0.104		0.080	

TABLE 6. YIELDS OF THREE VARIETIES IN SOLID STANDS AND TWO MIXTURES.

		Seeds/m^2 sown	Yield g/m^2	% of Total	% of Kernels[1]
1. Siete Cerros 66		200	646		
2. Tesopaco 76		200	654		
3. Pavon 76		200	721		
Mean			674		
4. New mixture.	Siete Cerros 66	67	254	39	41
	Tesopaco 76	67	176	27	25
	Pavon 76	67	225	34	34
Total		200	655		
5. Previous mixture.	Siete Cerros 66	96 [2]	333	51	54
	Tesopaco 76	70 [2]	109	17	15
	Pavon 76	34 [2]	207	32	31
Total		200	649		
5% LSD Main treatments					
5% LSD Mixture components					
C.V.%					

1 Number of kernels of one variety in 100 kernels of harvested crop. 2 Calculated

TABLE 7. THE EFFECT OF THREE BETWEEN-ROW SPACINGS ON YIELD OF TWELVE CULTIVARS.

Entry	Plant and Leaf habit	Height cm	Yield 10 cm g/m^2	Yield 20 cm g/m^2	Yield 30 cm g/m^2	PF+
Kal - Bb	N *	67	728	722	691	N. S.
Zaragoza 75	Leafy, early erect	92	806	786	801	N. S.
Siete Cerros 66	N *	94	705	668	655	N. S.
Fiserect 4A	Compact, very erect	56	554	551	488	*
Limpopo	Erect	62	577	560	571	N. S.
BbxTob-Cno/Huac'S'	Compact	82	608	641	577	*
Au - Top x Grajo	Moderately compact	87	633	601	568	*
HD 2182	Compact	69	657	573	555	**
Maya 74	Compact	96	635	607	595	N. S.
D 67.3 - Gav 'S'	Erect, very leafy	58	712	677	667	N. S.
Lechuza	Erect, compact	82	686	624	585	**
Erect RGA	Very erect, compact	89	634	574	552	**
Mean			661	632	609	**
LSD 5%	Means		16			
LSD 5%	Spacings within cultivar		56			
C.V. %			6.3			

* N = Lax leaves, 100% ground cover normally achieved ± 60 days after sowing

\+ = Probability of the calculated F value occurring by chance * = <0.05%
** = <0.01%
N. S.= Not Significant

TABLE 8. EFFECT OF DIFFERENT SEEDING DENSITIES ON YIELDS OF SIX CONTRASTING GENOTYPES.

Seedrate	YIELD g/m^2 50 kg/ha	100 kg/ha	200 kg/ha	300 kg/ha	PF
Kal - Bb	690	714	735	728	*
Zaragoza	734	726	731	730	NS
Anza	612	580	585	580	NS
Limpopo	504	485	499	506	NS
D 67.3 - Gav 'S'	667	656	660	669	NS
Maya 74	608	580	592	520	*
Mean	636	623	634	622	NS
LSD 5% Means	16				
LSD 5% Within variety	40				
C.V.%	4.5				

Training

In 1978, the wheat training program in Mexico was CIMMYT's largest teaching operation ever undertaken. Courses were given in breeding and pathology, production agronomy, experimental farm management and industrial cereal technology. A total of 57 agricultural officers from 26 countries participated (table 1), in the subjects outlined below:

BREEEDING AND PATHOLOGY

These two courses closely follow CIMMYT's wheat breeding activities. The wheat breeding trainees participate in two crop cycles and are employed in the field routines associated with the development of bread wheat, durum wheat, triticale and barley.

The plant pathology trainees receive the same education plus special training on the support functions such as rust reading, spore collection, storage and creation of epiphytotics.

PRODUCTION AGRONOMY

The general goal is to train a wheat production agronomist in rain-fed wheat agronomy. This is accomplished in Mexico's upper rain-fed plateau with the help of CIMMYT's Wheat Program and local Mexican farmers. In the process of training the wheat production agronomist, the following objectives are considered to be fundamental:

1. To provide to the trainee with an experience in a production research program that uses on-farm testing.
2. To use a multidisciplinary team which includes farmers, agronomists, economists and breeders to establish short and long term research goals.
3. To develop methodologies which characterize farmer recommendation domains i.e., agroclimatic regions, similarities in production scale.
4. To use appropriate scientific methodology in the conduct of off-station testing.
5. To give a sound knowledge and appreciation of wheat, triticale and barley agronomy under rain-fed conditions.
6. To understand the nature of the farmer and his biological, economic and social constraints.

Trainee/Trainer Instruction

This activity is a limited effort which was begun in 1975. In essence, a practising agronomist is accepted from a national program, who depending on his experience, can participate in the Production Agronomy Training course as a training assistant for up to one year, or as a regular in-service trainee with a supplementary four month's training in the organization and execution of in-service training within his national research organization.

EXPERIMENTAL FARM MANAGEMENT

This course is designed to give experimental farm managers an understanding of on–station agronomy and administrative techniques for better station management.

The practical training takes place on CIMMYT's wheat and maize research stations in Mexico and emphasizes the agronomy of both crops, their cultural practices on station and in farmer fields. A lot of effort is given to maintenance and operations of farm machinery.

This is a four month's course but it can be arranged to best fit the needs of the participant. It should be emphasized that it is a practical "learning by doing" type course and it is necessary that the participant possess good physical health.

INDUSTRIAL CEREAL TECHNOLOGY

Two persons were trained in 1978 in CIMMYT's industrial quality laboratory. The course which extends over four months, is designed as a support activity during final selection. The quality results obtained in the laboratory are taken into consideration at the time of crossing.

ASSISTANCE TO NATIONAL TRAINING PROGRAMS

If needed, CIMMYT wheat training staff are available to assist returning trainees on a short term basis in their own national training programs. The success of in-service training at the national level will be assured provided the national research service is prepared to take the initiative to train in the context of its own research activities. An in-service training activity at the national level of this nature helps to bridge the gap between the national extension service and research.

In 1978, members of the wheat training staff participated in national training programs in Madagascar, Algeria and Syria. These consultancies have demonstrated that in the case of the non-traditional wheat producing countries which are in the initial phases of wheat production, CIMMYT training personnel can make a useful contribution. The total CIMMYT experience is drawn upon to help orient both production research and long term research goals.

In the case of Madagascar, which is a country just beginning its wheat production efforts, a two week's intensive training course was given to 28 research and extension personnel. The time was shared with training personnel from CIP (the International Potato Center), which was found to be a convenient arrangement in approaching the production resource problems of both wheat and potato crops.

Due to some advanced planning by outreach regional personnel from both CIMMYT and CIP, research plots and farmer demonstrations formed an integral part of each day's practical work.

In Algeria, the National Field Crop Research Institute, I.D.G.C., together with wheat training staff, planned and installed a series of verification trials which were designed to orient both agronomic research and economic studies. These same trials will also serve as a focus for future in-service training activities within the national program.

In Syria, wheat training personnel have helped the in-service training department of ICARDA to organize a wheat production course that will serve the regional needs of ICARDA's mandates.

TABLE 1. Origin of Wheat In–service Trainees 1978.

Country	Breeding & Pathology	Production	Farm Management	Industrial Cereal Technology
Algeria		3		
Bangladesh	2		1	
Bolivia	3	1		
Chile	1			
Colombia		1		
Ecuador		1	1	1
Egypt	1	2		
Guatemala		1	1	
Hungary	1			
India	5			1
Jordan		2		
Korea	1			
Malawi	1			
Mali		1		
Mexico		2		
Nepal	2	2		
Pakistan	1	2		
Peru	1	1		
Philippines	1			
Rwanda	1			
Syria		1		
Tchad		1		
Tunis		1		
Turkey	5			
Zaire		1		
Zambia	2	1		
TOTAL	28	24	3	2

Wide Crosses

Intergeneric hybridization research in some Triticeae has been carried out in a Kansas State University–CIMMYT collaborative program, at Kansas State University.

Crossability of *Triticum monococcum, T. turgidum and T. aestivum with Secale cereale* was studied after treatment with GA_3, 2,4-D and EACA. The maternal genotype exerted an influence on crossability in all cases. Kr_1 Kr_1, Kr_2 Kr_2 genes were expressed optimally at the tetraploid level.

The environment modified the crossability of *T. timopheevi x Secale cereale.* The major factors influencing crossability were temperature, light intensity and humidity. E. amino caproic acid (EACA) enhanced embryo recovery where there was distinctive endosperm development.

Hybridization of *Hordeum vulgare x Secale cereale* was not facilitated by using the hormones 2,4-D or GA3, the immuno suppressant EACA, or gamma radiation application, either alone or in combination. Only maternal germ plasm exerted an effect.

In the crosses of *T. aestivum x H. vulgare,* prefertilization phenomena were observed. The primary crossability barrier for this genotype combination was identified to be the result of a failure of the pollen tube to grow into the ovary.

The following intergeneric hybrids were cytogenetically analyzed:

T. aestivum L. cv. Chinese Spring x *Elymus sp.* (2n=4 =28 chromosomes).
H. vulgare x Elymus sp. (2n=6 x =42 chromosomes).
H. vulgare L. cv. Manker x *T. turgidum* L.cv.Cocorit 71
H. vulgare L. cv. Manker x *T. aestivum* L. cv. Tobari
T. turgidum L. cv. Cocorit 71 x *Agropyron junceum*

Additional studies on these hybrids included:

1. Pollen development and pollen exine differentiation under scanning electron microscopy
2. Pollen development under light microscopy. Abnormalities related to preferential separation of univalents at anaphase I, and presence or absence of anaphase II. Pollen tetrad and size variations were correlated with chromosomal information transferred during meiosis.
3. Stomate differentiation size and epidermal cell characteristics on the flag leaf. Biparental morphology was evident although the hybrids phenotypically expressed the *Triticum* oriented parental dominance.
4. The hybrids are maintained as clones. Colchine was used to induce amphiploidy in an F_1 of *H. vulgare* L. cv. Manker x *T. turgidum* L. cv. Cocorit 71 but the amphiploid was meiotically unstable and the plants were male x female sterile.

Other intergeneric hybrids being maintained are:

Tritico-secale x A. junceum
A. elongatum x S. cereale
A. elongatum x H. vulgare
H. vulgare x T. aestivum cv. Bonza

Five cytogenetically stable lines selected from *T. turgidum x A. elongatum* amphiploid x *T. turgidum* L. cv. Cocorit 71 and the reciprocal were analyzed for nutritional properties and observed for plant characteristics at CIMMYT, Mexico. One of these lines has been selected for further study and agronomic performance. At present, investigations are being designed to consolidate the findings on crossability, to study the double fertilization phenomenon by histological and fluorescent microscopy, enhance the embryo frequency in intergeneric hybrids in the tribe Triticeae, characterize the hybrids available and induce amphiploidy.

International Nurseries

In the summer of 1978, CIMMYT distributed 1602 bread wheat, durum wheat, triticale and barley nurseries, the details of which are shown in table 1. This distribution involved 7628 lines and 281 cooperators in 106 nations. In addition, 60 trials of winter triticale materials were despatched, making a total distribution of 1665 trials.

The total weight of the air shipments was 9.3 tonnes and consisted of 31 different nurseries and half a million seed packets. There may be a set of up to 700 varieties or lines in a nursery.

Each nursery focuses on specific features, such as yield stability under a wide range of environmental conditions, or disease and insect resistance.

Local breeders may use an entry to cross with local varieties, or make selections from or multiply the entry for release to farmers. When directly released as a commercial variety, CIMMYT requests that the origin of the germ plasm be recognized.

Varieties derived from these nurseries and released for commercial production, cannot be protected under patent's or plant breeders' rights legislation.

TABLE 1. Nurseries distributed by the International Nurseries Program, 1978

	Africa	Asia	Caribbean	Central America	Europe	Mid East	North America	Oceania	South America	Totals
BREAD WHEAT										
F_2 Irrigated	9	6			3	7	1		14	40
F_2 Dryland	6	7		1	4	8	1	1	12	40
F_2 S x W	12	8		1	30	8	20	1	19	99
F_2 Type 7C	5	8			4	10	1		2	30
F_2 Aluminum	8	2	3	1	1	1		2	11	29
Helminth	9	10	2	4		1		3	9	38
IBWSN	41	33	5	6	13	20	15	9	38	180
ISWYN	19	12	1	3	12	14	17	1	16	95
ISEPTON	8	2		1	11	3	8	1	10	44
DURUM WHEAT										
F_2 Irrigated	8	5			12	10	4	1	9	49
F_2 Dryland	6	8		1	10	11	7	1	6	50
F_2 C.Tolerant	5	7			17	5	12	1	8	55
C.B.	6	5			7	6	2	1	2	29
IDSN	18	13		2	12	14	4	3	13	79
IDYN	18	12			10	15	8	2	11	76
EDYT	8	2			1	3				14
TRITICALE										
F_2 Irrigated	7	10		1	5	9	8		8	48
F_2 Dryland	4	8		1	3	9	5		9	39
F_2 S x W	3	8			7	3	5		4	30
C.B.	2	1			2	1	2		3	11
ITSN	25	23	3	3	15	15	11	3	23	121
ITYN	16	15	1	2	12	14	15	2	19	96
TDRN	5	4			1	2	1	1	6	20
Forage Lines	2	1			2	1	4		6	16
Good Seed Type	3	3			3	1	5	1	3	19
BARLEY										
F_2 Spring	9	10		1	4	10	11		10	55
F_2 S x W	2	4			1	2	2		2	13
C.B.	8	7			4	6	7	1	10	43
IBON	18	16		2	6	9	10		13	74
EBYT	14	13		2	4	12	6		9	60
Miscellaneous	4	2				3	1		3	13
TOTAL	**308**	**265**	**15**	**32**	**216**	**233**	**193**	**35**	**308**	**1602**

CIMMYT Quality Laboratory

BREAD WHEAT

Not only do plant breeders look for variability in agronomic characteristics but they are also interested in creating good variability for quality. They are aware that each country and even in the same country, different qualities are required for the production of different products. For example, the quality that is required for sandwich bread is different from the quality required for tortilla and chapati.

To attain this variability, the CIMMYT Wheat Quality Laboratory applies different quality tests to evaluate all the material that has been selected in the field for good agronomic characteristics. Screening for different quality characteristics is started in the early generation material, when more variability is observed. In the bread wheats, by using the Pelshenke test (wheat–meal fermentation test), 12,000 individual plants from the F_3 and F_4 generations were evaluated in 1978 for gluten strength, after they had been selected for seed type. Only the ones with good seed type were evaluated by the Pelshenke test.

Advanced Materials:

The laboratory evaluated the crossing block, the International Bread Wheat Screening Nursery, the basic germ plasm material and the International Spring Wheat Yield Nursery for milling characteristics, protein percentage, sedimentation, alveogram, mixogram and baking test.

In the crossing block, 333 parental lines were evaluated. A good variability in quality characteristics was observed. For example, the alveogram data showed that P/G values (the ratio between measured dough, tenacity or resistance to extension P and extensibility G) ranged from 1.4–11.0 with W values (measured gluten strength) from 47–587. These values indicate strong, medium and weak gluten with tenacious, elastic and good balanced characteristics.

It is very important to know the quality characteristics of all the progenitors, in order to plan for better combinations of characters in the new crosses.

Screening Nursery:

Lines totalling 465 were analyzed in the laboratory. From this material, two groups were selected to go back into the crossing block. The first group included material with strong, good balanced gluten (table 1). In the second group, weak elastic material was included. This material is being crossed with some tenacious material in the program to try and correct this undesirable characteristic (table 2).

Basic germ plasm program:

Some materials, including dwarf CIANO lines, were evaluated for quality from this group. There were also some CIANO line derivatives in this group with better quality characteristics than CIANO 67. In this program, lines with a high protein content are being developed. Some of these lines have a flour protein content up to 17.7 per cent and possess very good baking characteristics.

TRITICALE

Some 245 advanced lines and varieties in the 11th International Triticale Screening Nursery were evaluated for quality. The lines which were included possessed good grain, a high test weight, and yielded well. Together with improvements in seed type, there has been a remarkable improvement in test weight, which has resulted in higher flour extraction.

The improvement in quality is shown in the following figures:

	Hectoliter Weight (kg/hl)	Flour Yield (Percentage)
1972	65.6–70.2	51.7–59.0
1978	76.4 per cent of lines ranged 70–78	63 per cent of lines ranged 65–72

In 1973, only 13.1 per cent of the samples had a loaf volume higher than 600 cc. In 1978, 72 per cent of the lines had a volume higher than 600 cc, and 20 per cent of these lines exceeded a volume of 700 cc.

The quality data for some of the analyzed lines are shown in table 3. Flour from these lines was baked in mixtures with the wheat varieties Pavon 76, Pima 77 and Hermosillo 77 at 25, 50 and 75 per cent, and then compared with loaves of bread made from 100 per cent wheat and 100 per cent triticale flours.

The quality of the bread prepared with triticale–wheat mixtures, was satisfactory and in some cases, the loaf volume of the mixtures was higher than the loaf volume of the 100 per cent wheat or triticale breads. The mixtures of Hermosillo 77 and the triticale consistently produced good quality breads, (table 4).

TABLE 1 LINES SELECTED FROM THE 12th IBWSN WITH GOOD BALANCED STRONG GLUTEN

No. Lab.	Origin Y-77-78	Variety or Cross and Pedigree	Protein %	Sediment. c.c.	Alveogram W	Alveogram P/G	Loaf Vol. c.c.
11267	SN-29	Flicker "S" CM8954-B-7M-1Y-1M-0Y-(1-21B)	11.7	45	334	3.1	825
11268	30	Flicker "S" CM8954-B-7M-1Y-1M-0Y-(1-35B)	11.8	43	338	3.0	910
11286	48	Dic Keissel "S" CM31099-C-1Y-1Y-0M	12.9	43	312	2.6	830
11316	78	[(PAK F4 6313/Tob-Cfn x BB) B. Man-OnxCal]Maya 74"S" CM26346-A-11Y-1M-3Y-1M-1Y-0B	13.0	34	367	3.1	860
11319	81	[(PAK F4 6313/Tob-Cfn x Bb) B. Man-OnxCal]Maya 74"S" CM26346-B-12Y-8Y-3M-1Y-0B	12.7	51	445	3.9	840
11364	127	(Tob "S" -Npo x CC-Inia/Cno-No66)Sajame "S" CM30663-3M-3Y-1M-0Y	12.6	38	230	2.5	910
11365	128	(Tob "S" -Npo x CC -Inia/Cno-No66) Sajame "S" CM30663-3M-3Y-5M-1Y-0B	13.6	38	260	2.8	840
11474	239	Swift "S" CM33232-C-5M-1Y-10M-0Y	11.8	43	286	3.3	830
11483	248	Kal x Kal-Bb/Flicker "S" CM33446-H-4M-5Y-3M-1Y-0M	11.8	53	397	3.6	890
11517	282	Bjy "S" -Grajo "S" (Maipo "S"/Bb x Tob-Cno) CM34742-A-1M-1Y-4M-1Y-0M	12.0	39	274	2.4	800
11522	287	Yding "S" - Pci "S" CM35044-68M-7Y-0M	13.0	43	346	3.7	875
11525	290	Yding "S" - Zz "S" CM35048-33Y-2M-1Y-0M	13.0	48	325	4.0	815
11564	330	Az 67 x Cno-7C CM37229-9M-3Y-0M	12.8	51	352	2.8	875
11566	332	[(CalxCno"S"-Inia"S"^{2}/Bb-Tob66xCno^2-Chr)Sajame"S"]7C CM37477-C-1Y-11M-0Y	11.8	49	218	1.7	800
11589	355	(Bb-Cno x Inia-Soty/Sparrow "S") Pavon "S" CM37705-D-2Y-1M-1Y-0M	11.2	41	247	2.8	840
11612	378	Pima 77 - CD x Torim 73 CM37964-A-1Y-13M-4Y-0M	13.0	49	412	4.1	800
11665	432	{[HnIV(Kt54A-N10BxKt54B/Nar59)]Kal-Bb}Hork "S" CM41287-G-1M-1Y-0M	11.6	37	222	1.8	820
11691	458	Coc 75 x Cllf - Bez SWM5103-8M-1Y-0M	11.8	41	323	4.2	800

Y 77-78 = Yaqui Valley, Mexico, 1977-78 SN = Screening Nursery

TABLE 2 LINES SELECTED FROM THE 12th IBWSN WITH WEAK ELASTIC GLUTEN

No. Lab.	Origin Y-77-78	Variety or Cross and Pedigree	Protein %	Sediment c.c.	Alveogram W	P/G	Loaf Vol.	Cookie Quality
11301	SN-63	Harrier "S" CM33435-Y-3M-6Y-0M	11.7	34	199	2.9	780	R
11490	255	Junco "S" CM33483-I-1M-5Y-1M-4Y-0M	11.0	44	212	1.6	790	MB
11528	293	Sparrow "S" - Pavon "S" CM35210-48M-1Y-0M	11.2	42	200	2.2	845	B
11529	294	Sparrow "S" - Pavon "S" CM35210-5Y-1M-0Y	11.7	42	190	1.9	785	B
11533	298	Yding "S" /(Fn-Th^2 x II 44.29-Th^2/Cofn^4) Sr / CM35735-11M-2Y-1M-0Y	11.3	31	179	1.4	750	MB
11538	304	Za 75 - Pavon "S" CM36681-19Y-11M-1Y-0M	10.5	29	175	1.8	675	B
11587	353	/(Flr-McM x Kt-Y/Tob 66) Sajame "S"/ Bluetit "S" CM37693-G-5Y-2M-3Y-0M	10.9	33	162	1.4	750	MB
11592	358	(Bb-Cno x Inia-Soty/Sparrow "S") Pavon "S" CM37705-G-3Y-1M-4Y-0M	12.0	46	222	1.2	810	B
11633	399	Ti 71 Resel - Pima 77/Kal-Bb x Mildress CM38494-J-1Y-1M-1Y-0M	11.9	21	110	1.4	650	MB
11657	424	Sap "S" - Moncho "S" CM40392-17M-1Y-0M	10.9	25	143	1.9	725	MB
11658	425	/(Fr 316/McM-Kt x Y50) Za 75/ Bjy "S" CM40457-20M-5Y-0M	10.7	25	155	2.0	680	MB
11660	427	Veranopolis - Bjy "S" CM40891 -1M-2Y-0M	11.7	37	213	2.3	720	MB
11662	429	Heima - Coc 75 x Bjy "S" CM41195-A-13M-2Y-0M	11.4	34	199	2.5	640	MB
11681	448	(NdD-WW x Lee-Fn/N) Ti 71 Resel SWM4589-7Y-1M-3Y-0M	10.6	35	232	1.9	725	MB
11684	451	(NdD-WW x Lee-Fn/N) Ti 71 Resel SWM4589-7Y-18M-1Y-0M	10.1	24	144	1.4	750	MB
11686	453	Car 422-Anahuac 75 SWM4610-2Y-17M-2Y-0M	10.6	28	172	1.9	730	MB

Y 77-78 = Yaqui Valley, Mexico, 1977-78 SN = Screening Nursery

TABLE 3. QUALITY DATA FOR ADVANCED TRITICALE MATERIAL HARVESTED AT YAQUI, MEXICO, 1977-78

Lab. No.	Origin Y-77-78	CROSS AND PEDIGREE	Test weight	Flour yield	Protein %	Falling number	Loaf Vol.	Water Abs. %	Characteristics Cookies
498	PM- 1	KLA - M_2A X-8816-3Y-3M-2Y-0Y	70.8	66.0	9.3	102	660	58.0	Good
499	2	M_2A-KLA x BRN "S" X-10893-A-1M-1Y- 0Y	72.5	67.0	9.1	120	655	57.0	Good
500	3	M_2A^2 X-8266-H-4Y-2M-1Y-0Y	68.2	72.0	8.3	220	655	60.0	Good
501	4	KLA - M_2A X-8816-H-1Y-1M-2Y-0Y	69.8	67.0	8.2	192	720	60.0	Very good
502	5	M_2A-Tanori 71 X-14679-15Y-1Y-3Y-0Y	71.5	67.0	8.9	110	680	60.0	Fair
503	6	IA-KLA-x CAL X-14920-8Y-1Y-0Y	72.8	68.0	8.2	153	650	59.0	Fair
504	7	BGC-Bulk E_2 X-11066-A-6M-100Y-101B-100Y-0Y	65.7	61.0	11.3	70	810	58.0	Fair
505	8	IRA-CML "S" X-13019-A-1Y-1Y-7M-0Y	72.6	65.0	9.4	90	610	58.0	Poor
506	9	MA	74.2	63.0	9.5	288	680	58.0	Good
507	10	M_2A- BGL X-15490-3Y-0M	66.6	65.0	9.6	120	630	61.0	Fair
508	11	IA-IRA x BUI X-12257-1N-0M	64.1	66.0	9.2	120	500	61.0	Poor
509	12	M_2A - IA X-12677-56Y-1Y-3M-0Y	71.6	67.0	9.2	85	700	58.0	Good

TABLE 4. LOAF VOLUMES IN C.C. OF THE BREAD BAKED WITH THE MIXTURES OF FLOURS OF TRITICALE LINES AND THE WHEAT VARIETIES PAVON 76, CHOLI 77, AND HERMOSILLO 77.

PM Tcl	PAVON			CHOLI			HERMOSILLO			TCL
Y-77/78	75%*	50%*	25%*	75%*	50%*	25%*	75%*	50%*	25%*	100%
498	760	765	725	665	715	750	780	800	760	660
499	805	755	725	675	700	705	750	750	690	655
500	740	780	720	670	690	670	795	785	730	655
501	780	800	740	715	740	720	860	875	800	720
502	790	805	760	710	730	750	870	850	780	680
503	780	790	715	725	725	705	875	865	795	650
504	825	825	840	760	800	800	935	880	830	810
505	790	770	685	710	700	660	880	810	720	610
506	790	775	740	665	690	700	850	825	770	680
507	700	715	675	675	665	660	750	750	670	630
508	835	810	740	760	760	690	875	850	730	500
509	775	770	735	710	725	700	850	820	800	700

Pavon 100% = 870 c.c.
PM= Multiplication Plot
* = Percentages of wheat

Choli 100% = 700 c.c.
Tcl = Triticale

Hermosillo 100% =920 c.c.

Basic Germ Plasm Improvement

Work was continued in 1978 on many aspects of the development of basic germ plasm, particularly with respect to dwarfness, protein and grain quality, rust resistance, spikelets/spike, kernels/spikelet, triticales, wheat-triticale crosses, tolerance to aluminum toxicity and wide crosses.

On a more limited scale, work is also proceeding on such other desired characteristics as a larger root system, straw strength, vigor, erect leaves, branched heads and larger kernels.

DWARFNESS

Isogenic lines of the somewhat tall varieties CIANO 67 and Santa Elena, were developed with short straw in the E_3 and E_2 + form, respectively. The source of dwarfness was S948.A1. These have been used to demonstrate the favorable effect of short straw on grain yield and facilitates the use of these varieties and their useful characteristics in the conventional breeding program. This transfer is now completed. The transfer of dwarfness from the winter wheat, Hisumi, to Jupateco spring wheat has also been achieved.

Presently, the height of Huamantla Rojo, Nainari 60, Lerma Rojo 64A, Pitic 62 and Penjamo 62 is being reduced. These varieties have such useful characters as excellent grain in Huamantla Rojo, wide adaptation in the case of Pitic 62, Penjamo 62 and Lerma Rojo 64A, and they all possess a high yielding capacity. All are susceptible to rust races in Mexico. Huamantla Rojo and Nainari 60 are tall varieties while the remaining three are of the single gene height.

Since tallness and susceptibility to rust make it difficult to use these varieties in crosses with other types, CIMMYT is attempting to incorporate dwarf habit and rust resistance to overcome these problems. It is expected that the desired lines will have been developed by the 1978–1979 season. Data on these materials are presented in table 1.

In a similar fashion, many of the newer varieties which are often used as parents are being shortened and given enhanced disease resistance.

Work in this area is of increased interest as a result of the demonstration that isogenic double and triple dwarfs of Santa Elena, Chris, Bonza 55 and Ciano 67 give substantially higher yields than their tall progenitors. These types with their reduced lodging are suitable for the higher fertility, irrigated areas. In table 2 are listed some of the lines in which dwarfness from S.948.A1, Hisumi and Norin 10 are being incorporated.

PROTEIN

In order to produce bread wheats with a high protein content, use is being made of several varieties which show high protein percentages. These include Frondosa, Nap Hal, Pioneer, Kenya C, Mahratta, etc. Most of them are undesirable agronomically. Thus the high protein characteristics of these are being placed in a superior agronomic background so that again as in the case of dwarfness, they are more readily used in the normal breeding program.

Over the past several years such undesirable traits as excessive height, weak straw, long cycle or winter habit and susceptibility to rusts have been gradually eliminated. Much progress has also been made in the development of good kernel types. However, there are still fertility problems in some of the shorter lines. In spite of this, some of the lines are now available having good agronomic type combined with acceptable fertility and high protein content. These have been passed to the regular bread-wheat breeding program.

Field and laboratory data have revealed that certain of these high protein lines are quite outstanding (table 3). Lines derived from the crosses Cal-MH x H 567.71 and from FMH 73A.497–H570.71 x CMH 73A.497 show a very high protein content and good agronomic type. Nap Hal in the first cross, and Nap Hal and Mahratta in the second cross are the sources of better protein levels.

Yield tests of some of these lines will be conducted in 1978–79. Information derived from these trials will provide flour protein content and grain yield in solid stands and show better what actual progress has been made.

RUST RESISTANCE

Stem Rust

Work has been continued on the improvement of plant type in varieties which have retained a high degree of resistance for several years.

Isogenic lines in a dwarfed form have been developed in such varieties as Yaqui 50, Bonza 55, Samaca, Andes 56, Eagle, Africa-Mayo 48, Chris, Tezanos Pintos Precoz and Era. These varieties are now being used to widen the genetic base for resistance to stem rust.

Materials are also being developed carrying the gene Sr30 which has been shown to confer resistance to a wide array of races of *Puccinia graminis.* It should be pointed out that this gene will not be used alone but be added to the already existing base of resistance in many CIMMYT varieties. Sr30 is derived from B-Sr.30Wst, a tall late wheat and the gene is being transferred to a short, earlier background.

Leaf Rust

INIA 66, Yecora 70, Cajeme 71, Potam 70, Zaragoza 75 and many other varieties were formerly high yielding commercial varieties which have become susceptible to leaf rust. They are being crossed to introduce further resistance to leaf rust, and have proven to be excellent parents for the transfer of resistance from Agatha (Lr19), RL6040 (Lr19) and RL6010 (Lr9). Resistance of these genes if known to be inherited dominantly and both provide resistance against a wide array of biotypes. Backcrossing to the superior agronomic varieties is being carried out.

Other genes for resistance to leaf rust were also tested at CIANO in 1977–78. These wre Lr12, Lr22 and Lr24. The first two proved to have little value against current races but Lr24 shows good resistance but less effective than the higher level of Lr9 and Lr19.

During 1978–79 it is expected that lines having these three genes in varying combinations can be selected and transferred to the normal bread wheat breeding program.

KERNELS/SPIKE

The number of kernels per spikelet and spikelets per spike determine the kernels per spike. In an attempt to increase this important yield component, CIMMYT is trying to determine whether the present varieties can be improved.

KERNELS/SPIKELET

Several lines of the cross CMH74 A.630-Maya"S" x CMH 74A.630 which includes germ plasm of the variety Morocco are able to produce up to eight kernels per spikelet in the center of the head, when plants are grown in spaced-plant fashion about 15 cm apart. These plants are about 70 cm tall under Obregon conditions, have reasonable tillering, have a short vegetative cycle, are resistant to rust, have good spike size and excellent fertility. Grains however, are somewhat shrivelled at El Batan in the summer cycle. Results appear promising.

SPIKELETS/SPIKE

The cross CMH 76A.769 which has Tetrastichon in its pedigree, has given segregates which are semi early, have 27–30 spikelets/spike, acceptable rust resistance and good plant type. Grain, however, is less than fully plump.

In another Tetrastichon cross CMH 76.951, large spikes of 30–40 spikelets/spike are produced, but plants are late and grain is poorly developed.

KERNELS/SPIKE AND SPIKELETS/SPIKE

The cross CMH 74A.582 was the first one in which it was possible to combine the large number of kernels/spikelet (from Morocco) with the large spike of CMH 72.527. The resulting plants showed 7–9 kernels/spikelet and 26–30 spikelets/spike. In a later cross, CMH 76.1084, which has the parentage CMH 72.428-Morocco x Jupateco73/CMH 74A.582, these characters were further increased. However, both CMH 74A.582 and CMH 76.1084 are both highly susceptible to both stem and leaf rust, resulting in shrivelled grain.

New crosses which have been made between CMH 76.1084 and resistant varieties have provided materials with better rust resistance and better grain development. It is hoped and expected that it may be possible to produce varieties with higher yield potential based on this increase in total spikelets/spike. Whether this can be successful will only be known when uniform lines derived from these crosses and possessing adequate disease resistance and good agronomic traits, are subjected to yield trials to ascertain their production potential.

TOLERANCE TO ALUMINUM TOXICITY

The objective of this line of research is to combine the good agronomic traits and high yield potential of CIMMYT wheats with the tolerance to aluminum toxicity possessed by some of the wheats developed in Brazil.

Most of the Brazilian wheats with tolerance are tall, weak strawed, and have spikes with a very low number of kernels. The poor agronomic type is associated with low yield. As a first step, many of the Brazilian wheats are being dwarfed to produce isogenic short varieties. These will provide an assessment of the effect of dwarf habit on tolerance to aluminum.

This first step was undertaken several seasons earlier in cooperation with Brazilian breeders. In 1978 the material was tested in Brazil and results were quite positive. Table 4 shows the results of trials in Brazil and Mexico. It may be seen that IAS20 and Pelotas-Arthur are rated as resistant while Jupateco 73 and Zaragoza 75 are susceptible. Two lines from Zaragoza 75 x Pelotas-Arthur are resistant, one is moderately resistant, one is moderately susceptible and five are susceptible. This demonstrates that aluminum toxicity tolerance is well defined genetically. The table further demonstrates that short lines can be produced which have good tolerance so that dwarfness **per se** has no direct relationship to susceptibility.

In another interesting piece of work, segregates from crosses of triticale and wheat have a wheat-like phenotype but show a higher level of resistance to aluminum than is present in normal Mexican varieties (table 5).

TRITICALE

Work has been continued on shortening and strengthening straw, increasing the number of spikelets/spike and kernels/spike as well as improving grain characteristics. From table 6, it may be seen that the main building blocks for developing these types of materials are available and it should be possible to combine these to give superior types. Presently, the segregating populations in which these are being combined are in early generations.

WHEAT X TRITICALE PROGRAM

Several lines of the CMH 76.1330 cross are providing segregates with excellent grain type at both CIANO and El Batan. These lines are E_3– to E_3+ in height, are intermediate in phenotype between wheat and triticale and show the slight pubescence common to triticale at the juncture of the spike and peduncle. The spike is of intermediate size with pubescent glumes, it has few kernels/spike, but the grains are large and well developed. There are only a few non-plump grains. It is hoped that this may be studied cytologically and from an industrial viewpoint. In the meantime, new crosses are being made to improve agronomic characters and to investigate the possibility of transfering this good kernel type into conventional triticales.

Crosses of wheat with triticale are being continued to incorporate dwarfing genes into triticale. Some E_3 and E_4 types have been developed from the cross H277.69 x -Tob 66/F.S.102 9 and more recently E_1 + to E_3 selections have been produced from Beagle x S948.A1-Bonza 55^4.

Attempts are being made to move high protein, high fertility and good grain from wheat to triticale.

WIDE CROSSES

In this project, crosses have been made chiefly between wheat with barley and species of *Agropyron, Elymus* and *Aegilops*. Crosses are made under field conditions. To achieve these crosses, chemicals have been applied to mother plants to increase the chance of fertilization and to obtain better developed embryos. Crosses have been attempted without application of chemicals as well. After fertilization the embryos are excised at an early stage and complete their development on an artificial medium. From the small plant to the adult plant stage, they are maintained in pots in the greenhouse.

Although many embryos die before reaching the adult stage, several adult hybrids have been obtained from crosses using chemicals and non treated alike.

In 1978, wheat x barley crossings and barley x wheat were attempted. F_1 plants were obtained which showed phenotypic characters which suggest they are classic hybrids, that is, having the chromosome of both parents. Normally they are completely sterile. They are being maintained as clones in the greenhouse together with others produced in previous years. By so doing, they can be maintained and different treatments can be applied to see if they can be doubled to give fertile plants. Some of the plants being maintained are listed in table 7.

F_1 plants which because of their characteristics appear to be what have been termed partial or insertion hybrids are kept in the greenhouse for the first generation and in succeeding generations are grown in the field. Such plants show good fertility, are in general similar to the mother plant in phenotype, yet show distinctly different individual characteristics. For example, in cross L78–45 in which Tobari 66 and Snoopy rye were crossed, both parents have awns, yet the F_1 plant showed very short awns (figure 1).

In other crosses of wheat x barley there have appeared distinct variations in such characters as height, earliness, awn development, spike shape, number of spikelets/spike and rust resistance. It has been possible to obtain uniform lines from these which are now used in the conventional program. For example, dwarf barleys of $\pm$ 40 cm arose from a cross of CM67 barley x a rye. Recently, other uniform lines have been identified for several of the above mentioned characters and these are listed in tables 8, 9 and 10.

The variations coming from these partial or insertion hybrids are interesting and potentially useful. The cytological, biochemical and quality characteristics of the material are unknown and it is difficult to determine just how this mechanism works. When CIMMYT has its own cytological laboratory in full operation, it will be possible to more closely examine this phenomenon.

F_1 plants from embryos developed in an artificial medium without a previous maternal treatment. The progenitors of this cross were the wheat Tobari 66 (female) and the dwarf rye Snoopy (male). Both parents possess awned spikes. However, the F_1 plant (right) has an awnless spike. Both F_1 plants have normal fertility and are phenotypically similar to wheat.

The F_4 of the cross Jupateco 73 wheat (female) with Celaya barley (male). A strong segregation in plant height is evident.

F_4 lines of the cross Za. 75 wheat (female) and Dic.Hip barley (male) without a previous maternal treatment. A nutrient medium was used to develop the F_1 embryo. Phenotypically, the row on the left is a short strawed awnless wheat. Because Za. 75 is an awned wheat, the possibility of this plant having developed from self pollination is eliminated. The line in the center is also a short strawed awned wheat, phenotypically. The variety Za. 75 is shown on the right. It served as a female parent. Its height and awns contrast with those in its progeny. Dic.Hip barley is awned and shows certain variations in height.

TABLE 1. Dwarf lines of Huamantla Rojo, Nainari 60, Pitic 62 and Lerma Rojo 64A.

No. of Order	Y.78-79 Row No.	Variety or Cross	Pedigree	BV/78 Days to flower	Height
1	-	Huamantla Rojo		68	Alto
2	E-2615	HuaR-Cj71 x $HuaR^5$	CMH77A.531-3B	-	E4
3	E-2707	HuaR-Cj71 x $HuaR^4$	CMH77.574-3Y-3B	73	$E4^-$
4	E-2709	HuaR-CJ71 x $HuaR^4$	CMH77.574-5Y-5B	73	$E4^-$
5	E-2710	HuaR-Cj71 x $HuaR^4$	CMH77.574-9Y-1B	73	$E4^-$
6	E-2716	HuaR-Cj71 x $HuaR^3$	CMH76A.510-9B-7Y-1B	69	E4
7	PH-83	HuaR-Cj71 x $HuaR^3$	CMH76A.510-9B-3Y	73	$E3^+$
8	-	Nainari 60		70	$E1^-$
9	E-1599	H499.71A-$Nai60^5$	CMH77.570-8Y-5B	74	$E4^-$, $E3^+$
10	E-1597	H499.71A-$Nai60^4$	CMH77.570-1Y-1B	74	$E4^-$
11	E-1598	H499.71A-$Nai60^4$	CMH77.570-1Y-5B	74	$E4^-$
12	-	Pitic 62		75	E1
13	E-2610	H570.71-$Pi62^3$	CMH77A.510-1B	-	$E3^+$
14	E-2611	H570.71-$Pi62^3$	CMH77A.510-4B	-	E3
15	-	Lerma Rojo 64A		64	$E2^-$
16	E-2618	H499.71A-$LR64A^5$	CMH77A.526-1B	-	$E4^-$
17	E-2621	LR64A-S948A1 x $LR64^2$/LR64A	CMH77A.528-4B	-	$E4^+$
18	E-2622	LR64A-S948A1 x $LR64^2$/LR64A	CMH77A.528-5B	-	$E4^+$
19	E-2646	H499.71A-$LR64A^4$	CMH77.566-2Y-2B	66	$E4^+$

TABLE 2. E_3 and E_4 lines developed from outstanding varieties in the bread wheat breeding program, CIMMYT.

No. of Order	Y.78-79 Row No.	Variety or Cross	Pedigree	BV/78 Height
1	PH-66	Hork"S"	CM-8874K-1M-1Y-0M (1-356Y)	E2$^-$
2	E-2554	CMH72A.429-Hork"S"^{3}	CMH77A.520-14B	E3
3	E-2559	CMH72A.429-Hork"S"^{3}	CMH77A.520-4B	E3
4	E-2563	CMH72A.429-Hork"S"^{3}	CMH77A.520-10B	E4$^-$
5	PH-65	Pavón "S"	CM.8399D-4M-3Y-1M-1Y-OM	E2
6	E-2573	H567.71-Pavón"S"^{3}	CMH77A.518-9B	E3
7	E-2574	H567.71-Pavón"S"^{3}	CMH77A.518-10B	E3$^+$
8	PH-70	Cuckoo	II-28424-8Y-1M-1Y-OM (1-161B)	E2
9	E-2575	CMH72A.429-Cuckoo^3	CMH77A.521-4B	E3$^+$
10	PH-63	Nac.76	-	E2
11	E-2579	H567.71-Nac76^3	CMH77A.524-1B	E3$^-$
12	E-2581	H567.71-Nac76^3	CMH77A.524-5B	E3$^-$
13	PH-67	Flicker"S"	CM.8954B-7M-1Y-1M-0Y 1Y(1.75B)	E3 a E2$^-$
14	E-2585	H567.71-Flicker"S"^{3}	CMH77A.522-4B	E3$^+$
15	PH-59	Maya "S"	II-27829-19Y-1M-500Y-501M-0Y	E2$^+$
16	E-2595	H570.71-Maya "S"^{3}	CMH77A.502.1B	E3
17	E-2596	H570.71-Maya "S"^{3}	CMH77A.502-2B	E4$^-$
18	E-2597	H570.71-Maya "S"^{3}	CMH77A.502-6B	E3
19	E-2598	H570.71-Maya "S"^{3}	CMH77A.502-7B	E4$^-$
20	PH-61	Tesopaco 76		E1$^+$
21	E-2587	H567.71-Tes.76^3	CMH77A.500-2B	E3
22	E-2588	H567.71-Tes.76^3	CMH77A.500-3B	E4$^-$
23	E-2592	H567.71-Tes.76^3	CMH77A.530-2B	E3$^+$
24	E-2589	Tes.76-Za.75 x Tes.76^4	CMH77A.511-1B	E2$^+$
25	E-2590	Tes.76-Za.75 x Tes.76^4	CMH77A.511-6B	E2$^+$
26	PH-48	Tanori F71		E2$^+$
27	E-2671	H499.71A-Ti.71^3	CMH76A.477-2B-1Y-1B	E4
28	E-2672	H499.71A-Ti.71^3	CMH76A.477-2B-1Y-4B	E4$^+$
29	E-2673	H499.71A-Ti.71^3	CMH76A.477-2B-3Y-1B	E4
30	E-2674	H499.71A-Ti.71^3	CMH76A.477-2B-3Y-3B	E4$^-$
31	PH-49	Jupateco 73		E2$^+$
32	E-2834	H499.71A-Jup.73^4	CMH76A.494-11B-2Y-2B	E4$^-$
33	E-2835	H499.71A-Jup.73^4	CMH76A.494-11B-2Y-4B	E4
34	E-2836	H499.71A-Jup.73^4	CMH76A.494-11B-2Y-5B	E4
35	E-2837	H499.71A-Jup.73^4	CMH76A.494-11B-4Y-1B	E4$^-$
36	E-2838	H499.71A-Jup.73^4	CMH76A.494-11B-4Y-3B	E4$^-$

TABLE 3. Wheat lines showing the best agronomic performance associated with high protein content.

No. of Order	Y 78-79 Row No.	Variety or Cross	Pedigree	% Protein Y 77-78	% Protein BV-78	Days to Flowering	BV/78 Height
1	PH-142	Ron#2-Fnd.	CMH72A.479.6B-2Y-4B-OY	17.0	17.8	64	E3
2	E-138	Ron2-Fnd x PaBo/Ron2-Fnd.	CMH77.134-9Y-1B	17.1	18.8	60	E4$^-$a E2$^+$
3	E-139	"	CMH77.134-9Y-4B	17.1	17.2	60	E4$^-$ a E2$^+$
4	E-147	Ron2-Fnd.x Z a.75	CMH76.28-3Y-1B-2Y-1B	15.4	17.1	69	E3$^+$
5	E-148	"	CMH76.28-3Y-1B-2Y-1B	15.4	16.8	69	E3$^+$
6	E-149	"	CMH76.28-3Y-1B-2Y-5B	15.4	17.6	69	E3$^+$
7	E-181	Fnd-Cno.F67^3	CMH75A.65-7B-2Y-3B-1Y-1B	16.8	17.2	65	E3$^-$ E2$^+$
8	E-182	"	CMH75A.65-7B-2Y-3B-1Y-6B	16.8	17.5	65	E2$^-$, E2$^+$
9	E-183	"	CMH75A.65-7B-2Y-3B-1Y-8B	16.8	17.5	65	E3$^-$, E2$^-$
10	E-185	Fnd-Cno67^2 x Ron2-Fnd.	CMH75A.66-8B-1Y-4B-1Y-1B	17.2	17.2	66	E2$^+$
11	E-186	"	CMH75A.66-8B-1Y-4B-1Y-4B	17.2	17.6	66	E2$^+$
12	E-187	"	CMH75A.66-8B-1Y-4B-1Y-5B	17.2	18.0	66	E2$^+$
13		Frondosa	PI-106504-8-1	16.1	-	90	E1$^+$, N$^-$
14	E-336	Cal-NH x H567.71	CMH75A.34-3B-1Y-2B-2Y-1B	16.6	17.6	64	E2$^+$
15	E-337	"	CMH75A.34-3B-1Y-2B-2Y-2B	16.6	17.3	64	E2$^+$
16	E-338	Cal-NH x H567.71	CMH75A.34-3B-1Y-2B-4Y-1B	16.0	17.4	64	E2$^+$
17	E-339	"	CMH75A.34-3B-1Y-2B-4Y-3B	16.0	17.5	64	E2$^+$
18	E-341	"	CMH75A.34-3B-1Y-2B-5Y-1B	16.6	17.4	64	E2$^+$
19	E-342	"	CMH75A.34-3B-1Y-2B-5Y-2B	16.6	16.8	64	E2$^+$
20	E-343	"	CMH75A.34-3B-1Y-2B-5Y-4B	16.6	17.2	64	E2$^+$
21	E-344	"	CMH75A.34-3B-1Y-2B-5Y-5B	16.6	17.6	64	E2$^+$
22	E-346	"	CMH75A.34-3B-1Y-2B-7Y-3B	16.9	17.6	64	E2$^+$
23	E-347	"	CMH75A.34-3B-1Y-2B-7Y-4B	16.9	17.1	64	E2$^+$
24	E-348	"	CMH75A.34-3B-1Y-2B-7Y-5B	16.9	17.2	64	E2$^+$
25	-	Nap Hal	PI-176217	16.0	-	94	E1$^-$
26	E-576	(CMH73A.497/Chr-S948A1 x Chr^6) CMH73A.497	CMH77.183-1Y-1B	16.2	17.2	64	E3
27	E-577	"	CMH77.183-1Y-2B	16.2	16.6	64	E3
28	E-578	"	CMH77.183-1Y-3B	16.2	17.1	64	E3
29	E-767	CMH73A.497-H570. 71 x CMH73A.497	CMH76.173-1Y-1B-1Y-1B	18.1	18.5	60	E2$^+$
30	E-768	"	CMH76.173-1Y-1B-1Y-2B	18.1	18.9	60	E2$^+$
31	E-769	"	CMH76.173-1Y-1B-1Y-3B	18.1	18.5	60	E2$^+$
32	E-778	CMH73A.497-H570.71 x	CMH76.173-4Y-1B-2Y-1B	17.5	19.0	60	E2$^+$
33	E-779	CMH73A.497-H570.71 x CMH73A.497	CMH76.173-4Y-1B-2Y-3B	17.5	17.8	60	E2$^+$
34	E-781	"	CMH76.173-4Y-1B-2Y-4B	17.5	18.6	60	E2$^+$
35	E-793	"	CMH76.173-7Y-1B-3Y-1B	15.8	17.6	60	E3$^-$
36	E-794	"	CMH76.173-7Y-1B-3Y-2B	15.8	18.2	60	E3$^-$
37	E-795	"	CMH76.173-7Y-3B-1Y-2B	17.5	17.2	60	E3$^-$
38	E-796	"	CMH76.173-7Y-3B-1Y-3B	17.5	17.8	60	E3$^-$
39	E-797	"	CMH76.173-7Y-3B-1Y-4B	17.5	18.0	60	E3$^-$
40	E-803	"	CMH76.173-7Y-4B-2Y-1B	17.8	17.9	60	E3
41	E-804	"	CMH76.173-7Y-4B-2Y-2B	17.8	17.8	60	E3
42	E-805	"	CMH76.173-7Y-4B-2Y-4B	17.8	18.1	60	E3
43	E-763	CMH73A.497-Maya"S"/ CMH73A.497 x Cal-NH	CMH76.172-1Y-8B-2Y-1B	17.0	17.9	60	E3$^+$ a E2
44	E-764	"	CMH76.172-1Y-8B-2Y-3B	17.0	17.5	60	E3$^+$ a E2
45	E-725	CMH73A.497-H567.71/ CMH73A.497 x Ron2-Fnd.	CMH77.182-5Y-1B	17.7	18.0	59	E4$^-$ a E2$^+$
46	E-726	"	CMH77.182-5Y-2B	17.7	16.7	59	E4$^-$ a E2$^+$
47	E-727	"	CMH77.182-5Y-3B	17.7	17.1	59	E4$^-$ a E2$^+$
48	E-728	CMH73A.497-H567.71/ CMH73A.497 x Ron2-Fnd.	CMH77.182-5Y-4B	17.7	18.3	59	E4$^-$ a E2$^+$
49	E-729	"	CMH77.182-5Y-8B	17.7	18.0	59	E4$^-$ a E2$^+$
50	E-730	"	CMH77.182-5Y-6B	17.7	17.1	59	E4$^-$ a E2$^+$
51	E-731	"	CMH77.182-5Y-10B	17.7	18.4	59	E4$^-$ a E2$^+$
52	E-732	"	CMH77.182-5Y-12B	17.7	18.1	59	E4$^-$ a E2$^+$
53	E-733	"	CMH77.182-5Y-14B	17.7	19.2	59	E4$^-$ a E2$^+$
54	E-734	"	CMH77.182-5Y-15B	17.7	18.2	59	E4$^-$ a E2$^+$
55	E-735	"	CMH77.182-5Y-17B	17.7	17.6	59	E4$^-$ a E2$^+$
56	E-847	(Cal-NHx H570.71/Cal-NH) (Fnd-Cno67^2 x Ron2-Fnd)	CMH76.217-3Y-1B-1Y-1B	17.3	18.5	62	E2$^+$
57	E-848	"	CMH76.217-3Y-1B-1Y-2B	17.3	17.7	62	E2$^+$
58	E-849	"	CMH76.217-3Y-1B-1Y-4B	17.3	17.7	62	E2$^+$
59	E-850	"	CMH76.217-3Y-1B-1Y-5B	17.3	19.7	62	E2$^+$
60		Ciano 67		15.8	16.2	59	E2
61		Jupateco 73		13.0	12.8	66	E2$^+$
62		Pavón 76		12.8	14.2	68	E2$^+$

TABLE 4. Performance of dwarf wheats tested in Brazil for tolerance to aluminium toxicity.

No.of Order	Variety or Cross	Pedigree	Height Batan	T.T.A. C.A.	Batán/78 Row No.
1	Pelotas-Arthur		N	1	-
2	Zaragoza 75		E2+	5	
3	Za.75-P.Ar.	CMH76A.944-1B-1Y	E2+, E1-	2	E-730
4	" "	CMH76A.944-1B-5Y	E2-	1	E-731
5	" "	CMH76A.944-1B-6Y	E1+	1	E-732
6	" "	CMH76A.944-5B-1Y	E2+,	5	E-733
7	" "	CMH76A.944-5B-3Y	E3 a E1+	1	E-734
8	" "	CMH76A.944-5B-4Y	E2-	3	E-735
9	" "	CMH76A.944-2B-1Y	E2-	5	E-738
10	" "	CMH76A.944-2B-2Y	E1+	5	E-739
11	" "	CMH76A.944-2B-4Y	E2-	5	E-741
12	" "	CMH76A.944-2B-6Y	E2+	5	E-742
13	Torim 73-P.Ar.	CMH76.947-1B-1Y	E3	1	E-743
14	" "	CMH76.947-1B-2Y	E4, E2+	2	E-744
15	" "	CMH76.947-1B-3Y	E4 a E1+	2	E-745
16	" "	CMH76.947-3B-1Y	E3 a E1	2	E-746
17	" "	CMH76.947-3B-3Y	E3 a E1+	2	E-747
18	H567.71-P.Ar.	CMH76A.957-1B-1Y	E2+	5	E-763
19	" "	CMH76A.957-1B-2Y	E4+a E2+	3	E-764
20	" "	CMH76A.957-1B-3Y	E2+	5	E-765
21	" "	CMH76A.957-1B-4Y	E2+	5	E-766
22	" "	CMH76A.957-1B-5Y	E4+	1 Seg.	E-767
23	CMH75.859-P.Ar2	CMH76A.991-1B-1Y	E2+ E2-	5	E-771
24	" "	CMH76A.991-1B-2Y	E2-	5	E-772
25	" "	CMH76A.991-1B-3Y	E2-	5	E-773
26	" "	CMH76A.991-1B-4Y	E4- a E2-	5	E-774
27	" "	CMH76A.991-1B-5Y	E4- a E2+	5	PH-27
28	Ias.20		N	1	-
29	Ias.20-H567.71	CMH76.480-13Y-5B-1Y	E2+	1	E-804
30	" "	CMH76.480-13Y-5B-2Y	E2+	1	E-805
31	Ias.20-H567.71 x Ias.20	CMH76A.974-1B-1Y	E1+	1	E-789
32	" "	CMH76A.974-1B-3Y	E4 a E1+	1	E-790
33	" "	CMH76A.974-2B-1Y	E2+	1	E-796
34	" "	CMH76A.974-2B-3Y	E3+	2	E-791
35	" "	CMH76A.974-2B-4Y	E4+ E3	1 Seg.	E-792
36	" "	CMH75A.270-1B-2Y-2B-1Y	E3+	1	E-816
37	" "	CMH75A.270-1B-2Y-2B-2Y	E3+	1	E-817
38	CMH75.859-Ias.20	CMH76.940-1Y-1B-1Y	E2	1	E-814
39	" "	CMH76.940-1Y-1B-2Y	E2-	1	E-815
40	" "	CMH76.940-1Y-1B-3Y	E2+, E1+	1	PH-26
41	Ias.20 x Sam-Cj71 2/P.Ar.	CMH76A.975-5B-1Y	E3+ a E1	5	E-828
42	" "	CMH76A.975-5B-2Y	E4 a E1	5	E-829
43	" "	CMH76A.975-5B-3Y	E2+ a E2-	5	E-830
44	" "	CMH76A.975-5B-5Y	E4 a E2	5	E-831
45	" "	CMH76A.975-5B-6Y	E2+	5	E-832
46	" "	CMH76A.975-5B-7Y	E3+ a E1+	5	E-833
47	" "	CMH76A.975-5B-8Y	E2+	5	E-834
48	H570.71-Ias.20 2 x P.Ar.	CMH76A.977-1B-1Y	E3+ a E1+	1	E-835
49	" "	CMH76A.977-1B-6Y	E1+	1	E-836
50	" "	CMH76A.977-1B-8Y	E2, E1+	1	E-837
51	" "	CMH76A.977-1B-9Y	E3+ a E2-	1	E-838
52	" "	CMH76A.977-1B-10Y	E4-	1	E-839
53	Ias-20-H567.71xIas.20 2 P.Ar.	CMH76A.978-1B-1Y	E4+, E3	5	E-841
54	" "	CMH76A.978-1B-3Y	E2+, E2-	5	E-842
55	" "	CMH76A.978-1B-4Y	E4-	5	E-843
56	" "	CMH76A.978-1B-5Y	E3+	5	E-844
57	" "	CMH76A.978-1B-6Y	E3, E2	5	E-845
58	" "	CMH76A.978-1B-7Y	E4- a E1+	5	E-846
59	" "	CMH76A.978-1B-8Y	E4+ a E3	5	PH-28
60	" "	CMH76A.978-3B-1Y	E4+	5	E-847
61	" "	CMH76A.978-3B-4Y	E4 a E2	5	E-848
62	" "	CMH76A.978-3B-5Y	E4, E3-	5	E-849
63	" "	CMH76A.978-3B-6Y	E4+ a E2+	5	E-850
64	" "	CMH76A.978-3B-8Y	E4-	5	E-851
65	Ias.20-H567.71xIas.20 2/P.Ar.	CMH76A.978-4B-1Y	E2+, E2-	1	E-852
66	" "	CMH76A.978-4B-2Y	E2-	1	E-853
67	S.Seafoam-H499.71AxP.Ar.	CMH76A.981-1B-1Y	E3+, E2-	1	E-854
68	" "	CMH76A.981-1B-5Y	E3+ a E1-	1	E-855
69	" "	CMH76A.981-3B-1Y	E3+ a E2	1	E-856
70	" "	CMH76A.981-6B-1Y	E1	1	E-857
71	" "	CMH76A.981-6B-2Y	E2, E2-	1	E-858
72	" "	CMH76A.981-6B-3Y	E2+ a E1	1	E-859
73	S.Seafoam-H567.71xP.Ar.	CMH76A.984-4B-1Y	E2	5	E-861
74	" "	CMH76A.984-4B-2Y	E4 a E2+	5	E-862
75	" "	CMH76A.984-5B-1Y	E2	2	E-863
76	" "	CMH76A.984-5B-4Y	E2	2	E-864
77	" "	CMH76A.984-5B-5Y	E3-, E1	2	E-865
78	Jupateco 73		E3-, E2	4	-

Batán = El Batán, México
T.T.A. = Tolerance to aluminium toxicity
C.A. = Cruz Alta, Brazil
1 = Resistant
2 = Moderately resistant
3 = Moderately susceptible
4 = Susceptible
5 = Highly susceptible

TABLE 5. Performance of lines derived from triticale - wheat tested in Brazil for tolerance to aluminium toxicity.

No. of Order	Variety or Cross	Pedigree	Height Batán	T. T. A. C. A.	T. T. A. P.F.	Batán/78 Row No.
1	IGA-Fliker "S"	CMH76A.1247-1B-1Y	E2+, E1+	3 +	MR	E-4107
2	" "	CMH76A.1247-1B-3Y	E2+, E1+	3 +	MR	E-4108
3	" "	CMH76A.1247-1B-4Y	E3, E2 +	3 +	MR	E-4109
4	" "	CMH76A.1247-1B-5Y	E2+, E2-	4	MR	E-4110
5	H622.71xFury-Kal^{2}/H622.71-Maya "S"	CMH76A.1309-3B-2Y	E2+	-	MR	E-4164
6	H622.71xS948A1-Bza^{4}/H622.71	CMH76A.1305-2B-1Y	E3+ aE2	-	MR	E-4174
7	CMH73A.785-P.Ar.	CMH76A.1296-1B-1Y	E4, E1+	-	MR	E-4177
8	" "	CMH76A.1296-1B-3Y	E3+, E2+	-	MR	E-4178
9	" "	CMH76A.1296-1B-6Y	E2+ aN +	-	MR	E-4181
10	M2A-Sar."S"xCMH74A.630/M2A-Sar."S"	CMH76A.1319-12B-1Y	E3+, E3	2	S	E-4189
11	" "	CMH76A.1319-12B-3Y	E3, E2+	2	S	E-4190
12	" "	CMH76A.1319-12B-4Y	E3+, E2 +	2	S	E-4191
13	M2A-Sar."S"xBuitre "S"	CMH76.1330-1Y-1B-1Y	E4, E3-	2 +	MR	E-4231
14	" "	CMH76.1330-1Y-1B-2Y	E3+, E2+	2 +	MR	E-4232
15	" "	CMH76.1330-1Y-1B-3Y	E3+, E3	2	MR	E-4233
16	" "	CMH76.1330-1Y-3B-1Y	E4-, E3	2	MS	E-4234
17	" "	CMH76·1330-1Y-3B-10Y	E4-, E3	2	MS	E-4242
18	" "	CMH76.1330-1Y-4B-1Y	E4, E3	2	MS	E-4243
19	" "	CMH76.1330-1Y-4B-3Y	E4+, E3-	2	MS	E-4245
20	" "	CMH76.1330-1Y-4B-4Y	E4, E3	2	MS	E-4246
21	" "	CMH76.1330-5Y-2B-1Y	E2+, E2	1	MS	E-4247
22	" "	CMH76.1330-5Y-2B-2Y	E2+, E2-	1	MS	E-4248
23	" "	CMH76.1330-5Y-2B-3Y	E2+, E2	2	MS	E-4249
24	" "	CMH76.1330-5Y-2B-4Y	E2+, E2-	2	MS	E-4251
25	CMH76A.576-Jup.73^{2}	CMH76.1337-7Y-4B-2Y	E3-, E2	3 +	MR	E-4258
26	CMH72A.576-CMH73.648^{2}	CMH76.1340-1Y-3B-2Y	E3-, E2	2	MR	E-4266
27	CMH74.1072-H570.71	CMH72A.1185-2B-3Y-1B-1Y	E3-, E2-	2 +	MR	E-4271
28	" "	CMH72A·1185-2B-3Y-1B-2Y	E3-, E2	3 +	MR	E-4272
29	M2A-Sar.70^{2}xINIA.66	CMH75A.1259-1B-1Y-4B-1Y	E4+	1	MR	E-4317
30	" "	CMH75A.1259-1B-1Y-4B-2Y	E4+	2	MR	E-4318
31	M2A-Sar.70^{2}xJup.73	CMH75A.1261-4B-1Y-1B-1Y	E3, E3-	2	MR	E-4320
32	" "	CMH75A.1261-11B-3Y-1B-1Y	E2+, E2	3 +	MR	E-4321
33	M2A-Sar70^{2} x Jup73	CMH75A.1261-11B-3Y-1B-2Y	E2+, E2	2	MR	E-4322
34	" "	CMH75A.1261-11B-3Y-1B-3Y	E3-, E2	3	MR	E-4323
35	M2A-Sar.70^{2}	CMH75.1185-3Y-2B-3Y-1B-1Y	E4-, E3	2	MS	E-4324
36	Pelotas-Arthur	-	N	1	-	-
37	Ias.20	-	N	1	-	-
38	Jupateco 73	-	E3-, E2	4	-	-
39	Zaragoza 75		E2+	5	-	-

T.T.A. = Tolerance to aluminium toxicity
Batán = El Batán, México
C.A. = Cruz Alta, Brazil
P.F. = Passo Fundo, Brazil
1, R = Resistant
2, MR = Moderately resistant
3, MS = Moderately susceptible
4, S = Susceptible
5 = Highly susceptible

TABLE 6. Progenitors for developing basic Germ plasm in Triticales.

No. of Order	Y78-79 Row No.	Variety or Line	Outstanding characteristics
1	PH-208	IRA-H277.69 CMH72A.576-9B-4Y-3B-1Y-1B-3Y-0Y	Dwarf
2	PH-209	H277.69 x Tor"S"-Tob66/Fs.1029 CMH74.1211-3Y-1B-1Y-7Y-3Y-1B	Dwarf
3	PH-210	H277.69 x Tor."S"-Tob.66/Fs.1029 CMH74.1211-3Y-1B-1Y-2Y-2Y-1B	Dwarf
4	PH-212	H507.71A-CMH72A.576 CMH75.993-1Y-1B-0Y-1B	Dwarf
5	PH-213	CMH73.802-CMH72A.576 CMH75.1070-1Y-4B-2Y-9B-0Y-1B	Strong straw, e/E
6	E-9273	H277.69 x P4160-Tcl. H523.71A-1B-1Y-1B-1Y-2B-0Y	Thick stem
7	PH-221	H277.69-UMX2[2] CMH72A.579-21B-4Y-2B-1Y-1B-3Y-2B-0Y	e/E, high
8	PH-230	M_2A^2 X8504C-2Y-2M-100M-104B-109Y-0Y-4Y-0B	G/e, fertility
9	PH-232	H515.71A-Cin CMH74.1072-7Y-5B-9Y-13B-1Y-2Y-1B	G/e, F/e
10		TRITICALES CONVENCIONALES	Good grain

e/E = Spikelets per spike (espiguillas por espiga)
G/e = Grains per spikelet (Granos por espiguilla)
F/e = Florets per spikelet (Flores por espiguilla)

TABLE 7. Classic hybrids (phenotypically) maintained through clones in the greenhouse.

No.of Order		Laboratory	Maternal Treatment	1977 No. Greenhouse
1	Chinese Spring x Elymus giganteus		No	220
2	Cocorit 71 x Agropyron junceum		No	221
3	Agropyron elongatum x secale-cereale		No	223
4	Agropyron elongatum x Ralle "S"-Ptl."S"		No	225
				1978
5	M16 x Cocorit 71	L75.4100	No	231
6	M16 x Cocorit 71	L78.1046	No	317
7	M16 x Cocorit 71	L78.1062D	Yes	319
8	M16 x CMH73A.497	L78.1082E	Yes	320
9	Agr.elongatum/Cr"S"-T.Pol x G.G[2]	L78.1057	No	326

M16 = Barley CMH73A.497 = Hexaploid wheat with high protein content.

TABLE 8. Variation observed in Jupateco 73 x Celaya, and Jupateco 73 x M16 At El Batan during summer season, 1978.

No. of Order	BV-78 Row No.	Variety or Cross	Pedigree	Maternal Treatment	Days to Flowering	Height
1	E-4680	Jupateco 73		-	70	E2+, E2 -
2	E-4661	Celaya	-	-	66	E2-
3	E-4681	Jup.73-Celaya	L75.4875A-2B-1Y	No	70	E2+, E2
4	E-4684	" "	L75.4875A-2B-6Y	No	66	E3-, E2+
5	E-4685	" "	L75.4877A-1B-1Y	No	66	E4
6	E-4686	" "	L75.4877A-1B-3Y	No	66	E4
7	E-4687	" "	L75.4877A-1B-5Y	No	66	E3, E2 +
8	E-4688	" "	L75.4877A-1B-6Y	No	64	E4+, E3 -
9	E-4689	" "	L75.4877A-1B-9Y	No	66	E4, E3, E2 +
10	E-4723	M16			74	E1
11	E-8822	Jup.73-M16	L74.5374-1B-1Y-3B-2Y-1B-0Y	Yes	57	E1+
12	E-8823	Jup.73-M16	L74.5394-1B-3Y-6B-2Y-2B-0Y	Yes	59	E4-
13	E-8824	" "	L74.5394-1B-9Y-4B-4Y-2B-0Y	Yes	59	E3+
14	E-8825	" "	L74.5394-3B-2Y-1B-1Y-1B-0Y	Yes	64	E2-, N+
15	E-8826	" "	L74.5394-3B-2Y-1B-2Y-2B-0Y	Yes	69	E1 -, N+
16	E-8827	" "	L74.5394-1B-7Y-2B-1Y-1B-0Y	Yes	78	E1 +
17	E-8828	" "	L74.5394-1B-8Y-6B-0Y	Yes	57	E4-
18	E-8829	" "	L74.5394-3B-7Y-5B-0Y	Yes	73	E1+
19	E-8830	" "	L74.5394-3B-7Y-5B-1Y-1B-0Y	Yes	73	E1+
20	E-8831	" "	L74.5394-6B-1Y-3B-0Y	Yes	56	E2-
21	E-8832	" "	L74.5394-6B-1Y-4B-2Y-1B-0Y	Yes	56	E2+

Celaya and M16 = Barley
Jupateco 73 = Bread wheat

TABLE 9, Variation observed in populations of Bonza 55 x Apizaco at El Batan, during summer season, 1978.

No. of Order	BV-78 Row No.	Variety or Cross	Pedigree	Maternal Treatment	Days to Flowering	Height	Awn	P.gr
1	E-4755	Bza.55	-	-	86	E1-, N	No	MS
2	E-4756	Apizaco	-	-	84	E3, E1+	-	-
3	E-4758	Bza.55-Apizaco	L76.270A-1B-2Y	Yes	82	E2, E1-, N	No	MS
4	E-4767	" "	L76.270A-2B-6Y	Yes	74	E2+, E2, E2-	Yes	MS
5	E-4768	" "	L76.270A-2B-7Y	Yes	74	E2+, E2-, E1	Yes	MS
6	E-4769	" "	L76.270A-3B-1Y	Yes	86	E1+, E1-	Seg.	MS
7	E-4772	" "	L76.270A-3B-4Y	Yes	86	E3, E2, E1	No	R
8	E-4775	" "	L76.270A-3B-7Y	Yes	86	E2+, E1+, E1-	Yes	R
9	E-4783	" "	L76.270A-4B-8Y	Yes	80	E2+, E2-	Yes	MS

Apizaco = Barley
Bonza 55 = Bread wheat

TABLE 10. Variation observed in the population of Zaragoza 75 x Dic-Hip At El Batan during the summer season, 1978.

No. of Order	BV-78 Row No.	Variety or Cross	Pedigree	Maternal Treatment	Days to Flowering	Height	Awn	P. gr.
1	E-4940	Zaragoza 75	-	-	92	E2+	Yes	50
2	E-4732	Dickson-Hiproly	-	-	71	E3-, E2 -	Yes	-
3	E-4922	Za75xDic-Hip.	L76.1056A-1B-2Y	No	74	E2+	Yes	S
4	E-4923	" "	L76.1056A-1B-1Y	No	71	E2, E1+, E1	Yes	Seg
5	E-4937	" "	L76.1056A-3B-1Y	No	74	E3, E2-, E1	Yes	R
6	E-4939	" "	L76.1056A-3B-3Y	No	74	E4+, E3, E1+	Yes	TMS-S
7	E-4941	" "	L76.1056A-3B-4Y	No	74	E4-, E2+, E1+	No	MR-S
8	E-4946	" "	L76.1056A-3B-9Y	No	72	E4+, E3+	Yes	TR-MS
9	E-4949	" "	L76.1056A-4B-4Y	No	74	E4+, E4-, E3 -	Seg	R
10	E-4951	" "	L76.1056A-5B-1Y	No	74	E4-, E3, E3 -	Yes	TR-MR
11	E-4963	" "	L76.1056A-6B-2Y	No	68	E4, E2+	No	Seg
12	E-4976	" "	L76.1056A-8B-1Y	No	74	E4+, E4	No	MR-S
13	E-4978	" "	L76.1056A-8B-3Y	No	71	E3, E2+	Yes	MR-S
14	E-4981	" "	L76.1056A-8B-6Y	No	72	E4+	Yes	MS

Zaragoza 75 = Bread wheat
Dickson-Hiproly = Barley

Regional Programs

ANDEAN PROGRAM

INTRODUCTION*

The CIMMYT Andean Regional Program for wheat, barley, and triticale was initiated in September, 1976 with its base in Quito, Ecuador. The program is working with the various cereal research programs in Bolivia, Colombia, Ecuador, Peru and Venezuela.

These Andean countries cover an area extending from 11°N–23°S latitude. Small grains are grown in this region at elevations ranging from 300m –4000 m , but the majority of the production is in areas between 2200-3200 m. Most of the small grain production is under rainfed conditions, with annual precipitation ranging from 500-1500 mm. A small portion of the wheat is irrigated and a little more receives supplementary irrigation. Rainfall distribution fluctuates greatly from year to year and from month to month and this uncertainty of precipitation is one of the factors affecting production in the entire region.

Most of the small grains are grown in the intermountain valleys and on the slopes. Some of the slopes are severe and in these areas the soils are frequently shallow. Wheat and durums are normally grown on the better soils and at lower elevations, while barley is generally grown on the poorer soils and at higher elevations. Colombia is an exception because barley occupies the better soil areas.

The temperatures in the region are moderately cool (10°–16°C daily average) during the growing season; thus the wheat cycle is generally 5–7 months long. Frosts are a problem only at higher elevations and the crops are generally seeded at a time to reduce the chance of frost damage. Barley is commonly grown in areas where frost might be a problem. Its early maturity enhances the chance of escape from frost damage.

The cool temperatures are the major factor influencing the incidence of the worst disease in the region, viz., stripe rust *(Puccinia striiformis)*.

PROGRAM OBJECTIVES

The objectives of the program are to strengthen the national research programs in these basic food crops and to establish active research linkages between the Andean countries and the other small grain growing countries of Latin America plus the world wide network of cereal improvement programs. The program also has taken an active role in training national scientists from the Andean countries and in supplying basic research equipment to the research programs.

A series of nurseries has been established to screen the genetic materials from the region and from other parts of the world for the prevalent diseases and to monitor the dissemination of these diseases. An extensive effort has also been made to encourage the free interchange of genetic materials, ideas, and scientific visitors between all the programs in the region.

AREA AND PRODUCTION

The region was sown with 285,000 ha of wheat and produced 276,000 t in 1978, representing a decline in both area and production (table 1). This decline was caused by reduced rainfall, especially in the northern part of the region, and by farmers shifting to the cultivation of other crops which are more profitable than wheat.

In 1978, the region grew 413,000 ha of barley and produced almost 400,000 t (table 1), representing a decrease in both area and production. Part of this decrease was caused by drier than normal conditions but the effects of the new stripe rust race on barley caused the greater portion of the decrease. This new stripe rust race (Race 24) first appeared in Colombia in late 1975 and by the end of 1978 had spread southward to the southern portion of Peru.

BOLIVIA

Total wheat area in Bolivia in 1978 was estimated at 65,000 ha and total production was about 60,000 tonnes. Durum wheats comprise 40–50 per cent of this area and production. In fact, durums demand a price almost double bread wheats in the local markets because of a preference for large seed types in the traditional food preparations.

A wheat area of only 65,000 ha represents a slight decrease from previous years and was probably the result of low prices and lack of a firm market for the commodity. As in most Andean countries, there is a preference for

* CIMMYT assists the national programs of the Andean Region in their wheat, barley and triticale research through the assignment of a CIMMYT scientist. The CIMMYT involvement is financed by a grant from the Canadian International Development Agency.

imported wheat by the millers and very little demand for the wheat produced locally.

Barley area was estimated at 118,000 ha and total production was 85,000 t. Both of these figures are near normal. Most of the barley is used for human consumption and very little enters the market. Most farmers grow barley for their personal consumption and a little for selling in the local market place. It is estimated only 20 per cent of the national production is used for malting.

Wheat imports in 1978 were 280,000 t of wheat and flour, representing an increase from the previous year but no more than would be expected due to the population growth and higher per capita consumption. Barley imports in 1978 has a total value of $5,000,000 U.S., representing 20–25,000 t. All of this barley was used by the brewing industry. Barley imports are likely to increase in 1979 because the new stripe rust race has been identified in Bolivia and the race will reduce production and consequently increase dependence on importation.

COLOMBIA

In 1978, Colombia grew 35,000 ha of wheat and 85,000 ha of barley. Total wheat production was 48,000 t and barley production was 150,000 t. This represents a near average yield for wheat and an increase in the average yield of barley. The price of barley has increased due to internal demand and farmers are utilizing good management practices on this crop.

A large portion of the crop is being grown in the savannah around Bogota where farmers are applying a fungicide, Bayleton, to control stripe rust. In the process, they are actually controlling or decreasing the incidence of other diseases, resulting in higher yields than were obtained previously.

Durum wheats are not grown and triticales are being tested but are still not in commercial production.

Colombia is importing more than 400,000 t of wheat annually; probably 420,000–430,000 t in 1978. The government had originally planned to import 500,000 t in 1978 but this amount was later reduced for various reasons. Colombia also imports some 25–35,000 t of barley annually, all for malting purposes. The amount of barley imported has been decreasing since 1976 with increasing national production and hopefully self-sufficiency will again be obtained by 1980 or 1981.

ECUADOR

Ecuador grew 44,000 ha of wheat in 1978 and produced 42,500 t, representing an average production of 970 kg/ha. This is a near average yield level but the total wheat area is still decreasing and is expected to decrease further in 1979.

The decrease in wheat area is being caused by the land tenure system, high cost of inputs, low profitability of wheat, drought and other factors. Many Ecuadorian scientists estimate there were only 35,000 ha of wheat in 1978 with a total production of approximately 35,000 t. However, these lower estimates cannot be substantiated.

The barley area in 1978 was estimated at 60,000 ha and production was 41,000 t, representing an average yield of 700 kg/ha. There is some conjecture that these figures are also inflated and should be closer to 45,000 ha and 35,000 t production. In 1978, the area decreased considerably in relation to the previous year and yields were also lower due to the effects of the drought and the new stripe rust race.

Most barley farmers have small holdings and could not or did not apply fungicide to control the rust, thereby, reducing yields considerably. Due to the rust danger, many farmers shifted to other crops with a resultant decrease in barley area.

Ecuador grows little or no durum wheat and triticales are still in the experimental stage and have not entered commercial production.

Ecuador imported 240,000 t of wheat and 20,000 t of barley in 1978. All of the imported barley was used for malting purposes. Wheat imports are increasing rapidly due to the lower national production and a rapidly increasing national consumption. Domestic per capita consumption has increased 50 per cent in the last eight years and the trend appears to be continuing with greater urbanization.

Barley imports also represented an increase over previous years and it is probable that further increases will occur until farmers can utilize varieties resistant to the stripe rust races.

PERU

The wheat area in Peru in 1978 was estimated at 140,000 ha with a total production of 125,000 t. Durum wheats probably constitute 40 per cent of this area and an equivalent percentage of the production. The barley area was 150,000 ha and production was estimated at 120,000 t.

The wheat area and production were near normal; possibly slightly reduced due to drought conditions especially in the northern sierra. The barley area was somewhat below normal, but production was much less than normal due to the drought and to the first effects of the stripe rust, which first appeared in 1978. Because of the new race, it is anticipated that the barley area and production will undergo a further decline in 1979. However, a new barley variety (Zapata) tolerant to the new race has been released and will be grown commercially on limited hectarage in 1979. With further disseminations in subsequent years, the barley area and production should recover to previous levels.

Barley imports in 1978 were 80,000 t and this is somewhat average for Peru. Barley imports may increase until the new stripe rust race is controlled by increased use of fungicides and/or resistant varieties. All of the imported barley in used for malting while most of the local production (90 per cent) is used for human consumption.

Peru imported 800,000 t of wheat in 1978, which was less than originally planned. Wheat consumption is increasing rapidly due to rapid urbanization and imports and/or production must expand to meet these requirements. Increasing yields in the sierra will be a slow and difficult process, but wheat can be cultivated in the irrigated coastal valleys and if this alternative is pursued, wheat production could be expanded rapidly. However, it is highly unlikely Peru will ever be self-sufficient in wheat.

VENEZUELA

Venezuela grew only 1,500 ha of wheat in 1979 with a total production of 550 t. Wheat is grown only in certain areas of Venezuela and is not really a commercial crop. Total imports of wheat and flour were estimated at 500,000 t in 1978. No barley, durum wheat, or triticale are currently being grown in Venezuela.

Table 1. Summary of the estimated wheat and barley sown areas and production in 1978.

Country	Wheat Area ha	Wheat Production tonnes	Barley Area ha	Barley Production tonnes
Colombia	35,000	48,000	85,000	150,000
Ecuador	44,000	42,500	60,000	41,000
Peru	140,000	125,000	150,000	120,000
Bolivia	65,000	60,000	118,000	85,000
Venezuela	1,500	500	–	–
Total	285,500	276,000	413,000	396,000

IMPORTS

In 1978, the countries of the region imported a total of 2,240,000 t of wheat (table 2) which is a significant increase over the previous year. Increased consumption due to increased population, shifts in dietary preferences, less area devoted to wheat, and the effects of the drought were all instrumental in bringing about this higher importation. In 1979, it is probable that the wheat area and production will continue to decline somewhat and importations will be even higher.

The countries of the region imported 150,000 t of barley in 1978 (table 2) and this figure would have been higher if the data from Venezuela were included. The drought, reduced barley area and reductions in yield caused by stripe rust were all instrumental in bringing about this above average deficit. Since the cultivation of barley involves a high risk due to the uncertainity of production caused by stripe rust, more farmers will probably shift to other crops in the future. To reverse this trend, resistant varieties must be released as quickly as possible.

Table 2. Summary of the estimated Wheat and Barley imports, 1978.

	Wheat (tonnes)	Barley (tonnes)
Colombia	420,000	30,000
Ecuador	240,000	20,000
Peru	800,000	80,000
Bolivia	280,000	20,000
Venezuela	500,000	Unknown
	2,240,000	150,000

All of the barley imported in the region in 1978 was for malting purposes. The commercial malting varieties are all highly susceptible to the new stripe rust race, and the production of barley for malting purposes has suffered extensively. Beer consumption in the region is growing quite rapidly and demand for barleys of malting quality will increase in future years. If this demand is to be met with local production, resistant malting varieties also must be identified.

FACTORS ADVERSELY AFFECTING PRODUCTION

Probably the single most important factor is poor agronomic practices. Most wheat and barley is grown without fertilization or with very low levels of fertilization, little attention is given to good seedbed preparation, and little or no herbicides are used. In many cases barley is relegated to the poorest soils of the region, and wheat is generally grown on soils which are less than the best.

The use of fertilizer on cereals is limited throughout the region and in many countries increased utilization is unlikely because of the high costs of fertilizers. In several countries, urea costs more than 300 dollars/t and phosphorus fertilizers are similarly priced. These prices discourage the use of fertilizers on all crops except the most profitable, such as cotton, potatoes, rice and sugar cane. Government policies in regard to pricing of this important input need to be reviewed and, in some cases, fertilizer should probably be subsidized to encourage greater use and subsequent increases in national production.

Similarly, most other modern agricultural inputs in the region are expensive and their use is limited. Cereal production is seldom mechanized and normally all work is done with animals or human labor which is the traditional way. Herbicides and insecticides are generally readily available throughout the region but their costs are high and their adoption has been slow. The use of 2,4-D is spreading because of its effectiveness and relatively low price, but still the majority of the farmers in the region do not utilize any herbicide.

Most cereal farmers in the region have very small holdings and grow only small amounts of cereals each year. Since the holdings are small it is very difficult for many farmers to get credit at reasonable rates. Official government interest rates in nearly all the countries are quite reasonable but in many cases this credit is not readily available to the small farmer.

Therefore, these farmers must turn to local lenders at high interest rates to buy inputs, or as is commonly done, the small farmers do not utilize credit and as a result have little or no money available for purchasing inputs. Credit policies need to be reviewed in each country and special emphasis must be given to assuring readily available credit at reasonable prices for the small farmers.

The costs of inputs varies considerably from one country to another depending on the input and the country. For example, fertilizer is very expensive (prohibitively) in Bolivia and Ecuador and slightly less expensive in Peru and Colombia.

The small farmers of the region cannot buy even the simplest and smallest implements due to their high cost and the limited capital which these farmers have at their disposal. As a result of these factors, the small grains are a traditional crop, cultivated by hand or with animals and with little use of modern inputs.

Small grain production was adversely affected by drought in nearly all the countries in 1978. The drought was especially severe in southern Ecuador and northern Peru. Precipitation was not only below average, but it was poorly distributed throughout the growing season.

RESEARCH AND EXTENSION

Several countries in the region have initiated demonstration and research programs at the farmer level (on-farm testing). The demonstrations are being utilized to illustrate the best technological information derived from previous experimentation in regard to varieties, fertilization, weed control, seeding dates and rates, and soil management.

The on-farm research trials are being used to verify research results in farmers' fields and under farmer conditions. In certain instances these trials are being used to ascertain recommended levels of the various technological inputs under the inherent farmer's conditions and economic situation.

Several programs are planning to give greater emphasis to the demonstrations and on-farm testing trials in the future. It is now being realized that yields cannot be increased by new varieties alone but instead, increased production will be the result of the combination of better crop management, better fertilizer and weed control practices, and better varieties.

MARKETING PROBLEMS

The availability of markets and the prices received for the commodity are also adversely affecting cereal production throughout the region. Most countries have an official price structure for wheat and barley which is quite attractive when viewed in relation to international prices, but when compared to the cost of inputs and prices paid for other crops, they offer much less incentive.

Few government buying agencies (elevators) are available in most countries and farmers cannot move their commodities the distances required, so they frequently sell to middle-men (intermediaries) at reduced prices. The prices received are frequently 65-75 per cent of the official government price.

When these prices are used to calculate profitability of the cereals, their advantage is even further reduced in relation to the cost of inputs and other crop alternatives.

In certain areas throughout the region, farmers frequently have difficulty in finding a market for their grain. All of the countries in the region import more than 80 per cent of their wheat requirements. The millers and bakers would rather use imported grain of fixed quality and purity standards than the national product which is normally quite variable in regard to purity, quality, and moisture percentage.

Storage facilities are limited and while imported grain can be contracted for delivery when storage is available, the national production must be bought as the crop is harvested and frequently storage facilities are inadequate.

In certain countries, government policies actually encourage importation of wheat rather than the utilization of the local production. Importations are frequently subsidized and enter without tariffs, allowing the millers and bakers to make good profits and thereby discouraging their participation in the local production.

Throughout the region more storage and marketing centers must be established and the various governments must develop policies which strongly encourage the industry to buy local production before turning to importation.

VARIETIES

Throughout the Andean Region improved wheat varieties are grown extensively and constitute the bulk of the production. However, many of these improved varieties are quite old and should be replaced by better adapted and higher yielding materials currently available in the various breeding programs. The durum wheats grown in Peru and Bolivia are unimproved varieties and efforts are being made to replace them as fast as possible.

In Colombia, nearly all the barley area is devoted to improved varieties while in Ecuador about half the area is sown to improved varieties. In Peru and Bolivia more than 90 per cent of the total barley area utilizes local varieties; however, this is expected to change rapidly because the new stripe rust race eliminated the old varieties (both improved and local) and new varieties with resistance must be identified and released to the farmers. In a few years, it is anticipated more than 90 per cent of the barley area in the region will be utilizing improved varieties resistant to the new race.

In Colombia, old improved varieties such as Bonza 63, Tota 63, Sugamuxi, and Crespo are being grown on most of the area. In 1976, two new wheat varieties, Icata and Engativa, were released and in 1978 they entered into commercial production. In the central region around Bogota, several Pavon sibs and several lines from the cross Ciano—Gallo are very promising and should be released. In the southern part of the country (Nariño), three lines were multiplied in 1978 for release in 1979 to the farmers. These lines are:

K1 Imp-Son63 x Np63	22700-5t
Mef"S"-Tota63	52129-7n-2n-2n-3n-1n
Mef"S"-Cpo63	51548-1n-2n-1n-2n

The principal barley varieties in Colombia are V-124, Mochaca, Galeras, and Surbata, but all are susceptible to the new stripe rust race and must be replaced. The research program to the brewing industry (Agrofomento) is currently multiplying three lines for probable release in 1979 and 1980. All three lines are from the cross MCU 3021-Mochaca and are currently designated as PM8, PM15, and PM16. PM8 is in the final stages of testing and multiplication, and it should be named and released in 1979.

These three lines are tolerant only to the rust and are not completely resistant, necessitating the use of one application of fungicide, instead of the current two applications. More resistant materials are entering the early stages of testing and multiplication and they should be available in another 3-4 years.

In Ecuador most of the wheat area is currently devoted to the improved varieties Atacazo, Cayambe, and Romero. Two new varieties, Chimborazo and Antizana were released in 1977 and will enter commercial production in 1979. In 1978, the variety Cotopaxi was officially released and is currently undergoing multiplication. Also in 1978, six promising lines were provisionally named and these lines are undergoing final testing and preliminary multiplication in 1979. The names and pedigrees of these lines and the other new varieties are listed below:

Chimborazo	=	Mef"S"/M-Rw^2 x Bza^2 II20911-2e-8e-2e
Antizana	=	Cno"S"-Gallo 27829-19Y-2M-3Y-0M
Cotopaxi	=	Linea E72-220 MsD$_6$72-220E
Altar	=	Tob"S" x Desc-Fr EII3965-1e-0e-0e-3e
Imbabura	=	TL365A/34-SX x CC CM11699-K-1Y-6M-1Y-0M
Tungurahua	=	Amz [(Fr^2-Fn x Y/4777^4)Fr-My54^2 x 4777] EII 5512-7e-0e-0e-6e
Saraguro	=	Tob"S"-Napo EII 3958-2e-0e-0e-12e
Iliniza	=	Linea E72-259 MsD$_6$72-259E
Sangay	=	Linea E72-21 MsD$_6$72-21E

The barley breeding program in Ecuador has released three new varieties in the last two years. Duchicela (CN48-CI8985, II17641-1e-1e-9e) was released in 1977 and should enter commercial production in 1979. Teran 78 (Dorada Distica) and Convenio 78 (Galeras (Ki-CI2376)^2, II17060-3e-3e-2e) were recommended for release in 1978 and will undergo further multiplication in 1979. Convenio 78 is a malting variety with tolerance to the new stripe rust race, Duchicela has marginal malting quality but good resistance, and Teran 78 has good resistance and is used for human consumption. These three varieties plus the commercial variety Dorada (for human consumption only) will become the main barley varieties in Ecuador in the next few years.

In Peru, the new barley variety Zapata was released by the Universidad Nacional Agraria-La Molina in 1978. This variety is tolerant to the stripe rust race and has acceptable malting characteristics. Plans are being made to seed 6000-8000 ha of Zapata in the sierra of Peru in 1979 and an additional 3000 ha on the coast. By 1980, the variety should be in wide scale production. Several other lines with better resistance are undergoing final testing and multiplication and 2—3 lines should be recommended in 1979.

Two new varieties of wheat have recently been released for cultivation on the coast of Peru. The variety Participación was released in 1976 and Costa 78 (Bb-7C^2, CM5452-E-1Y-2M-0Y) was released in December, 1978. These two varieties have good resistance to leaf rust, the prevalent disease on the coast, and have good adaptation and yield potential. In 1978, several lines underwent final evaluation for release in the sierra of Peru and two or three of these lines will be released in 1979 to replace the current commercial varieties, Ollanta, Cahuide, Huanca, Sinchi, and other local varieties.

The Bolivian national research program released two barley varieties in 1977 viz., San Benito and Promesa. These varieties were multiplied in 1978 and should enter commerical production in 1979 or 1980. However, they have little tolerance to the stripe rust race and new lines with better resistance must be identified quickly and released to the farmers.

A new wheat variety, Valluno 78 (Fr^2-S x K51-B11-39/Fr-Cou) was released in 1979 to replace the old commercial varieties Chinoli 65, Chinoli 70, and various local varieties. Another line (Md x McM-Ex/K58-N x Fn) has entered the preliminary stages of multiplication and will probably be released in 1979. By 1980, several lines of Mexican origin should be ready for release.

SEED INDUSTRY

In the last two years, the various research programs in the region have been very active in releasing wheat and barley varieties. This activity is expected to continue and maybe even intensify as more barley varieties are released to overcome the stripe rust hazard. However, once the varieties are released, their delivery to the farmers is usually delayed several years because most countries lack an efficient seed certification and multiplication program.

Several programs are aware of this problem and effort are being made to organize efficient seed certification organizations. These organizations play an integral role in the delivery system from the experiment station to the farmers and this role must be emphazised because a variety is of no value unless it is in the hands of the farmer.

GRAIN END USES

Wheat is commonly eaten throughout the region as bread. Limited use is made of wheat in soups and other preparations and very limited amounts are used as animal feed. In Colombia and Venezuela barley is primarily used for malting purposes but in the other three countries, it is used mainly as a human food in soups and other food preparations. In certain parts of Bolivia and Peru, barley is one of the staple food crops. There is limited use of barley grain for feeding animals but some barley is grown as forage in Bolivia and Peru.

Durum wheats are grown only in Peru and Bolivia and estimates indicate they constitute 40–50 per cent of the total wheat area. Durum is eaten in soups and other traditional preparations of the people of the sierra of these two countries. Triticale still is not being grown commercially in the region but it is being evaluated as both a grain and a forage crop.

DISEASES AND PESTS

1. Stripe Rust

The cool temperatures are the main determining factor for the major disease of the region, stripe rust *(P. striiformis)*. Stripe rust races which are specific on wheat, barley, and durums are prevalent throughout the region. Since temperatures fluctuate only slightly and are cool throughout the growing season, stripe rust infects both the leaves and the heads of the small grains. Losses aproaching 100 per cent are common if susceptible varieties are grown.

The Andean Region is frequently cited as possessing the highest virulence and the greatest diversity of stripe rust races in the world. One fact is certain, virulence patterns change frequently and new races spread rapidly. These race changes and their dissemination are facilitated by the fact that small grains are grown throughout the year in Colombia and Ecuador, thereby constituting a year round host for the pathogen.

In late 1975, a new race of stripe rust on barley suddenly appeared in the area near Bogota, Colombia. Prior to the appearance of this race, stripe rust on barley had been a minor disease problem. However, the new race (a variant of Race 24) was both highly virulent and aggressive and attacked all of the commercial barley varieties in Colombia. By late 1976, the new race had spread to southern Colombia and was causing devastating losses. By June 1977, the race had moved as far south as southern Ecuador, eliminating all the malting barleys of Ecuador and all but one of the commercial varieties grown in the country.

The race was identified in Cuzco, Peru (southern Peru) in February, 1978. By May, 1978 it had spread to nearly all of the barley areas of Peru, eliminating all commercial varieties. Preliminary reports in January 1979, indicate the new race has been detected in the sierra of Bolivia. No one knows if it will continue its southern migration into the barley areas of Chile and possibly even Argentina.

Since none of the commercial varieties are resistant and since little of the breeding materials present in the various research programs carries suitable levels of resistance, the world collection of barley was quickly screened and fungicide trials were initiated.

Bayleton was identified as the most effective fungicide for controlling the stripe rust. Two applications of approximately 500 gm/ha each gave very effective control, but increased production costs considerably (approximately $40 US/ha). Due to these increased costs and the uncertainty of control, farmers reduced the barley area drastically in 1976 in Colombia. By 1978, with increased confidence in Bayleton and with increased barley prices to offset the additional production costs, farmers again began to expand the barley area but the total area is still 30,000 hectares less than in the pre-rust years. When resistant varieties are released, the area will probably increase further if the current price structure and demand holds; however, this will take at least 2–3 years.

The screening of the world barley collection identified some 250 lines which had resistance to the new race. Most of these lines originated from Ethiopia and probably represent only one or two genes or blocks of genes for resistance. These lines were quickly evaluated for adaptation and yield potential and were entered into the various crossing programs. The results of these crosses will not be forthcoming for at least 3–4 more years, but fortunately resistant varieties may be released sooner.

The CIMMYT base program in Mexico sends nearly all of its advanced materials in wheat, barley, triticale and durums for screening in Ecuador.

2. Barley Yellow Dwarf Virus (BYDV)

This disease has become more prevalent in the last two years. It is transmitted by aphids and has caused extensive damage to barley and wheat in Colombia and Ecuador in 1977 and 1978 as well as unascertained damage in Peru and Bolivia.

Aphids and BYDV seem to be more prevalent in dry years such as 1977 and 1978, and less damaging in normal or wet years. However, in the last two years the aphids have become established and most of the native grasses are infected, serving as an excellent reservoir of inoculum. BYDV may now become an endemic disease in the region. It is almost certain that Peru and Bolivia have or will have similar problems with BYDV.

Ecuador serves as a screening site for barley yellow dwarf disease. All materials received are screened for resistance to it, and also to stripe rust, and the results are reported to the Mexico base programs.

These data then serve an important role in CIMMYT's effort to incorporate broad based stripe rust resistance into all new advanced lines. In a similar manner, data on adaptation and BYDV tolerance in the Andean Region are utilized in the crossing program to obtain better materials for future use in the region and throughout the world.

3. Other Diseases

Some other problems in the region include leaf rust on the coastal areas of Peru, stem rust in the drier lowlands of Bolivia, *Septoria and Helminthosporium* in the humid lowlands of Bolivia, and an increasing problem with *Sclerotium sp.* in the coastal areas of Peru and Ecuador.

The main disease on barley is stripe rust, but the various *Helminthosporium spp., Rhynchosporium secalis,* and leaf rust are also prevalent diseases. Leaf rust *(P. hordei)* is the major disease of barley in the coastal areas of Peru. *Sclerotium sp.* is also becoming more prevalent on barley in these areas.

4. Insect Pests

Insects on small grains are of limited importance. Aphids are becoming more prevalent but cause only minor direct damage. They are of economic importance because they serve as vectors for BYDV. Soil and storage insects are present in certain areas but cause minor damage generally.

NURSERIES

The second set of regional nurseries was prepared and distributed to the various countries in Latin America in 1978. Three nurseries are currently being prepared and these are called the Vivero de Enfermedades y Observación de Latino América for wheat and barley (VEOLA and VEOLA de Cebada) and the Ensayo Latino Americano de las Royas (ELAR).

The VEOLA for wheat and barley is principally a screening nursery for diseases and adaptation, similar to the RDISN in the Middle East. The principle function of the VEOLA de Cebada is to identify lines resistant to the stripe rust race in the region. Lines displaying resistance throughout the region are tested for adaptation, and those showing promise will be multiplied for rapid release.

The ELAR is basically a trap nursery similar to the RDTN of the Middle East. It is composed of the commercial wheat and barley varieties of the region and the differentials for each of the three major rusts. Its objectives are to monitor race changes in the rust as they occur and hopefully help map the distribution pattern of the various rusts throughout South America.

On a practical basis, its main purpose is to serve as an early warning system for new races in the rusts so that breeders in the region can change varieties before the new virulence becomes prevalent and in this way diminish losses due to susceptible varieties.

The VEOLA and VEOLA de Cebada are composed of the advanced lines from each of the breeding programs in the region, plus materials from Mexico and other countries in South and Central America. In 1978, materials were received from Ecuador, Peru, Bolivia, Colombia, Brazil, Guatemala, South Africa, Holland, and Mexico. These materials were sent to Quito, prepared in sets, and distributed to selected sites for evaluation.

In 1978, 30 sets of these nurseries were distributed to the following countries: South Africa, Peru, Bolivia, Colombia, Ecuador, Mexico, Guatemala, Guyana, Brazil, Chile, Paraguay, Uruguay, U.S.A, Kenya, Venezuela, Argentina, and Holland. Of the 30 sets, twelve will be grown in the Andean Region and 26 will be grown in Central and South America.

The data from the first regional nurseries prepared in 1977 are still being received. When the data are complete, a summary will be made and will be sent to each of the cooperators. These data should identify lines with broad adaptation and with a broad based disease resistance.

The regional program also assists in the distribution of the CIMMYT nurseries in the Andean Region. Discussions between the regional national scientists and CIMMYT staff result in the most important nurseries for each program being delineated. Every effort is made to have CIMMYT supply these materials.

In certain instances, special nurseries or materials for special purposes such as the world collection of barley for stripe rust screening, winter wheat materials and nurseries for the altiplano of Peru, etc., are also ascertained. All efforts are made to obtain whatever germ plasm is necessary to resolve the multitude of problems present in the Andean Region.

TRAINING

One of the basic goals of the project is to assist the countries of the region to strengthen their national research programs. This assistance is accomplished in many ways, but one of the most important is through the training of national scientists. The training is generally of a practical nature and involves short or medium length visits or courses in Mexico. In certain cases, post-graduate training is also furnished, generally at the M.Sc. level.

In 1978, eight regional wheat scientists were trained in CIMMYT, Mexico for periods ranging from 6–8 months. Four were trained in plant breeding (one Ecuadorian, three Bolivians), three in wheat production (one Bolivian, one Ecuadorian, one Colombian), and one Ecuadorian was trained in experiment station management. A Peruvian scientist spent one month in the plant breeding course. Training of this type will continue to receive priority in order to develop a highly trained team of wheat scientists in each of the wheat research programs in the region.

In 1978, one Ecuadorian scientist was given a fellowship to obtain his M.Sc. degree at Chapingo, Mexico in plant breeding and genetics. In early 1979, a Peruvian scientist will begin her Masters program in plant breeding and genetics at Oregon State University. There is a need in the region for more training at the graduate level (M.Sc.) and every attempt will be made to meet these requirements, but the number of candidates will depend on the financial support available for these fellowships.

Short term training in Mexico is generally for 2–4 weeks. It is a very important part of the overall training program. During these visits the scientists work in areas of special interest such as pathology, breeding, and agronomy and/or spend their time selecting new germ plasm. These visiting scientists also become better acquainted with the CIMMYT philosophy, organization, and staff and better understand how CIMMYT functions and what it is trying to accomplish.

In 1978, five regional scientists spent three weeks each in Cd. Obregon, Mexico, during the main wheat season (one each from Colombia, Ecuador, and Peru, and two from Bolivia). Three scientists also visited during the summer season in Toluca for a period of 2–4 weeks each. One of these worked with the CIMMYT pathology program, one with the wheat breeding program, and one with the barley breeding program. These visits will continue on an annual basis since they represent an integral part of the training program for the regional scientists.

WORKSHOP

In October, 1978, scientists from three contries met in Lima to visit the Peruvian wheat research program for the coastal areas. The visit lasted 10 days and all the wheat areas on the coast were visited. These workshops allow the scientists to become better acquainted with other research activities in their region and contribute greatly to a better spirit of cooperation. Annual workshops will continue to be held and each year a different national program will serve as host.

CONFERENCE

In May, 1978 a regional wheat conference was held in Quito, Ecuador. The main topics of the conference were the problems with stripe rust of wheat and barley, the concepts of on-farm research and methods of transferring new technology, and the potential for triticale in the Andean Region. Approximately 45 invited scientists plus 30 Ecuadorian scientists attended the conference. The majority of the invited scientists were from the Andean Region but delegates from every country in South America, Guatemala, U.S.A., Mexico (CIMMYT), Canada, South Africa, and Holland also attended.

The conference provided an excellent opportunity for the delegates to exchange ideas and discuss mutual problem areas and it greatly enhanced the spirit of co-operation between the various wheat workers. A conference of this magnitude will probably be held every four or five years and each successive conference will address the major problems confronting the expansion of cereal production in the region.

REGIONAL VISITS

The Andean Regional Program also assists directly in the implementation of the various research programs. The regional CIMMYT representative makes frequent trips to assist in the selection of materials, reading of disease reactions, planning of future trials, observation and implementations of off-station trials and demonstrations, etc. In this regard, several visits were made to each of Colombia, Peru, Bolivia and within Ecuador.

This technical input is one of the prime responsibilities of the regional CIMMYT staff member and through this activity, a type of regional coordination is achieved wherein all the programs are working together for one common goal i.e., to increase cereal production.

EQUIPMENT FOR PROGRAMS

In 1978, a large amount of basic field and laboratory equipment was purchased for the programs in the region. Included were items such as plot threshers, plant threshers, seed cleaners, small mills for quality laboratories, and basic pathology equipment for collection, storing and inoculating rust spores. The purchases varied from one country to another depending on the needs and the equipment available beforehand.

The objective was to furnish each program in the region with the basic research equipment necessary to conduct an intensive wheat research program. The current needs of the programs have been resolved but additional purchases will be necessary in the near future as programs expand and as new problems are confronted.

CONSULTATIONS

Consulting by CIMMYT scientists continued to play an important role in regional activities. A total of seven

CIMMYT wheat scientists visited the region at least once during the past year. These visits are generally for specific purposes but also they help a great deal in cementing the relationship between the national programs, the CIMMYT regional program, and CIMMYT, Mexico. These visits will continue as the need and opportunity arises.

The regional program not only gives direct support through training, equipment, and technical assistance, but also attempts to serve as a catalyst for wheat research throughout the region.

Efforts are made to encourage government officials and administrators to assist agricultural research programs and agriculture in general. Frequent visits are made to the administrative heads of national research programs to keep them informed of the program's activities and to encourage increased support for research and production.

Success in the form of increased agricultural production can only be achieved when the various governments and agencies in the region decide to give agriculture and agricultural research its necessary priority. The Andean Regional Program is striving to achieve this goal through its various activities and through its direct participation in the agricultural sector and the agricultural research programs of the region.

EASTERN AND SOUTHERN AFRICAN PROGRAM

INTRODUCTION*

CIMMYT appointed a wheat breeder in 1976 to the Eastern and Southern African Regional Wheat Program. The operation is based at the Kenya National Plant Breeding Station, Njoro, some 200 km north west of Nairobi, Kenya.

The CIMMYT activities in this program are manifold. They include screening of germ plasm for disease resistance; circulation of uniform yield nurseries; cooperative measures with regional countries to assist in the improvement of wheat and triticale production; facilitating visits by local scientists to observe wheat and triticale research in neighbouring countries; conducting workshops to train national scientists; and consultations by visiting CIMMYT staff with national program scientists.

The countries in the region for the purpose of regional wheat cooperation range from Ethiopia in the north to Lesotho in the south. In total, 17 countries are included, and working contracts have been established with 14 of them. In 1978, discussions were held with nine of these countries.

Several countries in the region have been involved in military activities, and to a degree, this has limited the wheat work. Ethiopia, Somalia, Uganda, Tanzania, Zambia and Mozambique have been preoccupied with military action. It is encouraging that good contacts have been established at the level of agricultural research, despite the strife.

In several of the wheat and triticale programs of the region, significant progress was made in 1978, and comments thereon are provided below. Also, some basic background data on countries in the region, are presented in table 1.

BURUNDI

Over the past three years a number of triticale lines have been introduced in Burundi which have given a higher average yield than most bread wheats.

Limitations to wheat growing on Burundi lateritic soils are low pH and probable aluminum toxicity. Many wheats when planted in these soils died after a few weeks of plant growth, while certain other varieties such as Romany grew to a height of over one meter and produced yields of 1–2 t/ha.

Most triticale introductions showed a similar performance to Romany. This has raised great expectations in Burundi, to increase yields of triticale, and to provide a locally produced flour that can be mixed with wheat flour. Many questions however, still have to be answered viz., soil fertility, seed multiplication and distribution. The marketing of the produce is also complicated, as there are many small holders living in isolated areas with poor communications.

The new varieties of triticale and wheat have provided a burst of new activities, which can result in significant benefits for Burundi as well as Rwanda and Zaire.

KENYA

Research work in Kenya has continued along the lines of producing new stem rust and stripe rust resistant bread wheats. The long term program has been very successful over the years. Many Kenyan bread wheats continue to show very good resistance in the regions of the program and also in other parts of the world.

Recently released varieties, K. Kifaru and especially K. Fahari are rapidly expanding in area which indicates a very rapid adoption by farmers. A contributing factor is the availability of quality seed. In recent years, over

* CIMMYT assists the national programs of Eastern African countries, North Africa and the Near East in their research programs through the assignment of a CIMMYT scientist, based in Kenya. The CIMMYT involvement is financed by a grant from the Canadian International Development Agency.

Table 1. Populations, Gross National Product, Wheat areas and import needs in Eastern and Southern Africa.

Country	Pop. Est. Mid 1978 Millions	1978 Urban Population	Pop. Est. in 2000 Millions	Per capita GNP 1976	Estimated Hectares of wheat	Import needs tonnes*
Burundi	4.0	2	7.2	120	6,000	15,000
Ethiopia	30.2	12	53.9	100	816,000	200,000
Kenya	14.8	10	31.3	240	125,000	50,000
Madagascar	8.0	16	16.3	200	500	55,000
Malawi	5.4	10	9.8	140	1,000	18,000
Mozambique	9.9	6	17.7	170	13,000	150,000
Rhodesia	7.0	19	15.2	550	50,000	–
Rwanda	4.5	4	8.6	110	3,000	15,000
Somalia	3.4	28	6.5	110	5,000	80,000
Tanzania	16.5	7	33.1	180	24,000	100,000
Uganda	12.7	7	24.8	240	2,000	15,000
Zambia	5.5	36	11.5	440	2,000	140,000
Angola	6.4	18	11.7	330	13,000	110,000
Botswana	0.7	12	1.4	410	500	?
Lesotho	1.3	3	2.1	170	80,000	13,000
Swaziland	0.5	8	1.0	470	–	10,000
Namibia	1.0	32	1.9	980	15,000	?

Population data from 1978 World Population Data Sheet, Population Reference Bureau.
* Estimates from various sources and recent years.

half of Kenya's wheat area has been planted with certified wheat seeds. This has benefited many farmers, and it has proved to be an excellent channel for the newly released varieties. In 1978 several lines were multiplied for release in 1979 and probably two, K 6916-6 and K 6934-117, will be named soon.

Another promising development is the large scale multiplication of the triticales: T 50, T 65 and T 74. Njoro Plant Breeding Station has seen yields of these triticales that are consistently above bread wheats in nearly all the wheat areas of Kenya. Current interest is focussed on determining the best utilization of this new resource. Triticales will be available to many industrial users, and results from these tests will determine how much support this new crop will receive from consumers.

LESOTHO

Wheat studies in several parts of Lesotho have clearly shown that yields can be much higher than currently obtained. Several research activities are directed towards improving these very low average yields. The main areas of yield limitations are the land use patterns, low soil fertility levels and the low moisture holding capacity of the soils.

In nearby South Africa, many cultural practices have been developed that can be applied in Lesotho.

MADAGASCAR

This rice eating country has felt the rapidly increasing demand for wheat, which has to be met by imports that cost the country badly needed foreign exchange. The government has committed itself to developing wheat production in the country.

Wheat and triticale research has produced a number of good varieties in recent years. These are now being distributed to farmers by a cooperative project of the Malagasy and Norwegian Governments, FIFAMANOR. The stem rust resistance of these varieties is superior to the old tall types that were planted on a limited scale in earlier days. There is a shortage of seed of these varieties.

In 1978, a wheat workshop was held in Madagascar to show the requirements for growing wheat and triticale. Some 25 participants observed vigorous, healthy wheat crops at FIFAMANOR, in the region of red soils. The station has practiced soil improvement methods, and resulting yields of wheat and triticale are at the 3–4 t/ha level.

Rapidly growing imports form a strong encouragement to expand local wheat production. The various agencies and projects in Madagascar are working hand in hand to solve wheat production problems at the farmer's level. Recent introductions of wheat varieties and triticale lines from Kenya and Mexico have shown that results achieved elsewhere, are also promising on the island. Much agronomic research work needs to be applied, in order to raise yields to the necessary levels, to sustain a healthy wheat industry.

MALAWI

It is self sufficient in practically all food crops, with the exception of wheat. The country has tested wheats over several years, especially introductions from South Africa, Kenya and Mexico.

In 1976, results with K. 6290-4 (called K.Nyati in Kenya) were so conclusive that the Ministry imported a commercial amount of K.Nyata seed. This was increased in 1977 under irrigation and distributed to small farmers in the Western Hills, in the border area with Mozambique.

A very successful field day was held in 1978 at the Research Station in this area, the Kirk Range. Many research plots on fertilizer levels, seeding rates and dates showed farmers, extension officers and other government staff how wheat should be grown. Recommended practices are based on the results of the Research Station.

With the recommended variety already in the hands of the farmers, production of wheat will quickly increase. Malawi has a very active marketing agency which has established a good price for wheat. It has also organized storage and transport facilities to the mill in Blantyre.

Some triticales have also given very good yields in the hills. In one test, yields of three varieties were above 4000 kg/ha and in the same test, K. Nyati yielded 3100 kg. Response to nitrogen fertilizer was very clear, and more work on adaptation of triticale to Malawi conditions is planned.

MOZAMBIQUE

Because of a rapid growth in wheat imports, the government has placed a priority on expanding wheat production.

South of the Zambezi, there are some areas where wheat has been tested extensively under irrigation. In the northern parts of the country, wheat fits in best at higher altitudes where water is available from irrigation or from rain and residual supplies in the soil.

After independence, wheat research and production were severely affected by a shortage of staff. Only in 1978 could the national wheat research program be started up again.

In 1978 in the lower parts of the Limpopo River, a number of varieties was tested in research plots. Some varieties were vigorous, especially the Rhodesian line 69/12A1.

Wheat research in the north is also carried out by the staff of the national program based in Maputo. The recently introduced varieties from East Africa were planted there. Results will be of interest not only to Mozambique, but to Malawi as well, because of similar conditions.

With the change over in personnel, and the continuing shortage of trained staff, Mozambique is currently handicapped to launch a strong production campaign. However, research work has been started again. The National Institute has formulated a package of wheat growing recommendations. The variety Inia 66 is recommended for the five production zones of the country, especially for irrigation.

RWANDA

Wheat is grown by many farming families on very small plots in the highlands, mostly for home consumption. The National Wheat research program has located several testing sites in the northern part of the country, where wheat is most frequently grown.

Introductions from Kenya, Mexico and Tanzania have given very encouraging results in these test sites. After several years of testing, Romany and Norteño have been multiplied on the government stations and distributed to the farmers.

In 1978, Norteño showed heavy stripe rust infection at the three multiplication sites. Several resistant lines are available however. Recent introductions from Tanzania and Kenya appear to offer new varieties that are suitable to replace Norteño, especially the K. Fahari cross, K. 6648-6.

Also very good yields were obtained with triticales (T 65 and T 74), from Kenya. Some seed was given to workers on the Research Station, and comments were favorable about taste and sweetness of triticale when it was made into local dishes.

With these very encouraging results in wheat and triticale research, there is much interest to expand their cultivation to lower elevation areas in the country. In the densely populated areas such crops as banana, maize, sorghum are very intensively cultivated. Some potential areas for expansion may be found to the east and west of Butare in the southern part of the country.

In many countries in Africa where wheat is grown by small holders, weeding and threshing are very time consuming activities. Back pack sprayers and small stationary threshers may have to be introduced, in order to intensify production. In some countries the infrastructure is not yet available for these technical inputs. The problems for the growers of wheat or triticale remain large.

SWAZILAND

Little wheat is grown in Swaziland at present. In the early 1970's several irrigated farms successfully produced wheat, but there were marketing problems, severe bird damage to the crops and also disease damage.

In 1977 and 1978 several wheat yield tests were grown at the National Agricultural Research Station and yields of 3000 kg/ha were reported under irrigation. In one test from Kenya, triticales yielded about 15 per cent above the best bread wheats, partly due to less damage by birds in triticale. Also, the South African tests of SARWEIN were evaluated, and some entries yielded above 4000 kg/ha. Dwarf wheats selected from CIMMYT materials in South Africa for irrigation conditions yielded the highest. The Rhodesian line 69/12A1 was also very promising.

Limited resources for research have restricted wheat studies to variety introduction and simple agronomic tests. There is a strong case to use the recommended South African wheats, as these can be readily sold in the Republic.

Land tenure and cropping activity in the small holdings are not directed towards wheat production. There is a general lack of irrigation, so wheat could only be grown with moisture from rain or from residual moisture. There is very little effort in wheat research due to a severe shortage of trained staff. The government would like to reach self-sufficiency in wheat and 10,000 tonnes will be needed per year. Training of wheat research workers has started, but no date has been set for the initiation of a national wheat production program.

ZAMBIA

Wheat imports in Zambia are larger than in the other countries in the region with the possible exception of Mozambique. The Zambian government has committed several staff members to work on the increase of wheat in the country and it has also obtained considerable assistance to stimulate production.

Two types of wheat production are possible in Zambia; a capital intensive, high output type of wheat growing under irrigation in the cool season; and the growing of wheat under rainfed conditions in high altitude during the warm season. Developments are progressing with irrigated wheat production, while rainfed production is being actively studied. The most promising area for this second type of production is the Northern Province.

Foliar disease has been very serious in the limited areas of wheat under rainfed conditions in the Center of the country. *Helminthosporium sativum* reached such epidemic conditions that practically no yields were obtained.

Triticales yielded rather well in Northern Province—2.65 t/ha when the best seven lines from different nurseries were averaged. This was 25 per cent above the best bread wheats in the same tests. The test weight was about 11 per cent below the bread wheats however, and the milling percentage would therefore also be lower for the triticales.

Agronomic studies on fertilizer doses and liming will continue to raise yield levels from one t/ha to above 2 t. With such yields, Zambia will be able to produce much more wheat than at present.

DISEASE SCREENING IN INTRODUCTION NURSERIES IN KENYA

In bread wheats, excellent natural infections of stripe rust and stem rust occur at the Njoro National Plant Breeding Station. In addition, seedlings are attacked by stripe rust and in the presence of adequate humidity, very good leaf infections also occur. Although head infections can be seen at Njoro (2140 m elevation), the greatest incidence of infections in the head occurs at Molo, a station at 2852 m elevation.

Part of the new introduced nurseries was hill planted and scored for rusts in the offseason. Selections made in 1977 were repeated in the offseason, to confirm the previous rust scores.

In the offseason, stem rust in durums is more virulent than in other seasons. Only eight lines out of 181 pre-selected durums showed acceptable stem rust resistance.

The best looking lines in the repeat nursery were selected by Njoro plant breeders. They obtained over 60 selections of wheat, durum and triticale for further tests in the National program. In the review of 1977 preliminary yield trials, four introductions were identified for nationwide yield trials:

R 199 Kavkaz/Cno x Chris-On	SE 375-35-5S-0S-3Ke
R 200 Kavkaz/Cno x Chris-On	SE 375-35-5S-0S-4Ke
R 204 Brochis	CM 5872-1-1Y-5M-1Y-2M-0Y
R 206 Brochis	CM 5872-C-1Y-5M-2Y-2M-0Y

The cooperative screening program of 1978 is summarized in table 2. Plantings in the main season were much larger than in the offseason 1977-78. With little moisture available in the offseason, irrigation facilities became a limiting factor. A drastic reduction in numbers is achieved by this system of repeated screening in different seasons.

Table 2. Cooperative Screening Program 1978 of Wheats, Triticales and Barleys selected in Kenya in previous seasons.

Nursery	Origin Njoro 1977	Numbers selected
Repeat Nursery 1977-78:		
Bread Wheat	752	70
Durum	181	28
Triticale	152	33
Repeat Nursery 1978:		
Bread Wheat	669	65
Durum	493	115
Triticale	356	40
Barley at Mau Narok	574	61

TABLE 2. Continued

Stem Rust Parental Collection	461	396
Yellow Rust Parental Collection	89	89
African Coop. Wheat Yield Trials	30	10
Screening Nursery ACWYT	60	35

In table 3, the new materials introduced from many parts of the world are summarized. Over 23,000 entries were planted, with the largest numbers for bread wheats, followed by barley, durum and triticale.

Usually these new introductions are planted in single hills, as the rusts eliminate such large numbers. In bread wheat, over 90 per cent were eliminated, as based on stripe and stem rusts.

Foliar diseases created havoc among the barleys as well as the rusts. In addition to the frequently poor adaptation to the fairly warm day neutral highlands conditions, only three per cent of the barleys was kept.

Some breeding programs provide new germ plasm in the form of segregating populations. These have to be selected on an individual plant basis. However, to make this an effective selection, short rows are planted in the first year of introduction. Most rows show too much rust and are discarded. The harvested rows are planted in larger plots in the following main season for more detailed selection. With the large influx of materials, it is obvious that only small samples of each introduction can be grown.

Table 3. Screening of Small Grain Introductions at Njoro, Kenya, 1978.

Origin	BW	D	B	Oats	Rye	Tcl	Totals
Mexico	3711	382	1044			1510	6647
Andean Region	1555	45	155			155	1910
U.S.A.	1061		2523	362	477		4423
Near East Region	2700	690	842				4232
Turkey	1340	728					2068
Egypt	906						906
ICARDA	846	740	829			140	2555
Jordan		69					69
Portugal	16						16
Cyprus			259				259
F.A.O./Near East	7		7				14
Total	12142	2654	5659	362	477	1805	23099
Total kept	963	337	165	25		285	1775
Percentage kept	8.0	12.7	2.9	6.9	0	15.8	7.7

BW = Bread Wheat D = Durum B = Barley Tcl = Triticale

Results from these small plots are reported to the agency which supplied the introduction. The data are a vital link in the worldwide network of wheat screening, to find broadly based types of resistance. Timely returns contribute to this identification of new sources of rust resistance. These must be intercrossed with high yielding types. It is rare that a new introduction of bread wheat appears to combine the required resistance with the needed adaptation and yield levels. Kenyan wheats that have resulted from many years of selection in this environment are well adapted.

Triticales differ in this regard from bread wheat, as many new introductions show good adaptation and very little disease. The percentage of triticales kept for further screening (table 3) is accordingly high.

In 1978 two groups of new bread wheats were very promising by showing a number of crosses with good stripe and stem rust resistance. In the 11th International Bread Wheat Screening Nursery and PC-Bread wheats from Mexico, outstanding crosses included:

CM 33203, Bobwhite	= Aurora x Kal-Bb/Woodpecker
CM 33090, Chat	= Kavkaz–Tanori 71 x Tito
CM 33027, Veery	= Kavkaz–Buho/Kal-Bb
CM 33591,	= Kavkaz–Buho/Kal-Bb x Sparrow
CM 36867,	= Jupateco–Alondra
CM 38344,	= Kal x Kal-Bb/Kal-Bb x Mildress
CM 34630,	= Gallo–Cuckoo x Kavkaz-Super X

Tables 4 and 5 respectively show other bread wheat lines from the 11th International Bread Wheat Screening Nursery and from the PC (pure seed small plot multiplications) from Mexico, with their stripe rust and stem rust ratings. Stripe rust and stem rust were low in these selections in Njoro and Molo. They will be further selected and then yield tested.

A number of durum lines showed good stem rust resistance (table 6). Usually stem rust is not virulent on durums, but in the Njoro offseason, good screening was possible.

In triticales, many lines showed very good resistance and very good yield (table 7). In international yield trials such as the ISWYN and the Regional Wheat Yield Trial, a triticale is usually included with many bread wheats and durums. In such tests in 1977 and 1978 at Njoro, a triticale was the top yielder in every case. It must be mentioned that there was a prolonged drought at planting time. Despite this severe stress condition, triticales proved to be very high yielding and vigorous. This good adaptation coupled with disease resistance in the East African Highlands clearly demonstrates the potential of this new crop.

In the 2nd African Cooperative Wheat Yield Trial in 1978, triticales were consistently among the best yielders (table 8). The average yield of the three best triticales was 3.04 t/ha, while the best three bread wheats yielded around 2.5 t/ha—a 20 per yield difference in favour of the triticales. This percentage difference corresponds closely to the percentage difference measured in the trials held in the previous year.

Some selected characteristics of the varieties grown in the 2nd ACWYT are shown in table 9. The yield advantage of the triticales over bread wheats is partly reduced by the lower hectoliter weights.

In the 2nd ACWYT, triticales showed outstanding resistance to stripe and stem rust. The disease scores are shown in table 10.

There was very active cooperation in 1977-78 as shown in table 11. Results from 10 countries have been reported back.

The most impressive result indicated in table 11 is the performance of two triticales that were included in the First African Cooperative Wheat Yield Trial (ACWYT). In every test Tcl 65, which is a Bacum selection made in Kenya, and Tcl 74 (Cinnamon-ST 45, x 10149) were in the two top places. In Somalia, Tcl 65 ranked fourth, being the only exception.

Among the bread wheats Kenya Fahari (K 6648-6) was very often among the best yielders. It continues to expand in the area planted in Kenya. In 1978 it was increased in Tanzania under the name Kozi. When this variety was included in 1977 the name Jubilee had been proposed, and this was used in some locations.

Table 4. Lines in the 11th International Bread Wheat Screening Nursery with low Stripe Rust and Stem Rust, Kenya, 1978.

Entry No.	Variety Name	Cross	Stripe Rust Molo	Stem Rust Njoro
124	Cno-Pj62 x Gallo/Bon	CM22100-4M-1Y-1Y-1Y-0M	tR/0	10S, 40S
233	Kvz-Buho x Kal-Bb	CM33027-F-15M-500Y-0M	tR/0	tMS, 0
237	Kvz-Ti71/Maya x Bb-Inia	CM33089-F-2M-3Y-0M	0/0	0,0
239	Kvz-Ti71/Maya x Bb-Inia	CM33089-W-3M-11Y-0M	tR/0	0,0
245	Kvz-Ti71 x Tito	CM33090-T-1M-3Y-0M	tR/0	tMS, 0
246	Kvz-Ti71 x Tito	CM33090-T-1M-4Y-0M	tR/0	tMS, 0
250	Ymh-Jar66 x Y50/Alondra	CM33168-J-1M-8Y-0M	5MR/0	20S, 10MS
252	AuxKal-Bb/Bon	CM33202-E-1M-2Y-0M	5R/0	5MS, 20MS
253	AuxKal-Bb/Woodpecker	CM33203-G-9M-4Y-0M	tR/0	tMS, 0
254	AuxKal-Bb/Woodpecker	CM33203-G-9M-5Y-0M	tR/0	tMS, 0
255	AuxKal-Bb/Woodpecker	CM33202-H-4M-1Y-0M	5R/0	10MS, 0
256	AuxKal-Bb/Woodpecker	CM33203-H-8M-1Y-0M	5MR/0	tMS
257	AuxKal-Bb/Woodpecker	CM33202-N-1M-2Y-0M	tR/0	0, 5MS
259	AuxKal-Bb/Woodpecker	CM33203-K-8M-1Y-0M	5R/0	5MS, 0
261	AuxKal-Bb/Woodpecker	CM33203-K-9M-24Y-0M	tR/0	tMS, 0
327	Kvz-Cj 71	SWM 1430-4Y-3Y-0M	tR/0	t, 0

Selections of the cross CM 33203 have been renamed *Bobwhite* (Bow)
Selections of the cross CM 33090 have been renamed *Chat*

REGIONAL NURSERIES

The wealth of germ plasm screened annually at the NPBS, Njoro, Kenya and the established Kenyan varieties constitute vital components of the developing cooperative regional nurseries in eastern and southern Africa.

In 1977 and 1978, yield tests with the best available varieties were prepared and distributed to 15 countries in Africa. Often these varieties have not been evaluated in these countries, as they represent recent advances in the Kenyan breeding program as well as in other programs.

Levels of disease in the ACWYT tests were generally low. At Njoro in 1978 nine of the sixteen tested varieties were not attacked by stem rust. The level of stripe rust resistance was lower and four of the sixteen entries were clean. In Toluca, Mexico, ten varieties had low stripe rust levels.

In 1978, the 2nd ACWYT was prepared with the two triticales and four Kenyan bread wheats—the same as in 1977. Also an Ethiopian triticale, Bacum and the bread wheat Enkoy were included, as well as two Tanzanian

Table 5. Bread Wheats in Kenya 1977/78 with low Stripe Rust and Stem Rust from the PC (pure seed small plot multiplications), Mexico.

Entry No.	Variety	Cross	Stripe Njoro	Rust Molo	Stem Rust Njoro
267	Veery	CM33027-F-12M-1Y-4M-0Y	5MS	tMR/0	0
665	Veery	CM33027-D-2M-7Y-1M-1Y-0M	0	tMR/0	tMS
285	Kvz-Buho/Kal-Bb x Sparrow	CM33591-D-10M-1Y-13M-0Y	tS	0/0	tMS
286	[Cebeco 148/(Inia/LR64^2 Son 64 x CC) CC-Inia]Valdivia	CM33685-A-4M-1Y-1M-0Y	0	0/0	10S
287	Kvz-Gv(Ron-Cha x Bb-Nor 67/ Emech 132)	CM33942-C-1M-1Y-3M-0Y	0	0/0	10S
349	Bb-Gallo x Y50$_E$-Kal^3/Lfn x HD832-Bb	CM34574-F-1M-1Y-3M-0Y	tMS	0/0	20MS
346	AuxKal-Bb/Bon	CM33202-E-1M-2Y-0M	0	0/0	10MS
277	Bobwhite	CM33203-K-10M-7Y-3M-0Y	0	0/0	0
355	R37-Golils 121/Cno-Inia x HD 832-Cn	SWM4585-6Y-7M-0Y	0	0/0	0
357	Yr70-Trifon	CM36749-2Y-4M-0Y	10MS	0/0	30S
358	Jup-Alondra	CM36867-18Y-2M-0Y	0	0/0	0
373	Iding-Zz	CM35048-42Y-2M-0Y	10MS	0/0	10MS
378	Bb-Gallo x Alondra	CM32327-4Y-8M-0Y	0	0/0	10MS
401	Chat	CM30090-M-4M-2Y-5M-0Y	tMS	10MR/0	tMS
562	Mildress-Nad63	SWM1676-51Y-1Y-0M	0	tR/0	20MS
572	Kal x Kal-Bb/kal-Bb x Mildress	CM38344-H-4Y-1M-0Y	0	0/0	20MS
634	Kal x Kal-Bb/Kal-Bb x Mildress	CM38344-H-4Y-1M-3Y-0M	tMS	0/0	0
583	Gto-7C x Bb-Cno/Saka (Cebeco 148/ Ron-Cha x Bb-Nor67	CM34686-D-2M-1Y-16M-0Y	0	0/0	tMS
685	(7C-Cno x Cal/Kal-Bb)Bezol x Kal-Bb	CM41499-A-1M-2Y-0M	0	0/0	10MS
726	Bon-Yr70/T.Aest. x Kal-Bb	CM41860-A-5M-1Y-0M	0	0/0	20MS
732	Golden Valley-Az67 x Musala	CM41257-I-8M-3Y-0M	tMR	0/0	20MS
733	Golden Valley-Maya 74 x Pamir	CM41258-B-2M-1Y-0M	0	0/0	tMS
811	Mildress-Cocoraque 75 x Jup 73	CM41180-0-6M-2Y-0M	0	tMR/0	30S
1016	Gallo-YrResel/AuxKal-Bb	CM34603-A-1M-3Y-1M-2Y-0M	0	0/0	30S
1168	Condor-Alondra	CM36903-1Y-1M-1Y-0M	10MS	0/0	20MS-S
1241	Emu-Mildress x Kal-Bb	CM38199-A-1Y-10M-1Y-0M	tMS	0/0	30M
1318	Gallo-Cuckoo x Kvz-Sx	CM34630-D-5M-2Y-1M-1Y-0M	0	0/0	0
1400	Bb-Gallo x Sajame/Au x WS 1817	CM34580-A-1M-1Y-1M-1Y-0M	0	0/0	20M

Table 6. Durums with low stem rust, Njoro, Kenya, 1978.

Variety Name	Cross	Stem Rust	Stripe Rust	Origin 9th IDSN
Gerardo 471-Br x Pg/Rabi-31810	CD12489-1Y-10M-0Y	0	5MR	34
(Garza-CP x St464/Ch67 Gta) Mca-Gta	CD12736-1Y-3M-0Y	10MS	0	42
(Garza-CP x St464/Ch67 Gta)Mca-Gta	CD12736-1Y-6M-0Y	10MS	0	43
Gerardo 512-Cit x Ruff-Fg	CD10549-H-5M-2Y-5M-0Y	10S	0	92
Garza-Fg/21563-Gs x Cit-P66/270	CD1074-1Y-3Y	5S	0	166
JNK 4W-183		0	0	CB-D.15
Gerardo VZ 512		0	10S	89
Beladi 116		0	30MR	90
Egypt No. 8		0	40S	92
Roussia-BD 1419		0	0	115
BD 1645		0	20S	120
BD 2026 x BD 1419-BD 1708	D72-45-8Bj-oke	5MS	10MR	Rep.BW 196
Ruff-Fg	CM9880-25M-3Y-1M-0Y	tMS	0	Rep.BW 220
Ruff x Jo-Cr	CM18537-1Y-0Y-oke	0,20S	0	Rep.D 05
D21563-AA-Fg	CM9799-126M-1M-3Y-oke	5S,50S	5MS	Rep.D 010
Cit-Fg	CD3568-8Y-2M-0Y-oke	5S,20S	5MR	Rep.D 011
Mexi x Chap-21563	CD3909-12Y-0M-oke	5S,50S	tMR	Rep.D 057
P66/270(Gs/D.Buck x TM$_E$-Tc^2)lak Rabi x Gs-Cr/Jo-Cr	CD1894-15Y-0Y-oke	10MS,50S	tS	Rep.D 075
Fg-Rabi	CM18552-14Y-3Y-0Y-oke	tS,40S	20S	Rep.D 076

Rep = Repeat

Table 7. Top Yielding Triticales, Bread Wheats and Durums in International Trials, Njoro, Kenya, 1977 and 1978.

13th ISWYN – 1977.		**14th ISWYN – 1978.**	
Rank	**t/ha**	**Rank**	**t/ha**
1. Bacum Tcl.	5.36	1. Mapache Tcl.	4.46
2. Nacozari	4.27	2. Pavon 76	3.55
3. Chiroca	4.08	3. Nacozari "S"	3.53
4. Cuckoo	4.02	4. Emu	3.34
5. Maya 74	3.97	5. Nacozari	3.32
6. Cowbird	3.89	6. Nacozari 76	3.32
7. Giza 155	3.72	7. Mexicali 75 D	3.05
8. Pavon	3.64	8. Moncho	2.91
9. Cleopatra	3.62	9. Antizana	2.72
		10. Glenlea	2.39
8th ITYN – 1977.		**9th ITYN – 1978.**	
1. Beaver–Arm Tcl	6.76	1. Octo Bulk-Bush Tcl	5.56
2. Mapache Tcl	6.38	2. Mapache Tcl	5.26
3. Rahum Tcl	6.18	3. Yoco Resel Tcl	5.17
4. M I A x 2148 Tcl	5.97	4. Tcl 65 Tcl	5.11
5. Mapache "S" Tcl	5.93	5. Navajoa Tcl	5.09
8th IDYN – 1977.		**9th IDYN – 1978.**	
1. Bacum Tcl	5.02	1. Bacum Tcl	4.16
2. Macoun D	4.99	2. Quilafen D	3.96
3. Balc INTA D	4.74	3. Gta x 21563-AA D	3.92
4. Jo-Cr x Marte D	4.57	4. Balc INTA D	3.92
5. Cocorit "S" D	4.43	5. Crosby D	3.80
8th RWYT – 1977.		**9th RWYT – 1978.**	
1. M I A x 2148-IN-IM Tcl	5.34	1. Drira Tcl	3.85
2. Tob-8156 x CC-Inia	4.24	2. BYE^2-Tac$_E$ x AA D	3.47
3. Ddw-S15-Crane D	4.05	3. D 10 D	3.38
4. Jori–Crane D	3.98	4. D 14 D	3.27
5. Koala x 2091 Tcl	3.93	5. Ato x AA-Ple D	3.21
5th Rainfed WYT – 1977.		**6th Rainfed WYT – 1978.**	
1. M I I A = Arabian "S" Tcl	5.37	1. Inia–Arm = Lince "S" Tcl	4.42
2. Inia–Arm = Lince Tcl	5.32	2. FS 1534 Tcl	4.00
3. Bb–Kal	4.90	3. Brochis	3.54
4. Brochis	4.22	4. Snipe D	2.97
5. AA–Cr x Cocorit D	3.99	5. Brochis "S"	2.81

Tcl = triticale D = durum

varieties, viz., W 3697 and K 6290-17, selected from Kenyan sources. Two Brochis selections, a new durum KD 2–6 from Kenya and two new bread wheat lines, K 6916-6 and K 6928-1, were contributed to the 2nd ACWYT by Kenya. These varieties were sent to 14 countries, and results are rapidly accumulating.

In Kenya, the topyielders were Tcl 65 and Tcl 74, and in Rwanda, K 6919-6 and K. Tembo yielded best, closely followed by Tcl 65. Disease scores indicate a similar situation as in 1977 with the 1st ACWYT. Stem rust resistance is very good. Possibly K. Nyoka has broken down in 1978, in Kenya. Stripe rust resistance is acceptable, but not sufficient in areas with heavy infections. in one location in Kenya, leaf rust scores were high in most bread wheats and low in triticale. Further analysis will follow, when more locations return data.

In 1978 a screening nursery with promising lines in Kenya, obtained from many sources, was prepared. These lines were available in small quantities of seed for distribution in the Region. Results will aid in deciding which varieties will be included in the yield trials.

The first SNACWYT, the screening nursery for

Table 8. Second African Cooperative Wheat Yield Trial (2nd ACWYT, 1978). Yield results from locations which reported data to February 1979. The yield shown represents the average of four replicates (*), in t/ha.

Variety	Burundi	Kenya	Malawi	Mozambique	Rwanda	Swaziland	Tanzania	Average yield
1. Bacum Tcl	1.98	3.40	1.95	3.59	4.17	3.11	2.70	2.99
2. Tcl 65 Tcl	1.74	5.37	1.98	2.94	4.03	2.98	2.61	3.09
3. Tcl 74 Tcl	2.08	4.87	2.27	3.81	3.35	2.81	2.12	3.04
4. Brochis	.22	1.81	1.63	3.14	3.38	2.21	2.73	2.16
5. Enkoy	.34	1.70	1.52	2.59	3.34	1.39	2.36	1.89
6. KD2-6 D	–	3.18	1.12	1.47	2.72	.53	1.44	1.49
7. W3697-TAI	.42	2.32	1.75	2.92	2.74	1.88	2.35	2.05
8. 6290-17	.82	2.23	2.01	3.12	2.93	1.56	2.89	2.22
9. K Fahari	.43	2.79	1.40	2.87	3.81	2.75	2.93	2.42
10. K Nyoka	1.26	2.81	1.53	2.99	4.28	2.63	3.09	2.66
11. K 6916-6	1.13	3.32	1.54	3.20	3.30	1.94	2.63	2.43
12. R 204	.32	2.38	1.71	3.96	3.19	1.56	2.78	2.27
13. K Tembo	.88	2.37	1.28	2.64	4.23	2.14	2.09	2.23
14. K Kifaru	.93	2.57	1.42	2.82	3.03	2.20	3.13	2.30
15. K 6928-1	.95	2.81	1.78	3.02	3.21	1.95	2.94	2.38
16. Local Check	.91	3.28	1.92	2.28	3.09	–	2.95	2.40(6)
Check Name.	Romany	Kavco	Nyati	Inia 66	Norteño	–	Trophy	–

Tcl = Triticale. D = Durum wheat. Others bread wheat.

(*) Locations with very low yields:

Lesotho ranked the top five: K Fahari, Local check Bella. 6290-17, W 3697 and Brochis.

Botswana best five: Brochis, Tcl 65, Bacum, K Fahari, K Kifaru.

Kenya (Lanet) did not report complete yields due to extensive bird damage. Triticales suffered less.

Table 9. Selected Characteristics of Varieties in 2ND ACWYT.

Variety Name	Yield t/ha (Average) 7 loc.	Plant Ht. cm. Swaziland	Heading No. days Mozambique	Maturity No. days Tanzania	Straw wt. grams/plot. (Average) Malawi	Hectoliter Weight g/hl Tanzania
Bacum Tcl	2.99	92	66	98	860	62.9
Tcl 65 Tcl	3.09	98	68	101	1012	62.7
Tcl 74 Tcl	3.04	96	71	101	1505	59.8
Brochis	2.16	83	69	98	840	72.4
Enkoy	1.89	96	68	101	692	76.1
KD2-6 D	1.49	100	82	119	730	73.4
W 3697	2.05	99	77	101	795	75.1
6190-17	2.22	100	70	98	992	72.4
K Fahari	2.42	104	66	96	862	77.7
K Nyoka	2.66	100	67	98	842	76.8
K 6916-6	2.43	87	76	101	962	72.7
R 204	2.27	84	74	101	872	73.1
K Tembo	2.23	94	70	102	670	71.4
K Kifaru	2.30	85	67	98	740	74.9
K 6928-1	2.38	92	72	102	935	73.5
Local Check (6)	2.40	–	64	98	825	76.2
			Inia	Trophy	Nyati	Trophy

Table 10. Disease Scores in the 2nd ACWYT.

		Stripe Rust:				Leaf Rust:		
	Name	Kenya Njoro	Kenya Lanet	Tanzania	Rwanda	Kenya Lanet	Swaziland	Mozambique
1.	Bacum	tR	t	t	0	5R	90S	0
2.	T 65	tR	t	0	0	tR	90S	0
3.	T 74	tMR-R	t	t	0	10MR	90S	0
4.	Brochis	N	–	10S	1	5R	100S	0
5.	Enkoy	tMR-10Ms	–	15S	1	90S	95S	0-5MS
6.	KD2-6	tMR-10MS	–	0	1	40S	70S	0
7.	W3697	5MR-R	–	30S	1	80S	90S	0
8.	6290-17	60MS-S (1)	30S	30S	2	20MS-S	70S	0-10R
9.	Fahari	10MR	10MS-S	15S	1	20MR	0	0-10R
10.	Nyoka	20-30MS	30S	40S	2	–	100S (2)	0
11.	K 6916-6	10MR-MS	10S	t	1	40S	40S	0
12.	Brochis	t S	55.0	5S	1	20MS-S	100S	0
13.	Tembo	10MR-MS	t	t	2	20S	100S	0
14.	Kifaru	20MS	10S	20S	2	30S	0	0
15.	K 6928-1	tMR	0	10S	1	30S	90S	0
16.	Local Check	0	5S	50S	4	10MR	–	0
		Kavco	Paka	Trophy	Norteño	Paka		

(1) Head infection. (2) Also S in Burundi.

		Stem Rust:				Septoria:	Helminth:
		Kenya	Tanzania	Rwanda	Swaziland	Malawi	Tanzania
1.	Bacum	0	0	0	0	2.75	2
2.	T 65	0	0	0	0	1.50	2
3.	T 74	0	0	0	0	1.75	2
4.	Brochis	tMR	0	0	20S	4.25	1
5.	Enkoy	tMS	0	0	40S	3.75	0
6.	KD2-6	tMR	0	0	0	1.25(lowest)	0
7.	W3697	0	0	0	0	2.75	0
8.	6290-17	0	0	0	0	2.75	2
9.	Fahari	tMS	0	0	0	3.50	0
10.	Nyoka	5S	0	0	0	4.00	0
11.	K6916-6	0	0	0	0	3.00	0
12.	Brochis	0	0	0	5S	3.25	0
13.	Tembo	0	0	0	30S	4.00	3
14.	Kifaru	0	0	0	0	5.00	0
15.	K6928-1	0	0	0	0	4.00	0
16.	Local	0	0	0	–	4.50	0
		(3) Other locations in Kenya			50S	Nyati	Trophy

ACWYT, included 10 triticales, 10 durums and 40 bread wheats. During visits to nine countries, this SNACWYT was inspected in various stages of growth. Visual inspection resulted in the selection of 15 lines that had a large number of positive traits. These selections are listed in table 12, with the best listed first. Again, triticales appeared very promising, and also many bread wheats. Alondra has given very good results in Tanzania.

Fury x Cno-No66 has been used in Uganda. Brochis also showed very good growth in Southern Africa. Pavon 76 also appeared vigorous, and will be included in the next ACWYT.

Table 11. 1st. African Cooperative Wheat Yield Trial. Top yielders in each location.

Rank	Kenya, Njoro, 1977.	t/ha	Kenya, Njoro, 1978.	t/ha	Madagascar, 1978.	t/ha	Tanzania, Njombe, 1978.	t/ha	Burundi, 1977.	t/ha
1.	Tcl 65	3.97	Tcl 65	4.76	Tcl 74	4.92	Tcl 65	2.93	Tcl 65	1.04
2.	Tcl 74	3.75	Fahari	3.46	Tcl 65	4.16	Tcl 74	2.64	Tcl 74	0.68
3.	Kifaru	2.80	Mamba	3.07	Romany	3.95	Mamba	2.44	Romany	0.67
4.	Fahari	2.77	Tcl 74	3.00	Nyati	3.62	K6290-17	2.13	Nyoka	0.52
5.	Kanga	2.50	Kifaru	2.79	Kifaru	3.28	Fahari	2.02	Kifaru	0.49

Rank	Rwanda, 1977.	t/ha	Ethiopia, Holetta, 1977.	t/ha	Ethiopia, Arussi, 1977.	t/ha	Uganda, Kabale, 1977.	t/ha	Somalia, Afgoi, 1977.	t/ha
1.	Tcl 74	5.68	Tcl 65	5.33	Tcl 65	4.33	Tcl 65	4.49	Bounty	2.58
2.	Tcl 65	5.50	Tcl 74	4.91	Tcl 74	4.30	Tcl 74	4.21	Mexicani	1.98
3.	Fahari	4.78	Mamba	4.86	Enkoy	3.83	Fahari	3.45	Kanga	1.61
4.	Kifaru	4.73	Local Tcl	4.26	Nyati	3.76	Nungu	2.21	Tcl 65	1.57
5.	Nyoka	4.62	Enkoy	4.14	Nyoka	3.27	Nyoka	1.80	Fahari	1.49

Rank	Swaziland, Malkerns.	t/ha	Mexico, Toluca, 1977.	t/ha
1.	Tcl 65	3.78	Tcl 74	4.71
2.	Tcl 74	3.12	Tcl 65	4.25
3.	Mamba	3.03	Nyoka	3.57
4.	Nungu	2.90	Kiboko	3.46
5.	Kifaru	2.47	Fahari	3.28

As a group the durums showed less vigor in the areas tested sofar. When more data are available, a final selection will be made, and seeds can be increased for yield testing.

Table 12. Screening Nursery for the African Cooperative Wheat Yield Trial, 1978. Lines or Varieties with Promising Characteristics for the Region.

SNACWYT Entry No.	Variety Name	Pedigree
2.	Tcl 65 = Maya II–Armadillo = Bacum"S"	x 2832-24N-6M-1N-1M-0Y
6.	Beaver–Armadillo	74CT 301-6
53.	Alondra	CM11683-A-1Y-1M-2Y-0M
47.	FAO 24117-Nr.70	SE513-2S-1S-0S
41.	Fury x Cno-No.66	CM4210-10Y-4M-8Y-5M-1Y-0M
33.	Maya 74 = Cno-Gallo	
34.	Cowbird	CM16716-M-3M-2Y-3M-0Y
35.	Pavon 76	CM8399-D-4M-3Y-1M-1Y-1M-0Y
44.	Cno-7C x CC-Tob/Bb-Nor67	CM1671-30M-1Y-4M-4Y-2M-0Y
22.	Brochis	CM5872-C-1Y-1M-3Y-2M-0Y-0SK
23.	Bb-Kal	CM9160-11M-4Y-1M-0Y
28.	Brochis	CM5872-C-1Y-1M-1Y-3M-0Y
48.	Cno^2"S"–No x CC-Inia	CM15650-1S-3S-5S-0S
56.	Carpintero	II-30724-1C-4C-0C-7M-0Y
55.	Bb-Cno x Jar/Cno-7C x CC-Tob	CM5546-A-5Y-3M-2Y-3M-0Y

OTHER REGIONAL ACTIVITIES

1. Off Season Nurseries from the Near East

Among the many wheats, durums and barleys that were grown in Kenya, were a substantial number of selections made by plant breeders in the Middle East. They avail themselves of the disease screening facilities at Njoro NPBS. It is possible to advance early generation material by one generation. In 1978 the Turkish national program on spring wheats and durums, evaluated their newest screening nursery and crossing block materials for Kenyan races of stripe and stem rust.

Similarly, ICARDA provided their best lines, selected at the new station near Aleppo, Syria, in May for planting in Kenya in June. Diseases developed well in this late planting, and useful scores were obtained by ICARDA. The same material will be further tested in Syria in the main season, 1978-79.

Several Egyptian breeders also provided materials, many to be grown as F_1's or F_2's and others to be tested for diseases. One Egyptian breeder spent a month in Kenya to participate in the screening and selection of the Near Eastern material. Seed was taken back to Egypt by the national program leaders.

Smaller quantities of plant breeding material were sent to Kenya by programs in Jordan, Portugal, Cyprus, Lebanon and Nigeria.

This close cooperation between regions has now passed through five years of offseason nursery work. It has greatly strengthened the germ plasm exchange between the two areas. Material with acceptable disease resistance in East Africa, stands up well to the pressures of the rusts in the Near East. The regional nurseries distributed in North Africa, Mediterranean countries and the Near and Middle East have often used lines selected in the Regional program in East Africa. To maintain this close working arrangement between regions, regular visits are made by Regional staff; results and materials are exchanged.

2. Wheat Pathology Workshop

A second activity of interest to several countries in the Region was the wheat rust methodology workshop held in September at the National Plant Breeding Station, Njoro. Plant pathologists and breeders working with wheat from Ethiopia, Kenya, Madagascar, Mozambique, Tanzania and Zambia were invited to discuss methods of artificial inoculation of the rusts. Equipment was demonstrated, and provided to the country programs by a special grant from the Netherlands Government. Also other aspects of wheat pathology were reviewed, and several field trips were made to practice surveys in farmers' fields and to identify diseases.

Techniques and background lectures were presented by five wheat pathologists from different parts of the world. This added greatly to the discussions among participants. Improved disease scoring and better rust infections in the breeding nurseries will greatly help to identify superior germ plasm.

3. Southern African Cooperative Wheat Program

A third regional activity involved the establishment of working relations with the wheat cooperative program in Southern Africa. For several years countries in the areas have exchanged and evaluated wheats in the cooperative SARWEIN tests.

The coordinator of this test, Dr. J.A.M. van der Mey visits the test sites, and usually review all the wheat, triticale and barley germ plasm planted.

Discussions have started for a workshop in Lesotho where specialists from several countries will participate in the discussions of improved wheat production.

Dr. G. Kingma (left) CIMMYT breeder and Mr. M. Mosaad (right), Egyptian plant breeder examining Giza 155, and Egyptian wheat undergoing disease pressure testing at Njoro, Kenya.

REGIONAL SURVEILLANCE PROGRAM

INTRODUCTION*

The CIMMYT Regional Surveillance Program is concerned with assisting national wheat programs to identify superior varieties, and to locate germ plasm resistant to various diseases and insects. The diseases of wheat continue to receive the major emphasis because of their high priority as a factor in stable wheat production. The insects which are encountered throughout the region are much more sporadic in their occurrences. Consequently, to this date there is no emphasis given to the breeding for insect resistance. When insect infestation reach a critical level, chemical spray campaigns must be undertaken in order to obtain control.

The factors of yield, adaptability (environmental stability), and disease resistance occupy the majority of the breeding effort. The Regional Program assists in these efforts and attempts to develop the national capabilities into an international network. The information gathered is communicated to other programs and to CIMMYT. The network depends greatly upon the capabilities in the national programs. Unfortunately, in a number of programs there are too few trained scientists, particularly in the subject area that borders between breeding and pathology. The CIMMYT Regional Program tries to bridge this gap and encourage the training of additional manpower.

RDISN

In the past season, the Regional Disease and Insect Screening Nursery (RDISN) was assembled in cooperation with the International Center for Agricultural Research in Dry Areas (ICARDA) Aleppo, Syria. This year the bread wheat and durum wheat RDISN was divided into separate nurseries. This was done in an attempt to reduce the unnecessary efforts for those programs not interested in both crops. The Barley RDISN remained a separate nursery.

The nurseries were sent to 37 countries in West Asia, North Africa, and East Africa. The data returns for the year re-emphasize the importance of the cereal rusts in the region. The reports on rusts far exceed any other disease, and no more than two reports were obtained for any other disease. In most instances, only one report was received. In the case of the rusts, leaf rust (*Puccinia recondita*) was most common followed by stem rust (*P. graminis*) and yellow rust (*P. striiformis*). Table 1 gives a summary of the rust diseases encountered and the overall disease levels at those locations.

When the severity level is low there is a possibility of misinterpreting the results because a no test or an "escape" may be recorded as resistance. To avoid this possibility there are numerous check varieties included in the RDISN.

An average coefficient of infection (ACI) for the check varieties is calculated for each rust and used to determine whether the severity level was sufficiently high to include that location in the analysis. This is the primary factor determining which locations are included in the analysis (table 1).

TABLE 1. The number of locations reporting rust diseases (RR) in the RDISN during 1977–78 and the number of locations where the severity levels (SL) were sufficient for screening purposes.

	RUST REPORTED AND SEVERITY LEVEL					
	Leaf Rust		Stem Rust		Yellow Rust	
RDISN	RR	SL	RR	SL	RR	SL
Bread Wheat	19	12	15	9	10	6
Durum	12	7	8	7	7	5
Barley	4	3	4	4	5	4

Similarly, an ACI can be calculated for each location. The higher the location mean, the greater the virulence spectrum. These parameters can be calculated for each rust disease and location. In table 2, an example of a two high and one low site for leaf rust is given to illustrate the

TABLE 2. The Average Coefficient of Infection (ACI) of five common check varieties and the location ACI for three leaf rust populations in 1978. Data from bread wheat RDISN 1977–78.

Check Varieties	Class*	CIMMYT	Der-Alla	Ludhiana
Chenab 70	B.W.	67.5	0	87.5
Jori C 69	Dur.	1.8	4.2	35.0
S.A. 42	B.W.	88.3	0.5	100.0
Mexipak 65	B.W.	68.3	1.0	64.3
Haurani 27	Dur.	0.4	31.7	60.1
Location Mean		22.1	1.1	11.0

*** B.W. = Bread Wheat; Dur. = Durum Wheat**

* CIMMYT assists the national programs of the Mediterranean-Middle East region and Asia in their pathology research programs through the assignment of CIMMYT scientists. The CIMMYT involvement is financed by a grant from the Government of the Netherlands.

interpretations. The severity of disease was high at CIMMYT, Mexico and at Ludhiana, India. The leaf rust development at Der-Alla, Jordan was poor to moderate in intensity.. In Mexico, there is a lack of virulence on the durum wheats but there is a severe and virulent population on bread wheat. This is indicated by the high ACI score for the location mean. At Der-Alla a narrow virulence spectrum was present which could attack only local durum cultivars and the overall rust development was low. In North India the virulence for bread wheat was broad but not as virulent as in Mexico. There was also virulence for the durum wheats although not as broad as that for bread wheats. The lines with the best rust resistant lines identified in the RDISN in 1978 are listed in Appendices 1, 2, and 3.

RDTN

The Regional Disease Trap Nursery (RDTN) continues to be a system that monitors disease development, especially the rust diseases. The RDTN was distributed to 150 locations, during the past season. The data returns from this nursery are incorporated into a longer term analysis. This information is currently being computerized with Dutch assistance.

It is anticipated that sufficient background data have now been collected for the analysis of virulence patterns over a timeframe. This should allow us to better identify pathogen populations, measure disease potentials, establish probabilities for epidemics and document the movement of diseases. A computerized data-base should also provide us with the type of parameters which will allow us to correctly map virulence more accurately and identify genetic sources of resistance.

WHEAT PRODUCTION AND DISEASES IN 1977–78

Throughout all of the region from Morocco to Bangladesh the season was, in general, favorable for wheat production. Consequently, the environment also favored the development of some of the more serious wheat diseases. The wheat rust diseases continue to be the major disease problem encountered because of the presence of new races which have the ability to attack formerly resistant varieties. This situation occurred in some of the countries in the region during the past year.

It was well established that in some countries there were new rust races present which could attack the widely grown commercial varieties. There was also a concern that an epidemic was a real possibility in some circumstances. The possibilities for a rust epidemic situation increased in a number of countries when the early establishment of infection occurred and weather remained favorable.

In the Indo-Pak subcontinent, a favorable year for wheat production occurred. Record crops were harvested in Bangladesh and India. In Pakistan although initial projections were for a record crop, the early establishment of rust and the subsequent epidemic reduced yields significantly. The potential for a rust epidemic in Northwest India was the same as for the Punjab of Pakistan, but no epidemics materialized in India. The difference was the susccessful establishment of a varietal release and seed production system which averted the problem. It also represent a well planned program of diversification and a designed deployment of varieties that has been established by the Indian Coordination Wheat Program.

TABLE 3. The percentage change in wheat production based on different estimates of production for Pakistan in 1977 and 1978 (1,000 metric tons).

Estimates for 1977[1]	Production Estimates 1978 Preharvest[2]	Production Estimates 1978 Post harvest[3]	Change from 1977 Production (per cent) Preharvest	Change from 1977 Production (per cent) Post harvest	Change from 1978 (Estimated, per cent)
9155	9500	8300	3.8	– 9.3	–12.6
	9200	8158	0.5	–10.9	–11.3
9100	9500	8300	4.4	– 8.8	–12.6
	9200	8158	1.1	–10.4	–11.3
9006	9500	8300	5.2	– 7.8	–12.6
	9200	8158	2.2	– 9.4	–11.3
8998	9500	8300	2.2	– 7.8	– 9.8
	9200	8158	5.6	–10.3	– 1.1

1. Production figures represent estimates from the Pakistan Agriculture Research Council, Islamabad; FAO Production Yearbook 1977; and International Wheat Council, London.

2. Range of estimated yields projected from calculations of area sown, fertilizer sales and additional irrigation potential.

3. Unofficial estimates for current year (Sources: Pakistan Agriculture Research Council and International Wheat Council.)

In the case of Pakistan, the varieties which were released and originally provided the basis for the increase in yields in the late 60's and early 70's were still being widely grown. No effective seed multiplication and distribution system had developed during this period to insure the replacement of these varieties. Consequently, the old varieties which were now susceptible to the new races of rust came under severe attack during the 1977–78 season. The estimates on the losses vary substantially. Precise figures are difficult to determine but some degree of the magnitude of loss can be calculated by using general production figures (see table 3). It seems reasonable to say that a reduction of about 10 per cent occurred from the production level of 1977.

The reduction in yield resulted primarily because of the rust attack on the extensively grown varieties of Mexipak and Chenab. In the northern part of Pakistan, yellow rust (*Puccinia striiformis*) was severe, and in the central and southern part, leaf rust (*P. recondita*) became very severe at an early date. The combination of early and severe rust attacks reduced the number of seeds set per spikelet and the thousand kernel weight. In table 4 the 1,000 kernel weights of resistant and susceptible varieties are compared for the years 1977 and 1978. The kernel weight is a sensitive measurement and many factors affect it. However, it can provide some guidelines when judgments are required on the amount of losses caused by a disease. The use of kernel weight does not take into account other components of loss and should be considered only an approximation. If the kernel weight difference between resistant and susceptible variety groups is small in a low rust year (1977), and if the differences are small between resistant varieties in 1977 and 1978 (one a low rust and one a severe rust year), the comparison may have some validity.

TABLE 4. Comparison of the 1,000 kernel weights of rust susceptible and resistant varieties grown commercially in Pakistan in 1977–78. The 1976–77 season was considered a low rust year. 1977–78 was a severe rust year. Data are taken from Punjab yield trials.

Group	Varieties	1000 Kernel Weight(gm) 1976–77	1977–78	Per cent Difference
Susceptible	Mexipak	33.9	26.81	–20.8
	Chenab 70	41.0	33.7	–17.8
	Pak 70	39.0	33.7	–13.6
	Khushal 69	41.0	32.7	–20.2
	Tarnab 73	40.5	33.5	–17.3
	SA 42	45.5	32.4	–28.9
	Punjab 76	39.6	31.2	–21.1
	Mean	**40.1**	**32.0**	**–20.2**
Resistant	Lyallpur 73	32.6	35.0	7.4
	Sandal	38.5	43.4	12.7
	Pari 73	33.5	45.4	35.5
	Blue Silver	40.8	40.0	2.0
	Yecora 70	44.9	40.0	–10.9
	Mean	**38.1**	**41.4**	**8.7**
Difference (per cent) between groups (Susceptible/Resistant)		5.2	–22.7	

DISEASE DEVELOPMENT POTENTIAL

The potential was also favorable in parts of North Africa and Southern Europe. In eastern Algeria and Tunisia, yellow rust was severe on the varieties Soltane and Siete Cerros (=Mexipak). Fortunately, neither variety occupied a major position in the areas sown. However, individual farmers growing these two varieties realized substantial losses. The estimation of losses for the region would be difficult but past experience would indicate that the average yield depression on the two varieties was in the neighborhood of 20 per cent.

A yellow rust epidemic also occurred in Portugal and Spain. The seriousness of the epidemic in Spain prompted a request for a CIMMYT review of the situation. Yellow rust in Spain did not seriously affect national production because the two varieties did not occupy a large area. One conclusion from the review was that the disease screening procedures were inadequate. One of the varieties was a newly released variety and it was in the first year of seed multiplication. If the epidemic had not occurred and the variety had become widely distributed, a major problem could nave materialized in subsequent years. The potential seriousness of this can be estimated by calculating potential losses from yield trial data. In table 5 some comparative estimates for the losses caused by the yellow rust epidemic are given for the two susceptible varieties. The calculations are based on yield comparisons of resistant and susceptible varieties known to have similar yield potentials.

The estimates calculated in the case of Pakistan and Spain focus on the potential seriousness of the cereal rusts. Too often the rusts are dismissed or discounted because they are not causing obvious damage every year. When the combination of variety, race and weather set up a situation where early infection can occur, the losses can be substantial. This explosive situation is not always recognized or fully appreciated. When such an epidemic does happen, it can become a very expensive situation and may cause immeasurable suffering.

TABLE 5. The calculated reduction in wheat yields and kernel weight caused by severe yellow rust (YR) in the Cordoba area, Spain in 1978. Calculations based on the comparison of resistant and susceptible wheat varieties known to have similar yield potentials. Average of four yield trials; data courtesy of the Ministry of Agriculture, Madrid.

Variety	Year Score**	Average Yield kg/ha	Percentage Difference Cajeme	Percentage Difference X	1000 Kernel Wt. g.	Percentage Difference Cajeme	Percentage Difference X
Mahisse–1	VS	3138	–41.4	–41.2	31.0	–40.4	–33.0
Siete Cerros	VS	3259	–39.1	–38.9	26.5	–49.0	–42.8
Cajeme 71(Caj)	VR	5333		– 0.4	52.0		+12.3
Mean 3 Vars.(X)*	VR	5353	+ 0.4		46.3	–11.0	

* Average yield of the varieties Cajeme 71, Yecora 70, and Anza.
** VS = Very Susceptible; VR = Very Resistant.

The wheat rusts, and stem rust in particular, are notorious for the rapid shifts in virulences that occur regularly in the highlands of East Africa. In the 1978 season, changes in both yellow and stem rust resulted in severe attacks on two varieties in Kenya. Yellow rust now attacks the variety Kenya Kuboco severely, and the virulence factor is widely distributed. A new virulence (race) of stem rust attacking the variety Kenya Nyako was found to be widely distributed in Kenya. The prevalence of this virulence increased very rapidly. Last year it was reported for the first time as a trace infection on Kenya Nyako from a single area. The frequent and rapid shifts that occur in stem rust of wheat in Kenya are unusual. Consequently, for many years Kenya has been considered the hot spot for stem rust on bread wheats. This unique situation provides an opportunity for the development of stem rust resistance with a broad genetic basis.

Because the wheat growing season in Kenya spans the period of May-October, it allows the Middle East to utilize Kenya as a summer nursery location. For several years a number of national prgrams have regularly sent advanced lines for disease evaluation and segregating lines for advancement and selection. The CIMMYT-East African Regional Program along with the Kenya National Program make this service available for programs wanting to participate in this activity. In the Middle East area, ICARDA has assisted the National Programs in arranging the collection and sending of seed each year.

The need to search for germ plasm and new sources of resistance to the ever changing rust problem continues to be one of the major issues confronting national programs and CIMMYT. The capabilities and the urgency with which national programs respond to this ever evolving situation are partly reflected in their ability to affectively test and release varieties. It also points to the need to substantially improve the procedures for quantifying the losses that regularly occur. Our data basis on diseases and insect losses are meagre and inadequate.

Essentially, there seem to be three stages in the process of developing resistant varieties. The first is the identification of sources of resistance. The second is the method and screening techniques used to identify promising lines with the necessary levels of disease resistance. The third step is the release and distribution of these varieties to the farmer. All three steps are critical. The epidemics cited in the preceding paragraphs illustrate two different missing steps in the system. In the case of Pakistan, there was an inability to release and adequately distribute the new varieties to the farmers. In the case of North Africa and the Iberian Peninsula, the rust epidemics reflected the manner and methods used in the testing and screening of varieties.

WHEAT DISEASE METHODOLOGY WORKSHOPS

The Government of the Netherlands in cooperation with the Institute for Plant Protection (IPO), Wageningen, The Netherlands, has funded a series of Wheat Disease Methodology Workshops. The workshops concentrate on the techniques and equipment that are available to create artificial rust epidemics. The intent is to put together the latest information that allows breeding programs to adequately screen their varieties and lines for disease resistance.

In the 1978, two workshops were held which were the third and fourth in the series. The first two workshops were held in Pakistan and India in 1976. The workshops held in 1978 were in Turkey from May 3–13 and in Kenya from September 18–29. Both workshops were hosted by the National Wheat Programs of Turkey and Kenya, respectively. The planning and organization was executed by IPO and CIMMYT staff.

The workshops are unique in that the Government of the Netherlands supplies each participating country or program that attends the workshop with a set of equipment. The workshops are also an effective means of addressing a specific area which has been identified as needing additional attention.

The workshops have been considered successful in their efforts. It is customary to give the trainees a preliminary and final examination. In this manner, the progress made in the workshops can be measured, and the instructors can determine if they are achieving their desired goals. For example, in the workshop held in Kenya there were 13 trainees from five East African countries. The trainees increased their exam scores by 27 per cent. Future workshops are planned for the Middle East, North Africa, South America and South Asia. Coupled with these workshops are the possibilities for additional training with yellow rust at IPO, Wageningen, The Netherlands.

APPENDIX 1 RDISN 1977–78

RDISN–BREAD WHEAT

1. Lines Resistant to the Three Rusts

Entry No.	Variety or Cross and Pedigree
2	Kavkaz (cc-Inia/Cno x El.Gau-Son 64) SE-381-2S-6S-0S
3	Kavkaz (cc-Inia/Con x El-Gau-Son 64) SE-381-2S-5S-0S
4	Kavkaz (cc-Inia/Cno x El-Gau-Son 64) SE-381-4S-1S-4S-0S
11	Bb x CC-Cno^2/Tob-8156 x Bb CM 5793-G-8Y-1M-1Y-2M-0Y
12	Kenya Kuro = Romany^2 x Algerica Mayo K 6290-1
25	C 18155-Nar 59^2 Code / 70 = 133
31	1061 K4
37	K 4328D.1.A.2
48	Pyramid 73
49	Bb-Cal x 7C 2B-2B-1B-1B-0B
74	Kavkaz (CC-Inia/Cno x El-Gau-Son 64) SE 381-4S-1S-6S-0S
571	II-62-16

2. Lines Resistant to Yellow Rust and Leaf Rust

1	Tob'S'-Tob 66 CR 39-E-27
6	11-61-107-Tob'S' x Cal SE-642-17S-2S-0S
8	((908-Fr^2) /4160 x Yt54$_E$ x C 14^2) x OFn) xct/ch 166 x K.F. x L.N/M^2-ME)Fr A 3532-10P-1P-3P
9	Bb-Nor x Cal-7C CM 5576-2S-3S-0S
10	Bb-Nor 67 x Car-7c CM 5576-1S-2S-1S-6S-0S
18	Bb-Nor x Cro'S'-7c/Bb-Inia CM 15345-1K-2J-0R
32	Bb x CC-Cno^2/Tob-8156 x Bb CM 793-G-8Y-1M-1Y-1M-0Y
38	Cno'S'-Inia'S' LFn/Tob x Kl-Pet-RaF CM 2781-13M-1Y-3M-1Y-1M-0Y
52	BW-23
56	Bb-Nor 67 x Kalyan 227 A-Bb CM 6942-5L-1L
59	Cocoraque F 75
62	Ti (1A x Kr-KAD/Gb x Fr-KAD/Gb) CM 23091-1M-2Y-0Y
174	Tob'S'-8156 x CC-Inia CM 1208-1Y-6M-2Y-3M-0Y
183	Tob 66 x Bomen/Tob'S' x Napo 31321-1B-1Mch
326	M_2(4777/Rei x Y-Kt) A 5516-1P-2d-0b
364	(Cno-Tob'S' x Gallo/Tob cc x Pato)-Jar'S' (B) CM 23519-1S-6S-0S
402	Moncho'S' CM 8288-A-3M-6Y-6M-1Y-0M
486	II-62-84 015619
523	KVZ-UP 301 CM 20596-12Y-1M-1Y-0Y-3Ptz
572	Scout^5-Agent
673	Apepoglon/II-64-27
741	NS 2699
742	NS 2568/2

3. Lines Resistant to Leaf Rust and Stem Rust

15	Zho-KF J-9105/67
226	MN 7046/MN 69105
264	NPO-Tob'S' x 8156/Kal-Bb CM 7806-15M-2Y-2M-1Y-0M
327	PIE x 1150-32-Yt 54E A-4806-60P-1P-1P
485	Karlshuldska 321868
541	Rohin-Tob'S' CM-7704-3M-1Y-2M-1Y-0M
545	Bb-7c^2 CM 5449-C-8Y-3M-18Y-0M

4. Lines Resistant to Yellow Rust and Stem Rust

13	K 6656-Tob 66 = Agent (C 11 3523) x Tob 66^3 K 6670-4
14	K 4500 L.35.A.3.A R 35 x K.6849 K 6852
24	Azteca 67
28	K 6290/9 AF x Rom^2 (Kenya)
36	Wi x 245-FKN x C 18154 FR^2/Tob 66^2 6661-53
45	Cha = 2/II 123-Tob 66 x Cno'S' CM 22057-8S-1S-0S
55	No 66 x Cno^2-C11r CM 21453-1L
229	Brochin'S' CM 5872-C-1Y-1M-1Y-4M-0Y
285	Kavkaz-Cno 67 SWM 1433-2L-Oke-OSK
322	Wt (Nor10-K154^2 x Fn-NM/PtE A 3715-1P-2P-1D

APPENDIX 2

RDISN—DURUM AND TRITICALE

1. Durum Lines Resistant to the Three Rusts

1 CFn(Lan/Dwarf F_4 Lan) A 4590-51P-4P-2P-2P
56 Vz 484 Capelli x Yuma F_5
346 Tunisian Durums 1

2. Durum Lines Resistant to Yellow Rust and Leaf Rust

24 Maristella
27 Jo'S'-AA's' x Fg'S' CM 9899-197M-3Y-1M-1Y
77 Maghrebi'S'-Gs'S'-AA'S'/Gta'S'-Cit'S' CM 14473-B-8Y-1M-2Y-0M
81 Jo'S'-AA'S' D 27625-5M-2Y-2M-1Y-1M
82 Ruff-Fg'S' CM 9880-25M-1Y-1M-1Y
83 $BY^2{}_E$-Tac$_E$ x AA'S'
257 Ruff'S' x Jo'S'-Cr'S' CM 18537-1Y-0L
268 AA'S'-Cr'S' x Cit'S' CM 10182-7M-0Y
278 Cr'S'-Gs'S' x Fg'S' D 9663
301 D-8
302 Snipe'S' CM 13414-1Y-3M-0Y
303 Waha'S'-Rol CM 17904-B-3M-1Y-0M
304 Rabi'S'-31810 x Fg'S' 7849-OSK

3. Durum Lines Resistant to Yellow Rust and Stem Rust

89 Reichenbachi-BD 1645 FAO 25-190
134 Gab 125
352 Tunisian Durums 7

4. Triticale Lines Resistant to Leaf Rust and Stem Rust

362 Leo'S' x 2091-102Y-0N-2M-3N-3M-0Y
364 Kla'S' x 2091-1M-0N-0Y
370 Octo out-Agrotriticum x 7224-10M-1Y-100M-0Y
372 M_2A-CML x 7245-10M-2Y-0M-2B-0Y
374 M_2A-IA x 7249-20M-1Y-3M-0Y
392 Leo'S' x 2091-102Y-102Y-0N-2M-3N-3M-0Y
402 M_2A x 2802-41N-1M-2N-2M-2Y-2M-1Y-0M
404 M_2A x 2802-55N-3M-5M-2Y-0M
405 Kla'S' x 2091-100Y-101B-2N-2M-3Y-0M
421 FS 1795 IN-OM
423 Tcl E_3-Arm'S' H277-69-1Y-2B-5Y-101B-16Y-7B-0Y
429 M_1A x 2148-5N-2M-2Y-2M-0Y
435 M_2A x 2802-9N-1M-2N-2M-1Y-1M-100Y-0M
436 M_2A x 2802-41N-1M-2N-2M-2Y-2M-1Y-0M
442 IA x 1648-0N-4M-0Y
447 M_2A x 2802-70N-4M-2N-3M-1Y-4M-1Y-1M-0Y
58 (Var/2F8 x Oviachi) FI x 6540 x (Yt54E) BY^2 II 21566
75 E 3728-Cp^3/Gz x /$(4777)^2$ (Fn-K58/N x N 10B) A 4050-5P-5b-2P
163 Rabi'S'-31810 CM 10172-37M-0Y-2Y
165 E 3728-Cp^2/Gz (Y54-N10B.21.1C) x CP^2/Gz Tc
209 Rabi'S'-Fg'S' x Gerardo VZ 469 CD-7750-1SK-0SK
218 Gta'S' x D-21563-AA'S'/Stork'S' CD-8193-2SK-0SK
228 Marte'S'-Stk'S' x Ch-21563 CD 4404-B-9Y-3M-0Y

APPENDIX 3

RDISN—BARLEY

1. Lines Resistant to the Three Rusts

48 Nepal Barley-4502
49 (Cq-Comun x Apam x 12410) Gizeh 134-2L
127 Cr-366/13/1 (Giza 117 x Bahtim 52) (Giza 118 x FAO 186)
224 Iris C11 5008
272 Sofra

2. Lines Resistant to Yellow Rust and Leaf Rust

50 Nepal Barley-6314
53 Nepal Barley-6307
57 Iris CI 15017
170 Maris Canon
179 P. 12917
194 WI-2392
266 Cr-272-3-4 (Giza 117 x Apizaco)

3. Lines Resistant to Leaf Rust and Stem Rust

26 273-2 (Barley Germ plasm, Izmir)
51 Nepal Barley-4002
52 Alger-Ceres
55 Nepal Barley-2901
93 (Cn 100-Dc 73/Fun x Fun^2) x Trall-11361 1t-2t Athenais CYP 17-18A-1A-0A-0SK
114 Line 251/14

148	C11 3606
187	Svalof Mari
208	Bollo
301	CI-8887-CI 5761 SEA-13-10S-4S-0S
371	Zypher/Centennial Oregon S.F. 207.7S.1S.0S
374	CM 67-Bonanza CMB-72A-36-3S-1S-0S
376	(Fun x H 45-PI 3604 x Fun/Avt-Nor-Bz-Winn) Cer Pro^2 x Tol x V.1856) x Athenais 6L-7S-9S-0S
445	Mennet Dutch Variety
450	CM 67-Jet CMB 72-29-1Y-1B-1Y-2B-1Y-0B

4. Lines Resistant to Yellow Rust and Stem Rust

27	283-1 (Barley Germ plasm, Izmir)
28	291-3 (Barley Germ plasm, Izmir) SR
79	Sarutong
357	61-2951-26/Heines Hanna/Julia Oregon Malting-52-1S-2S-0S

ALGERIA

INTRODUCTION*

The cereal production needs of Algeria are presently 3.66 million tonnes. For a population of 18.3 million people, this represents a requirement of 200 kg/head. The Algerian population growth is at the rate of 3.2 per cent per annum —one of the highest in the world.

The average cereal crop harvest is about 1.85 million tonnes from about 3 million hectares. This means that Algeria needs to double its average production in order to arrive at a self sufficiency level. From then on, it must maintain a cereal growth rate of at least 3.2 per cent in order to be on par with the population.

THE SEASON

Algeria went through a second season of highly unfavorable crop production conditions during 1977-78. There was a total failure of pre-seeding rains in most regions. Hence a good part of the cereals was seeded on a dry seed bed. During November the rainfall was normal and this allowed all early seeded crops to germinate. The remaining cereals were planted during late December. From mid December to the end of February was also very dry and the winter was warm.

Thus due to the lack of adequate weed elimination during the pre-seeding preparations and the lack of moisture and warm conditions, the early seeded crop was very poor. Rains started towards the end of February and continued on periodically until June. The late rains helped the early sown crop and contributed to a good crop in the late sowings.

The details of area distribution and production are reported in table 1. The area stated is the actual harvested area and is only about 75 per cent of the projected seeded area. The production reported is 14.35 million quintals, but this do not take into account the quantities retained by the private farmers for home consumption and seed, and the home consumption in the other sectors. Taking all this into account, production might have been close to the national average.

DISEASES

Stripe rust was the only notable disease, which was limited to the bread wheat variety Siete Cerros and then only in the central and eastern regions. This was the third year in succession that Siete Cerros was highly infected by the stripe rust. This variety needs urgent replacement.

CEREAL BREEDING

Introduction

The agroclimatic conditions vary from region to region and from year to year. Almost all the cereals are rainfed. Different varieties are needed for different agroclimatic zones. Since the climatic patterns within regions are also variable from year to year, varieties must have tremendous flexibility in addition to local adaptation.

Bread Wheat

Algeria started growing the high yield varieties (HYV) of bread wheat in 1971. Today they occupy about 75 per cent of the bread wheat area. Siete Cerros has continued as the dominant variety covering approximately 85 per cent of the HYV area. About 10 per cent was sown to Strampelli and the remaining 5 per cent to Inia, Tobari and Anza.

The HYV's were grown mainly in the socialist and reform agrarian sectors due to the lack of their promotion in the private sector and the unavailability of the seed. Through the release of newer varieties and the seed multiplication of newer varieties, the dominance of Siete Cerros will decline. The local varieties in cultivation were Mahon Demias and Florence Aurore. They occupy 80 per cent and 20 per cent respectively, of the local varieties area.

In the 1977-78 season, Algeria named five bread wheat varieties (see table 2). All the new varieties are superior to Siete Cerros and Strampelli under stress conditions and they are on a par with them under good production conditions. Beni Slimane and Setif are adapted to all Algerian agroclimatic zones, while Tessalah is suitable only to the

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western sub-littoral zone due to its high susceptibility to stripe rust in the east. Ghriss and Cheliff are adapted to the sub-littoral and littoral zones of Algeria.

Results of the best eight out of 50 varieties in the 3rd year advanced yield trials in comparison with Strampelli the best check in the trials, are given in table 3. These trials were grown on seven different stations. Pato x CC-Inia is the most stable and promising line of this group. This line is very similar in appearance and behavior to that of Anza or Ghriss. Its chances of being released as a variety, are doubtful.

Results of the best five out of the 75 lines in the second year yield trials conducted in four stations are given in table 4. Yield and rank of Strampelli, the best check variety in each of the trials, are also given. All these five crosses show good promise. There are many sisters of the cross Bb-Kal under testing, and only the results of the best two are given in this report. The line NS-14-13 is a Yugoslavian spring wheat selection.

The first year yield trials were grown on three different stations. There were 300 different lines under trials this year. Results of the best 23 lines from these 12 trials are given in comparison with Strampelli in table 5. The best was again a Bb-Kal and this happens to be a reselection made at the Oued Smar station in Algeria. Many lines from Siete Cerros multiline did very well in these trials. In addition to the good results, they were also resistant to stripe rust, the main problem of Siete Cerros in Algeria.

The program continued to screen a wide range of germ plasm. Special emphasis is being put on exploiting the winter spring germ plasm at the Setif and Saida high plateau stations.

Durum Wheat

It occupies about 45 per cent of the cereal area or about 65 per cent of the wheat area in Algeria. It is grown mainly in the sub-littoral and high plateau areas. The agroclimatic conditions of these areas are highly variable. Varieties of high yield stability are demanded in order to buffer the adverse conditions.

The dominant local varieties are Bidi 17, Mohamed Ben Bachir, Hedba 3 and Oued Zenati. Polonicum x Z.B., although a recent variety, can also be classed in this group. Jori C69, was introduced during 1971-72, but is not well adapted and soon will go out of cultivation. Cocorit 71 is well adapted to the littoral and sub-littoral zones but its high yellow berry tendency makes its extension difficult. Mexicali 74, although it has the same adaptational pattern as Cocorit with less yellow berry, is highly susceptible to leaf rust. Inrat 69 of Tunisian origin and Capeiti of Italy, are also in limited cultivation but again are not very stable in yield potential.

During this cropping year, the program released five new lines for seed increase (table 6). Tell 76 and Timgad 73 are well adapted to the high plateau and sub-littoral zones—the two main durum zones of Algeria. Tassili 77 and Khroub 76 show general adaptation to all the zones but they are better suited to the sub-littoral and littoral zones.

The variety Sahel 77 performs best under the littoral conditions but it can also be extended to the sub-littoral zones. Most of these lines are local selections and with the availability of seed for general production, they will relieve the problem of the lack of high yielding stable durum varieties for the high plateau and sub-littoral zones.

Results of the promising lines in the advanced yield trials are reported in table 7. Two crosses Plc"S"-Cr"S"/Mca"S" x Pg"S"-Par and Plc"S"-Ruff x Gta"S"-Rol showed excellent adaptation to the different agroclimatic zones of Algeria and are potential candidates for new varieties. A Turkish high plateau selection, Uveyik 126 x 61-130, is also doing very well in the high plateau and some sub-littoral zones of Algeria. But its performance in the littoral zone and some sub-littoral zones is not promising.

The promising lines in the preliminary trials were 21563-AA"S" x Fg"S", Mexi-Fg"S" and (Gr"S"-Fg"S"/21563-Gs"S" x Cit"S") Par 66/270.

More than 300 lines from F_3 and F_4 were bulked during this year for yield trials. This is the first time that such a large number of local selections is entering the durum yield trials.

The program continued to make crosses and selection from a very wide range of germ plasm.

PRODUCTION AGRONOMY

The Institut de Dévelopement des Grand Cultures (IDGC) conducted on-farm and on-station agronomic trials relating to chemical and cultural weed control, fertilizer studies, potential cereal varieties and farm implement evaluations.

A number of new products for weed control were evaluated during the year. Dichlorophenoxy methyl, a Hoe product, seems to hold extreme promise as a broad spectrum grass weed killer. There were many large scale demonstrations of Dosanex and Suffix throughout the cereal belts of Algeria.

MEDICAGO RESEARCH

The commercial sowing of annual *Medicago* commenced in 1972-73 in the milder cereal zones. The varieties used were the currently available Australian cultivars Jemalong, Harbinger and Robinson (ex. Snail medic).

These cultivars have proved to be of great value at the lower altitudes (less than 800 meters) to replace the fallow with a high producing, nutritive animal feedstuff. Indeed, a grazing experiment carried out this year showed lambs to double their daily gain when grazing on medic, as compared with grazing "weed fallow".

There have been problems encountered during the initial phase of introduction. Although the medic-cereal rotation has been promoted as a simple system, it does involve changes in farm management which are relatively complex. Cultivation practices must be altered, fertilizer application timing must be changed, cereal seeding date may have to be later than that presently practised and the management issues involved with the integration of livestock into what was predominantly a cereal enterprise, must be mastered.

Because these management changes have not been accepted, weed levels in wheat following medic rotations have reduced cereal yield. Control measures are available for the broadleaf weeds and wild oats.

The introduction of the medic, and the subsequent elimination of the fallow, appears to have increased the relative importance of brome grasses *(Bromus ridigus; B. rubens; B. madritensis)* in cereal culture. No chemical control is available for bromes in wheat, although a high level of control is possible by cultural means.

Medicago research within Algeria has evolved from a program orientated towards the practical parameters (date, rate and depth of seeding, rate of fertilizer, choice of commercial Australian cultivars) to one largely concentrating on the evaluation of local ecotypes which may better fit the environments encountered in Algeria.

This is especially true for the high plateau areas. In this large cereal zone, the Australian cultivars will persist but their contribution to total feed availability is low, and their weed competitive ability is practically nil under the very cold winter conditions.

Medicago Ecotype Evaluation

In 1976-77, over 700 lines of medics were collected from Australia, Tunisia, Syria and Europe (plus some selections from the South Australian medic breeding program). They were sown in observation rows at Tessala (600 metres). This site has several advantages as an initial screening station.

First, there is a high probability of frost during winter and spring, although the intensity and duration is less than that of the high plateau. This provides an initial insight into cold tolerance. Second, it is considered to be a safe area, because it is rarely touched by severe drought. Thus, valuable seed will not be lost through drought. Third, it has deep soils with a high moisture holding capacity. The lines are therefore able to express their maximum potential with regard to the length of growth stages.

From these 700 lines, sixty-eight were selected, mainly with respect to winter vigor (although consideration was given to flowering characteristics, lengths of growing season and seed yield) for advancement into a replicated micro-sward nursery. This nursery was sown in 1977-78 at two locations–Sidi-Bel-Abbes (500 meters altitude) and Ain-el-Hadjar (1,000 meters).

The seed was rubbed out of the seed pods by hand between denticulated rubber. This was effective but very time consuming. The resultant seed had very low germination rates (0-71 per cent). All seed was therefore scarified using a vibrating electric sander fitted with very coarse emery paper. By this means, the seed germination levels were brought to an acceptable figure (74-100 per cent).

Seed rates were adjusted in accordance with the laboratory germination test. The nurseries were hand-seeded in plots of one meter by one meter.

Sidi-Bel-Abbes

The nursery was dry-sown on November 16, 1977 at a seed rate of 100 germinable seeds per square meter. Rains were recorded on 22-24 November and emergence commenced about four days later. Emergence was most rapid in the cases of *M. aculeata, M. polymorpha and M. truncatula. M. ciliaris and M. orbicularis* were late in emerging and *M. ciliaris* in particular, appeared to have several different emergences.

Seedling establishment in January as a percentage of germinable seed sown, is shown in table 8 as an average for the principal species studies, in comparison with the four standard cultivars used. In comparison with Jemalong, all species except *M. tornata* established satisfactorily, with *M. aculeata* being outstanding.

Winter vigor (plant vigor, February 4, 1978; table 8) was estimated at 68 days after emergence. The plant vigor was estimated in comparison with that of Jemalong (= 10) on a scale of 0-20. *M. scutellata,* followed by *M. aculeata* were the superior species. In the plant vigor at 117 days (plant vigor, March 25, 1978; table 8), the same two species performed well, followed by *M. polymorpha.* This estimation took place when most lines were at full-flowering. Plant vigor was estimated again when most lines appeared to be at a peak of production (April 18, 1978). *M. scutellata and M.aculeata* were still clearly outstanding.

The overall range of flowering dates was from 84-130 days. Late flowering was related to poor winter vigor. However, early flowering was not necessarily linked to good winter vigor.

Seed yields were generally acceptable. As winter forage production will be highly dependent on population density, the seed production ability of a line is of great importance. The seedcoat permeability characteristic is also important in determining regeneration populations.

The change from totally impermeable (i.e. hard) seeds at maturity to the proportion permeable at the true seasonal opening, was studied with laboratory germinations of pods during the July to the end of October period.

Briefly, the procedure was to harvest all pods in the three replicates, clean and weigh the samples, bulk all three replicates and return the pods to the field to undergo over-summering. One hundred of these pods were then collected at intervals of approximately three weeks for germination tests.

The average figures at the last germination are shown in the last column of table 8. It shows the percentage of seed which germinated at the end of October, i.e. the seasonal opening for 1978-79. Large differences exist between species in this characteristic. The range of all lines was from 0.53 per cent (a line of *M. polymorpha)* up to 39.25 per cent (*M. truncatula*).

It has been suggested that a permeability of about 20 per cent at the seasonal opening, would be the ideal. There are some lines, mainly within *M. truncatula, M. scutellata and M. aculeata,* with this characteristic.

Ain-el-Hadjar

The nursery at Ain-el Hadjar was dry sown and it also germinated with the rains of November 22-24. The data recorded, averaged over the principal species is shown in table 9. By comparing this table with table 8, it is possible to see differences between the two sites.

Seedling establishment (as a percentage of germinable seed sown) is lower. This was to be expected following seeding rate trials over the previous three years. For this reason, seeding rates for the nursery at Ain-el-Hadjar were 200 germinable seeds per square meter. Thus in point of fact, seedling density was higher than that at Sidi-Bel-Abbes.

The most spectacular decreases in establishment were noticed for *M. tornata* and the standard cultivar Harbinger. This was to be expected from the mild climatic nature of their naturalized distribution. Their inability to perform under cold conditions is further demonstrated in the results of plant vigor.

Relative to Jemalong, all except *M. aculeata and M. ciliaris* performed less well at Ain-el-Hadjar with respect to winter vigor. *M. aculeata* showed strong growth throughout the growing season and produced a good seed yield with acceptable "soft" seed characteristics.

Flowering commenced from about 2 days—2 weeks later, depending on the species at Ain-el-Hadjar. Although large differences in flowering duration between sites are not apparent, generally higher seed yields were obtained at Ain-el-Hadjar, possibly due to the milder spring conditions and the higher plant populations.

The milder conditions and the increased period between flowering and maturity are believed to be the cause of the dramatic fall in "soft" seed at Ain-el-Hadjar. The most affected species was *M. scutellata,* and in particular the standard cultivar, Robinson. This large effect of the growing environment on seed permeability is undoubtedly the cause of conflicting regeneration data for that cultivar.

Conclusions from Nursery Data

The nurseries reported here were compiled with two principal purposes, (1) to define the species which may best suit local conditions and (2) to agronomically define the environments into which the plants will be introduced.

In order to properly fulfill these two objectives, the same nurseries should be sown for at least two years. This is to be done. This nursery will be sown in six locations in 1978-79.

First Year Trial Conclusions

Medicago aculeata is an extremely promising species, especially on the high plateau. It germinates rapidly, has strong seedling growth and under the cold winter conditions, assumes an extremely prostrate habit forming a dense mat on the soil surface. Its competitive ability is therefore assumed to be good. As temperatures rise, it becomes semi-erect and as a pure ungrazed sward, it reaches a height of about forty centimeters. Most pods are formed very low on the plant and are thus protected from grazing animals. Some lines of this species have a tendency to bury their pods.

There are lines within the present collection which exhibit ideal seed permeability characteristics. The pod spines do not appear to be of a type to cause serious wool fault. However, some lines of this species were attacked quite severely by powdery mildew at Sidi-Bel-Abbes. Another species affected was *M. orbicularis.* In laboratory pod germination tests, some seedling damping-off was also noted.

Medicago scutellata has strong winter vigor. Under ungrazed conditions, its forage yields throughout the growing season are always the highest. This is demonstrated in tables 10 and 11 which show the best lines of each of the principal species. *M. scutellata* is always the species with best vigor at all three observations at both sites.

However, it has an upright growth habit, making it very prone to overgrazing with a subsequent deleterious effect on seed yield and the continuation of the system. This is a problem of education or experience, and there is no reason why grazing techniques for this species cannot be formulated in the future. In addition, *M. scutellata* may well find a place as a hay species for the high plateau areas.

Medicago truncatula shows reasonable winter vigor, although less than the other four lines shown in tables 10 and 11. However, it is extremely adaptable and over the past four years, cultivars from this species have shown good drought tolerance. Its reaction to grazing is good and seed yields are normally high. The permeability characteristics of the seed are reasonable and regeneration is acceptable.

Medicago polymorpha is the most widespread species in North Africa and is well adapted to most regions. There is, however, one main problem associated with it. The seed pods have long spines which are very often hooked at the tip. Thus the pods can become very severe contaminants of wool.

Two questions then arise: As it is so widespread, should there be concern about wool fault? Because most local sheep have bare legs and bellies, does the problem of wool fault arise? The answer in both cases is in the affirmative. One must be concerned about this aspect as the problem already exists, and it should not be increased.

Unfortunately in the Algerian collection, which contains about 250 lines of this species, the degree of pod spine is correlated with winter vigor, the most vigorous types having very large hooked spines.

Medicago ciliaris is a vigorous erect species well suited, it seems, to cold conditions except for its very low level of permeable seed (table 9, table 11). The seed after thrashing has a very low germination, which is a problem that could affect the commercialization of this species (table 12). In addition, the species seems very susceptible to pod-borne insects which destoy seed. It is the species best adapted to saline soils.

Of the other species tested *(M. orbicularis, M. tornata, M. rotata, M. littoralis, M. littoralis x M. truncatula)*, there was little immediate promise shown.

Table 12 shows two aspects which could affect the commercialization of the species viz., thrashing, and the germination of seed after thrashing. The thrasher used in this test had an incline base of indented tin (much like a kitchen grater) over which was mounted an electric belt sander fitted with a highly abrasive metal-finishing belt. The aperture between the base and belt is adjustable for different pod sizes.

M. truncatula and M. aculeata are relatively easy to thrash with *M. scutellata* slightly more difficult. Germination after thrashing of all three is quite acceptable. *M. polymorpha* presents difficulties in thrashing because it has a soft (non-woody) pod. Its germinability after thrashing is low. Considering all factors, three species have been selected for further study in 1978-79, viz. *M. aculeata, M. truncatula, and M. scutellata.*

Medicago Variety Trials

Trials were established at four locations in October 1977. One trial at Oran suffered drought after germination and the seedlings were killed. It was resown with the same result a second time. At Ain-el-Hadjar, the trial was inundated with broad-leaf weeds and observations only were recorded. Trials at Telagh (1,000 meters) and Tessala (600 meters) established normally.

Medicago forage yields during March are shown in table 13. Of the cultivars and lines of *M. truncatula,* Cyprus produced the most forage during winter. Ghor, which is earlier than Cyprus, suffers from poor seeding growth and is not suitable for most Algerian conditions. At Tessala, AR52 performed well.

In a second cut of the same plots on May 5 (to measure recovery) at Telgh, the growth patterns were very obvious. The Algerian lines produced forage late into the season and they were substantially superior to Jemalong in spring growth. By then, Ghor, Cyprus and Harbinger were beginning to mature.

At Tessala, the total forage produced by all three Algerian lines was more than two and a half times that of Jemalong. In that trial, there was an attack of powdery mildew. This tends to be a problem only in heavy lush growth; a situation which rarely exists in a properly grazed field. However, it is worthwhile to report that Borung and Harbinger suffered the heaviest attacks.

At Tessala, damage was also caused by *Sitona lineata.* All Australian cultivars were attacked. Of the Algerian ecotypes, AR5260 was mildly affected. AR52 was only slightly touched and it was impossible to find any sign of attack on Mo 49. Seed yields of the trials are shown in table 14. The Algerian ecotypes AR5260 and AR52 have good seed yields under the milder conditions of Tessala,and they are relatively stable under cutting. There is a tendency for late maturing types to perform better under this type of test. There was no strong effect of seeding rate on subsequent seed yields at Tessala. There was, however, a significant overall effect of doubling the seeding rate at Telagh. Yields of the late maturing Algerian ecotypes were affected by two days of Sirocco weather in mid May.

In conclusion, Borung has continued to demonstrate superiority over Jemalong in forage and seed yields. Cyprus appears promising, especially with regard to winter forage yield. It has high seed yields but this may not necessarily mean that regeneration will be reliable because the seed of this cultivar is highly impermeable. AR5260 appears to be the more interesting Algerian ecotype, especially for colder areas. It is a mixture of at least two lines and contains a range of plant types. In fact, the best line of *M. truncatula* in the nursery at Ain-el-Hadjar (Line 24) is a selection from this bulk.

TABLE 1. CEREAL SITUATION ALGERIA 1977-78

	Socialist			Agrarian Revolution			Private			Total		
	Harvested Area/ Production	% Area	Yield Qx/Ha	Harvested Area/ Production	% Area	Yield Qx/Ha	Harvested Area/ Production	% Area	Yield Qx/Ha	Harvested Area/ Production	% Area	Yield Qx/Ha
Bread Wheat	321.075 / 2.258.111	38.91	7.03	115.300 / 479.048	27.77	4.16	214.179 / 1.057.848	16.62	4.94	650.554 / 3.795.007	25.73	5.83
Durum Wheat	333.862 / 2.512.212	40.46	7.53	196.620 / 975.810	47.35	4.96	624.370 / 3.173.239	48.46	5.08	1.154.852 / 6.661.261	45.67	5.77
Barley	131.396 / 1.212.108	15.92	9.23	93.905 / 416.510	22.61	4.44	405.119 / 1.899.527	31.44	4.69	630.420 / 3.528.145	24.93	5.60
Oats	38.887 / 219.095	4.71	5.63	9.422 / 33.561	2.27	3.56	44.712 / 111.618	3.47	2.50	93.021 / 364.274	3.68	3.92
Total	825.220 / 6.201.526	32.63	7.52	415.247 / 1.904.929	16.42	4.59	1.288.380 / 6.242.232	50.95	4.85	2.528.847 / 14.348.687	100.00	5.67
Total Area seeded and % Area Harvested	886.840	93.05		499.725	83.10		1.997.643	64.50		3.384.208	74.73	

Qx = Quintals

TABLE 2. COMPARISON OF NEW BREAD WHEAT VARIETIES WITH THE VARIETIES AT PRESENT IN PRODUCTION IN ALGERIA 1977-78

Pedigree	New Algerian Names	1			2		
		Yield Qx/Ha	Rank°	% Stmp°°	Yield Qx/Ha	Rank°	% Stmp°°
Strampelli	-	48.45	6.67	100.00	16.52	12.00	100.00
Siete Cerros	-	40.40	19.00	83.66	16.53	14.50	102.88
FA or MDA[x]	-	35.07	22.67	72.12	16.71	12.88	102.24
Anza	Ghriss 75	47.45	6.67	98.38	17.49	10.63	108.99
Syrimex	Setif 76	47.34	7.17	98.12	17.87	9.63	110.41
ARZ	Beni Slimane 76	47.30	7.00	98.34	17.85	8.38	110.82
Mexicano 1481	Tessalah	46.54	9.50	96.52	18.58	5.88	116.66
Pavon "S" CM8399-D-4M-3Y-OM	Cheliff 78	48.32	6.50	100.15	17.62	10.38	110.24

1. Zone littoral and sublittoral with good rain distribution. Oued Smar, Guelma and Khroub.

2. Zone sublittoral and high plateau with less rainfall. Saida, Sidi Bel Abbes, Tiaret and Setif.

° Rank among 25 varieties mean of different stations.

°° Stmp = Strampelli

x FA = Florence Aurore and MDA = Mahon Demias.
Qx = Quintals

TABLE 3. PROMISING BREAD WHEAT LINES IN THE ADVANCED YIELD TRIALS ALGERIA 1977-78

Variety NO.	Pedigree	1			2		
		Yield Qx/Ha	Rank	% Stmp	Yield Qx/Ha	Rank	% Stmp
AB581	Pato x CC-Inia CM-1021-7MB-14Bj-4Bj	50.77	5.33	101.09	17.98	9.05	105.46
AB582	Pato (R)/Tob-8156(R)xCno"S" CM-1031-2MB-5BK-7Bj	45.76	17.00	91.11	18.85	7.75	116.71
AB585	Strampelli	50.26	6.00	100.00	17.13	10.75	100.00
AB586	CC-Kal(AzxNad-Lr64/Bb) CM-1163-E-IY-IM-3Y-OM	46.36	13.33	92.75	18.03	10.75	106.50
AB587	Bolsena"S" CM-8625-E-IM-4Y-IM-OY	45.68	17.00	90.98	17.63	13.00	108.10
AB591	EMU"S" CM-8327-C-9M-IY-OM	47.56	11.67	94.60	18.00	9.50	108.09
BB602	Cal-CnoxYr.70 Alg.65-IBK-52AL	42.46	13.00	90.83	17.05	10.50	108.45
BB603	Cha-3(Son64-SkE^{6}xAn^{3}E(St464) Alg-5-IBK-4AL	42.57	11.33	91.69	17.42	7.00	110.59
BB606	Bb-PatoxHD832-Bb CM-15626-4Bj-2AL	43.66	9.33	93.90	16.41	15.00	103.28
BB615	Strampelli	46.64	7.33	100.00	15.91	13.25	100.00

1. Zone littoral and sublittoral with good rain distribution. Oued Smar, Guelma and Khroub.
2. Zone sublittoral and high plateau with less rainfall. Saida, Sidi Bel Abbes, Tiaret and Setif.
3. Qx = quntals
4. Stmp = Strampelli

TABLE 4. PROMISING BREAD WHEATS FROM THE SECOND YEAR YIELD TRIALS ALGERIA 1977-78

V. No.	Pedigree	Yield Qx/Ha	Rank	% Stmp.
AA. 462	CC-IniaxCno-7c CM-4319-IY-2M-IY-2M-OY	32.63	6.75	104.90
AA. 466	Bb-Kal CM-9160-11M-5Y-4M-IY-OM	31.81	8.25	99.40
AA. 465	Strampelli	31.16	8.25	100.00
BA. 479	Bb-Kal CM-9160-11M-5Y-IM-2Y-OM	34.56	7.05	99.64
BA. 483	PV18A-Cno67/Tobxcc-Pato Alg 43-2AL-IAL-OG	33.15	9.75	96.89
BA. 480	Strampelli	33.82	8.25	100.00
CA. 513	NS-14-13	30.47	8.25	101.07
CA. 520	Strampelli	31.36	8.25	100.00

Qx = quintals
Stmp = Strampelli

TABLE 5. BEST BREAD WHEAT SELECTIONS OF THE FIRST YEAR YIELD TRIALS

ALGERIA 1977-78

V. No.	Pedigree	Yield Qx/Ha	Rank	% Stmp
A. 1	Blue Jay"S" CM-5287-J-IY-2M-2Y-3M-OY	45.90	3.5	117.89
A. 12	Oldafo 41A	43.96	4.0	115.06
B. 37	Laschish Line No. 1568/2	43.47	1.5	109.19
B. 42	Cj 71-Cpr CM-15070-IM-IY-OY	43.18	1.5	110.33
B. 47	7CxTob-Napo CM-789-21-IA-2Y-OM	40.40	6.0	100.74
C. 59	Tob-Cno"S"xPj62 CM-7369-6L-OL	44.57	5.5	100.72
C. 61	Cal-Lundi CM-1076-19M-3Y-OM-2Y-500M-OY	45.57	3.5	101.68
D. 81	Brochis "S" CM-5872-B-8Y-IM-2Y-4M-OY-OAL	42.25	8.5	107.95
D. 83	601 VD V Turquie	42.07	9.0	107.17
D. 86	Tob"S"-Napox7C II 30415-10S-IS-3S-OAL	46.00	1.0	117.55
D. 89	Mex. 50-B21-Cal"S" Tu147-IBK-3AL-IAL-OAL	44.32	3.5	111.41
D. 93	CgnxKal-Bb CM-15133-26Bj-3AL-IAL-OAL	43.18	6.5	107.80
D. 99	Pato(R)-Cal CM-1036-IMB-4BK-OBK-19AL-IAL-OAL	41.68	9.5	107.18
E. 103	PV18A-Cno67xCrt"S" CM-21467-12Bj-IS-IS-OS	41.43	3.0	114.88
E. 107	PV18A-Cno67xNar"S"-Pj"S" CM-21469-6Bj-IS-3S-OS	40.43	6.5	114.63
E. 117	CC-Kal(AZ67xNad-LR64/Bb) CM-1663-E-IY-IM-2Y-OM	42.18	1.0	117.79
F. 128	RR68-WW15/Ji"S"xCno-No 66 CM12272-N-IY-IM-OY-OBK	43.50	7.0	103.00
F. 146	Tzpp-Son64/Cno-JarxKvz CM-20707-A-IY-8M-IY-OY-1Ptz	44.17	4.7	105.95
F. 150	Brochis"S" CM 5872-C-IY-5M-IY-3M-OY-2Ptz	41.71	8.7	101.48
J. 237	Bb-Kal CM-9160-IIM-5Y-5M-2Y-OM	41.31	4.0	99.68
K. 252	Kal-Cal"S" Tu.71-29-34Bj-53j-OBj-3AL	45.27	3.3	97.39
K. 261	Bb-Kal CM9160-11M-5Y-5M-2Y-OM-2AL	48.44	2.0	103.23
L. 298	Castan	46.02	4.0	99.57

Qx = quintals
Stmp = Strampelli

TABLE 6. NEW ALGERIAN DURUM VARIETIES

Varietal Name	Pedigree
TIMGAD 73	Cisne"S" D 27617-21M-300Y-OBK
KHROUB 76	MASA 8Y-OM-OBK
TELL 76	Cr"S"-F3TuxAA"S"/Fg"S" CM-10200-IBK
TASSILI 77	Rabi"S"-Fg"S" CM-10162-76M-4Y-OM
SAHEL 77	Cit"S"xPg"S"-AA"S"/RuffxT. Dic. Ver-Gll"S" CM-14528-C-IY-IM-OY

TABLE 7. PROMISING DURUM LINES IN THE ADVANCED YIELD TRIALS ALGERIA 1977-78

Variety No.	Pedigree	1 Yield Qx/Ha	1 Rank	1 % Cocorit	2 Yield Qx/Ha	2 Rank	2 % Cocorit
551	Plc"S"-RuffxGta"S"-Rol CM-17904-B-3M-IY-IY	47.61	4.00	107.18	16.63	8.25	101.36
562	Plc"S"-RuffxGta"S"-Rol CM-17904-B-3M-IY	47.39	5.00	106.60	17.03	10.25	102.22
552	Stk"S"xChap-21563 CD-1894-18Y-OY	45.62	6.07	103.07	16.31	12.25	99.22
559	Tassili 76	46.44	5.00	104.67	16.00	13.25	98.54
563	Plc"S"-Cr"S"/Mca"S"xPg"S"-Par CM-18001-B-3M-7Y	46.58	7.00	104.45	16.98	5.75	104.33
567	Uveyik 126 x 61 - 130 C23-9-OA	41.08	15.00	92.32	17.31	9.05	106.27
571	Sahel 77	43.89	10.33	98.99	15.98	10.00	99.47
560	Capeiti	39.90	17.68	89.62	14.91	14.75	93.13
570	INRAT 69	42.69	12.00	96.12	15.28	17.00	91.13
565	Cocorit 71	44.45	9.00	100.00	16.16	10.00	100.00

1. Zone littoral and sublittoral with good rain distribution. Oued Smar, Guelma and Khroub.

2. Zone sublittoral and high plateau with less rainfall. Saida, Sidi Bel Abbes, Tiaret and Setif.

3. Qx = quintals

TABLE 8. SUMMARY OF MEDICAGO SPECIES, SIDI BEL ABBES, 1977-78.

	% Seed Establishment	Plant Vigour 4/2/78	Plant Vigour 25/3/78	Plant Vigour 18/4/78	Days to flowering	Days of flowering	Days to maturity	Seed Yield (gm/m^2)	"Soft" Seed %
Medicago polymorpha	68.3	11.1	12.3	11.5	98	63	156	101.8	3.84
Medicago truncatula	63.2	10.1	11.7	11.9	103	61	161	94.5	11.88
Medicago scutellata	65.5	13.2	13.8	12.8	92	63	155	143.5	12.82
Medicago orbicularis	46.3	6.4	8.4	8.8	114	53	167	72.6	1.71
Medicago ciliaris	56.8	11.1	11.9	11.4	97	69	166	161.1	2.32
Medicago aculeata	78.9	12.0	12.6	12.3	100	60	164	133.2	10.02
Medicago tornata	36.6	5.3	7.9	8.6	114	56	165	46.9	4.92
Medicago truncatula "Jemalong"	51.4	10.0	10.0	10.0	100	59	164	65.8	5.45
Medicago truncatula "Borung"	65.5	9.3	11.7	11.8	99	60	159	83.6	3.80
Medicago littoralis "Harbinger "	41.4	7.5	10.3	10.3	90	77	166	64.9	3.97
Medicago scutellata "Robinson"	83.3	13.8	14.0	12.5	89	61	151	169.9	23.68

TABLE 9. SUMMARY OF MEDICAGO SPECIES, AIN EL HADJAR, 1977-78.

	% Seed Establishment	Plant Vigour 19/2/78	Plant Vigour 26/3/78	Plant Vigour 19/4/78	Days to flowering	Days of flowering	Days to maturity	Seed Yield (gm/m^2)	"Soft" Seed %
Medicago polymorpha	46.1	10.6	12.4	12.1	108	61	172	126.7	2.90
Medicago truncatula	41.6	9.4	11.4	11.5	114	60	176	103.7	3.15
Medicago scutellata	51.5	11.7	12.8	13.4	102	67	174	202.0	1.11
Medicago orbicularis	27.9	6.4	9.7	9.6	116	53	175	119.1	0.83
Medicago ciliaris	47.4	11.3	13.0	13.2	106	66	177	218.5	0.18
Medicago aculeata	57.5	12.1	13.1	13.3	108	61	179	168.6	5.14
Medicago tornata	10.7	3.7	6.7	5.3	123	60	186	32.4	2.31
Medicago truncatula "Jemalong"	41.5	10.0	10.0	10.0	112	58	174	44.7	2.49
Medicago truncatula "Borung"	42.1	8.5	9.8	10.5	110	63	176	81.7	1.32
Medicago littoralis "Harbinger"	12.3	3.0	6.1	6.3	104	80	182	22.8	0.98
Medicago scutellata "Robinson"	61.9	12.1	13.3	12.8	103	65	175	166.9	1.21

TABLE 10. TOP LINES OF THE MOST PROMISING SPECIES, SIDI BEL ABBES, 1977-78

	Ident. of 1977/78	Country of origin	Vigour 4/2/78	Vigour 25/3/78	Vigour 18/4/78	Days to flower	Days of flower	Days to pod	Days to maturity	Days to complete maturity	Seed Yield (gm/m^2)	Regen. Population°
M. polymorpha	3	Tunisia	14.0	13.7	12.2	93	64	112	150	170	82.7	450
M. truncatula	30	Algeria	11.5	13.0	12.8	91	67	110	157	173	151.0	1380
M. scutellata	42	Australia	14.0	14.5	13.2	84	65	107	151	168	183.3	670
M. ciliaris	54	Algeria	12.0	13.2	12.8	97	63	110	164	174	223.3	790
M. aculeata	60	Algeria	12.7	13.2	12.8	96	60	112	167	176	175.1	540

° Regeneration Population (plants/m^2) = Seed Yield x % Soft Seed x Number Seed/gm.

TABLE 11. TOP LINES OF THE MOST PROMISING SPECIES, AIN EL HADJAR, 1977-78

	Ident no 1977/78	Country of Origin	Vigour 19/2/78	Vigour 26/3/78	Vigour 19/4/78	Days to flower	Days of flower	Days to pod	Days to maturity	Days to complete maturity	Seed Yield (gm/m^2)	Regen Population°
M. polymorpha	3	Tunisia	12.3	13.5	12.6	103	65	121	173	186	138.1	900
M. truncatula	24	Algeria	11.8	12.5	13.1	116	56	124	177	195	118.3	940
M. scutellata	41	Sicily	13.0	14.3	15.6	107	61	127	175	190	258.3	290
M. ciliaris	53	Algeria	12.5	14.3	14.3	103	69	122	177	190	266.2	0
M. aculeata	62	Algeria	12.6	13.5	13.6	104	64	121	177	192	188.2	280

° Regeneration Population (plants/m^2) =
Seed Yield x % "Soft Seed x Number Seed/gm.

TABLE 12.

THRASHING CHARACTERISTICS, MEDICAGO SPECIES, 1977-78

	Ease of Thrashing °	Germination after Thrashing
M. polymorpha	4	38.1
M. truncatula	2	77.7
M. scutellata	3	69.5
M. orbicularis	1	28.7
M. ciliaris	3	18.9
M. aculeata	2	58.7
M. tornata	2	64.2
M. truncatula ,"Jemalong	2	87.3
M. truncatula , "Borung"	2	74.2
M. littoralis, "Harbinger"	2	82.1
M. scutellata, "Robinson"	3	71.3

° Ease of thrashing on 1-4 scale estimated from results using experimental laboratory thrasher.

TABLE 13.

WINTER FORAGE YIELDS, MEDICAGO VARIETY TRIALS 1977-78,

(From Seeding Rate 12 Kg/Ha)

	TESSALA		TELAGH	
	Medicago (Kg DM/Ha)	Medic as % Total DW	Medicago (Kg DM/Ha)	Medic as % Total DW
M. truncatula "Jemalong"	92	24.5	203	9.4
M. truncatula "Ghor"	73	22.5	122	7.1
M. truncatula "Borung "	162	36.2	215	15.3
M. truncatula "Cyprus"	187	36.3	164	18.4
M. truncatula AR52 (Algeria)	174	40.1	146	7.2
M. truncatula AR5260 (Algeria)	131	24.3	185	10.4
M. littoralis "Harbinger"	148	28.2	189	9.8
M. scutellata "Robinson"	95	18.8	169	17.1
M. orbicularis Mo 49 (Algeria)	154	27.0	104	6.1

TABLE 14. SEED YIELDS, MEDICAGO VARIETY TRIALS, 1977-78 (Kg/Ha)

	TESSALA			TELAGH		
12 Kg/Ha	1[x]	2	3	1	2	3
Jemalong	186	188	145	173	148	66
Ghor	145	65	25	113	68	45
Borung	201	300	270	316	243	181
Cyprus	158	167	131	304	216	184
AR 52	221	327	287	156	186	111
AR 5260	188	446	392	176	174	82
Harbinger	111	144	129	204	124	75
Robinson (ex. Snail)	126	161	106	103	75	66
Mo 49	93	249	248	153	203	128
24 Kg/Ha						
Jemalong	99	148	126	223	172	147
Borung	209	333	129	366	252	226
Cyprus	263	216	217	466	176	170
Harbinger	106	176	108	305	228	236
Robinson	124	158	174	246	139	119

x 1 = Seed yields from uncut plots
2 = Seed yields from plots cut once
3 = Seed yields from plots cut twice

BOTSWANA

AREA AND PRODUCTION

Wheat is grown to a very limited extent in Botswana. Bread wheat is grown on approximately 300 hectares (200 dryland, 100 irrigated) with a grain production of 100 tonnes dryland and 500 tonnes irrigated. Planting is limited to the extreme southern portion of Botswana during the winter season.

Dryland production relies mostly on residual soil moisture since little precipitation falls during the growing season (April—August). Little water for irrigation is available, and in fact the most important constraint to expansion of the wheat area, is insufficient water.

IMPORTS

Grain produced is used for human consumption. Wheat flour valued at P 3.5 million (4.3 million dollars) is imported annually from the Republic of South Africa.

FERTILIZERS

Fertilizers are readily available but relatively expensive. A 3:2:1 fertilizer (12.5 kg N, 8.3 kg P, 4.2 kg K) costs farmers P 15 (18 dollars) and L.A.N. (28 kg N) costs P 12 (14.50 dollars) per 100 kg. Rates used on dryland wheat are 9N, 14P and 9K. Irrigated wheat is fertilized more heavily. Micronutrient deficiencies have not been observed.

DISEASES AND PESTS

Occasional stem rust *(Puccinia graminis-tritici)* and seedling blight caused by a fungus tentatively identified as *Septoria* have been observed. Bird pests are often severe requiring bird scarers in the fields.

SEED INDUSTRY

Seed not produced on the farm is purchased from South Africa as no commercial source is available locally. The Seed Multiplication Unit, a branch of Agriculture Research produces 5–10 per cent of the maize, sorghum, cowpea and sunflower seed used by farmers. A study of methods to increase production by the Seed Multiplication Unit has recently been completed by USAID and it is hoped that the seed industry in Botswana will be strengthened in the near future.

PRINCIPAL VARIETIES

The principal variety of wheat now grown is Inia but in recent trials Elize, Helene, Sonderend, Aerie and SST-3 have shown promising potential.

AGRONOMY

Time of planting is currently being studied. Early planting (February) places plants in good soil moisture but exposes them to high temperatures during early development. March–April planting exposes some early flowering varieties to frost damage during June. May–June planting is good with respect to temperature but soil moisture for seed germination and later plant development may be critically short.

FIELD TRIALS

Various trials were conducted at Sebele and Goodhope.

Sebele:

The time of planting trials indicated that during 1978 early planting (13 March) gave the highest yield. This was almost certainly due to availability of water as little rain fell after the end of February. The late planting (24 April) gave very low yields. There was no significant response to applications of nitrogen and phosphorus. The time to flowering was delayed by late planting probably due to lower soil moisture levels and lower temperatures.

The highest yields in the plant population and seed rate trial were obtained using the 25 and 50 cm rows and the results although inconclusive, indicated that a seed rate of 40 kg/ha and a row spacing of 25 cm or a seed rate of 80 kg/ha and a row spacing of 50 cm are likely to give the highest yields.

Soil moisture levels determined in the plant population trial at 100 days after planting on 6 July showed that there was significantly more moisture in the soil profile under the 100 cm rows than under the 50 cm rows and the soil moisture under the 25 cm rows was the lowest.

Four of the varieties in the South African Regional Wheat Evaluation and Improvement Nursery (SARWEIN) yielded over 500 kg/ha but there was no significant difference between the top 17 cultivars. The material from the African Cooperative Wheat Yield Trial (ACWYT) from Kenya was less well adapted and the highest yield was only 272 kg/ha (cv. T65). The local check Elize did very poorly in this trial and it is certain that the time of planting was too late (29 March) for the conditions during 1978.

During 1979 it is planned to plant the wheat during the January/February period so that the crop can establish and develop before the rains cease in the autum.

Goodhope:

The time of planting trials demonstrated that during 1978, late plantings (mid April and early May) gave significantly higher yields than the planting in March. This was probably due to the time of flowering. In the case of the March planting, flowering coincided with the sustained period of below zero night temperatures which extended throughout June.

The two later plantings did not flower until about 95 days and below zero temperatures did not occur at anthesis. There was no significant yield response to applications of nitrogen and phosphorus. The two later plantings took longer to flower and were shorter in height than the first planting.

Yields were low in the plant population and seed rate trial and were not significantly different. The trial was planted during March and flowering coincided with the below zero temperatures during June. As a result of the time of flowering, yields were severely affected and no treatment effects were detected. Days to flowering and the number of grains per head were reduced in the narrow row treatments.

Seven of the varieties in the SARWEIN trial yielded over 500 kg/ha and there was a significant positive correlation between days to flowering and grain yield of 0.7505. The varieties which flowered late, produced the largest yields. Elize which performed well at Sebele, was the lowest yielder as its time of flowering at 61 days coincided with the low night temperatures in June.

Nineteen of the entries in the Screening Nursery African Cooperative Wheat Yield Trial (SNACWYT) from Kenya yielded over 500 kg/ha and again there was a significant positive correlation between days to flowering and grain yield of 0.3333. The late flowering types were able to escape frost damage at flowering. Flowering in some types was delayed up to 126 days.

During 1979 it is planned to plant the wheat at Goodhope during the February period so that the crop can flower before the temperatures fall during June. Other plantings will be done in April and May as flowering will then occur after June.

COMMERCIAL PRODUCTION

Visits were made to farms in Botswana where wheat is produced commercially both under irrigated and dryland conditions. In the Barolong under dryland conditions, average yields of about 700 kg/ha were obtained by planting in February at 80 kg/ha and applying 9 kg N, 14 kg P and 9 kg K/ha at planting.

In the Tuli Block under irrigation, average yields of about 4,500–5,000 kg/ha were obtained by planting in May at a seed rate of 130 kg/ha and applying 6 kg N; I8 kg P and 2 kg Zn/ha at planting followed by 92 kg N/ha 3–4 weeks later. Seven irrigations totalling 430 mm were applied to wheat planted in May and five irrigations (300 mm) were applied to the June plantings.

EGYPT

INTRODUCTION

The land area of Egypt is 1,001,449 square kilometers, but only 2.3 million hectares, about three per cent, are arable. This area is completely irrigated from the Nile River. Since the completion of the High Dam at Aswan, irrigation is possible throughout the year. The irrigated area is immediately adjacent to the Nile River and forms a long narrow valley that eventually opens into a delta.

The farmland of Egypt can be roughly divided into three major areas: In Upper Egypt, there is no rain, winters are dry and of a short duration. This area extends approximately from Aswan at the High Dam, to Assiout. The area referred to as Middle Egypt extends from Assiout to Cairo (Giza). There is no winter rainfall and the winter is slightly longer than in upper Egypt. The Delta area accounts for approximately 60 per cent of the arable land, and it can be divided into north and south halves.

PRINCIPAL CROPS

They are wheat, maize, rice, millet, cotton, and numerous vegetables and fruits. Wheat is the major winter cereal crop and accounts for approximately one-fourth of the cultivated area. Wheat represents the main food staple of the urban areas and it is blended with maize flour in the rural areas. The wheat straw is considered an important commodity as an animal feed.

CLIMATE

There are some scattered rain showers during the winter months, and temperatures are cool during this period. There is also a north coast area which on average receives about 150 mm rainfall, with a range from 80–250 mm. It is common for nomads to cultivate barley in the hope that the rainfall will be above average. A successful harvest of barley occurs in only about one in three years.

The approximate averages for annual rainfall and minimum winter temperatures for the different regions are:

Region	Average Annual Rainfall (mm)	Min. Winter Temp. °C
Coast	124	9
North Delta	36	7
South Delta	15	7
Middle Egypt	0	5
Upper Egypt	0	6

IMPORTS

The consumption of wheat and wheat flour is approximately 6.7 million metric tons (t) per annum. There are approximately 2 million t produced locally. The remaining 4.7 million t must be imported. On a per capita consumption basis this equals approximately 150 kilograms per person. The population continues to increase at approximately 2.5 per cent per year, with the current population being estimated at 40 million. There is an ever increasing need for wheat and production is considered an important and vital factor.

WHEAT YIELDS

The average yields have increased in general over the past decade, but have now plateaued for the last five years (table 1). At first glance the average yield of three t or more per hectare seems high by world standards. It should be remembered, however, that this is a completely irrigated situation and sunshine is not a limiting factor. Consequently, higher yields are possible if the proper sequence of varieties, agronomy and incentives are provided.

CULTURAL PRACTICES

Wheat and barley should be sown during the first half of November in the Delta area. Wheat sown after cotton is often delayed and numerous farmers sow in late November and early December. In Middle and Upper Egypt, the later part of November is considered the optimum sowing period.

Seeding rates tend to be high, and about 90 per cent of the area is broadcast by hand. The seed rate used is 120–170 kg/ha for wheat and 100–120 kg/ha for barley. The high seed rate is used to compensate for the lack of land preparation and other factors.

From experimental results, the recommended rates of nitrogen for semidwarf wheats is 170 kg/ha and 100 kg/ha for the tall varieties. The general recommendation for phosphorus is 40 kg/ha. Potash is not a limiting factor and is usually not recommended for wheat. The number of irrigations recommended is 5–6 at three weekly intervals.

The recommended rates of seeding and fertilizer application for barley are about half the amounts given for wheat.

Weeding is done principally by hand. It is estimated that 85 per cent of the farmers will weed only once and 15 per cent do not practice weeding. Herbicides are not used because of a lack of equipment. In a few cases, the large government farms will use some of the more common broad leaf herbicides such as 2,4–D.

PRODUCTION PROBLEMS

Labor shortage at wheat harvest is an important problem. This is a time when cotton requires much attention, and the demand on the labor force does not allow the farmers to hire people readily. The high labor costs, the relatively low price of wheat and the subsidy on wheat and wheat flour makes wheat harvest a family affair rather than a commercial operation. This results in prolonged delays in the cutting and removal of wheat from the field.

The late harvest results in an excess loss due to shattering and birds, possibly 15 per cent of the crop, annually. Birds are becoming an increasingly important pest and the solution to this problem is not readily in sight. It does, however, tend to affect the farmers options. He will not always sow his wheat at the optimum dates. He tends to wait and plant with the majority of other farmers so that this crop is not as vulnerable to bird attack, but brings it into the hot period during the maturity period resulting in some seed shrivelling.

The delayed harvest adds to the amount of shattering that occurs. The semidwarf wheats have not been selected for this type of situation and, consequently, suffer more from shattering. The practice of moving unthreshed sheaves on camels and donkeys to a threshing floor also causes a loss of all but the most strongly glumed varieties. The tall improved wheats were locally bred and have been selected for a tight glume which is much more resistant to shattering. The farmers tend to prefer the tall wheats for these reasons.

The larger farmers who tend to be more commercially orientated are the principal growers of the semidwarf wheats.

SEMIDWARF VARIETIES

The semidwarf wheats have not been well accepted by Egyptian farmers although the average yields tend to be 15–20 per cent higher than the tall improved varieties (table 1). There are a number of reasons for the non-acceptability of the semidwarf varieties. The first is the subsidizing of wheat imports and bread. The second reason concerns the value of straw as animal feed. The government procurement price for wheat has been seven Egyptian pounds (L.E.) per ardeb (=150 kilograms), which is equivalent to 67 U.S. dollars/t for tall wheat varieties, and eight L.E. per ardeb (77 U.S. dollars/t) for semidwarf wheats, a factor favouring the latter. The price of straw varies depending on the season. The straw prices are usually approximately 7–10 L.E. per load (=250 kg), which is equal to 40–46 U.S. dollars/t. In years when the animal populations are high and the feed reserves low, the price per kg can be as much as three times that of wheat grain. In 1977 spring for example, straw prices reached the unheard level of 35 L.E. per load (170 U.S. dollars/t) for a short period of time. This is about 2.6 times the price of wheat grain.

Farmers also perceive a problem with the semidwarfs in terms of straw quality. There is a consensus that the semidwarfs are coarse and inferior in feed value. They consider the tall wheat straw to be fine.

TABLE 1. Wheat area, production and yield in Egypt.

Year	Wheat Type	Area (1000 ha.)	Production 1000 m.tons	Av.Yield m.ton/ha
1978	Tall	454.5	1456.8	3.21
	S.D.*	121.0	466.5	3.82
1977	Tall	381.5	1232.2	3.23
	S.D.	125.6	465.2	3.70
1976	Tall	512.2	1660.0	3.24
	S.D.	74.4	300.0	4.03
1975	Tall	507.1	1713.9	3.38
	S.D.	78.6	319.3	4.06

* S.D. = Semidwarf wheats.

BREEDING

The breeding programs in both wheat and barley have been active for several years. The release of the wheat varieties Giza 155 in 1968 and Giza 156 in 1972, helped raise the national wheat average to about 3.1 t/ha by 1972. The release of the semidwarf varieties in 1973 further helped to raise the average to 3.3 t. It is felt that the potential for further increases are substantial simply through the release of varieties, even if agronomic practices do not substantially change.

Four varieties were released in 1976. These were Giza 157, Giza 158, Sakha 3 and Sakha 8. The varieties Sakha 8, Giza 157 and 158, are now being grown on about 100,000 hectares. The area sown to Giza 157 and Sakha 8 will be increased next year and the area currently being sown to the variety Chenab 70, which is now highly susceptible to leaf rust, will be eliminated.

PROMISING MATERIALS

A number of promising new lines have been identified through the variety trials. The performance of the best advanced bread wheat lines in 1977 and 1978 are given in tables 2 and 3 respectively. Although they had high yield, a number of lines were discarded because of inadequate rust resistance, poor grain or shattering tendencies. In upper Egypt the season can be very short and this will be reflected in reduced yields as can be seen in 1977–78. The new lines appear to have a 10–20 per cent yield advantage and some of their pedigrees are given in table 4.

TABLE 2. Mean wheat yields (kg/ha) in trials conducted by the Wheat Research Section in 1976–77 (D trials).

Entry	REGION Delta kg/ha	Middle Egypt kg/ha	Upper Egypt kg/ha	Egypt kg/ha
Sakha 8	5231	6243	5060	5817
Arz	5303	6000	4696	5769
Giza 157	5074	5998	4370	5645
7C-On x Inia-B Man	5096	5917	4770	5605
Sakha 3	5146	5755	4041	5550
Condor "S"	5050	5822	4846	5548
UP 301 x Son-Pi 62	4924	5971	5112	5524
Chenab 70	3852	5552	4653	5167
Ch.L. Inia-S	4991	5281	4267	5307
Sparrow	4417	5538	4617	5015
Giza 158	4198	5117	4396	4720
Giza 155*	4125		3956	
Giza 156*		4670		
Average	4855	5655	4565	5424

Delta = Mean of 13 locations
Middle Egypt = Mean of 6 locations
Upper Egypt = Mean of 1 location
Average = Mean of 19 locations
* = Local variety in the Delta and Upper Egypt is G.155 and in Middle Egypt it is G.156.

TABLE 3. Mean wheat yields (kg/ha) in trials conducted by the Wheat Research Section in 1977–78 (D trials).

Entry	REGION Delta kg/ha	Middle Egypt kg/ha	Upper Egypt kg/ha	Egypt kg/ha
Sakha 61	5481	6400	2620	4834
Line 1628–2973	5286	6143	2773	4739
Sakha 60	5329	6359	2209	4632
Giza 157	5557	5650	2635	4615
Line 1628–2981	5500	6012	2194	4570
Chenab 70	5143	5974	2537	4567
Sakha 8	6000	5926	2144	4543
Line 3590–2653	5305	6052	2244	4534
Giza 158	4905	6112	2387	4470
Sakha 62	5429	5162	2380	4325
L.R. 64-Son	5005	5110	2187	4096
Giza 155	4798		2423	
Giza 156		4722		
Average	5312	5802	2394	4539

Delta = Mean of 16 locations
Middle Egypt = Mean of 7 locations
Upper Egypt = Mean of 2 locations
Average = Mean of 25 locations
Local variety in the Delta and Upper Egypt is Giza 155 and in Middle Egypt it is Giza 156.

DISEASES

The cereal rusts continue to be the principal diseases in wheat. All three rusts are found but leaf rust is the most persistent problem. A number of advanced lines listed in tables 2 and 3, although yielding well, do not had adequate resistance levels and have been dropped for this reason. In 1977 the principal semidwarf area was sown to Chenab 70, with some Mexipak also being grown. Leaf rust developed early and in the north Delta area, severe attacks occurred on Chenab and Giza 155. The early infection caused a reduction in the average yields, in spite of the fact that it was a very favorable year, weather wise.

The cereal pathology group has been developing chemical control procedures and loss estimates for leaf rust.

TABLE 4. Pedigrees of some varieties and promising advanced lines.

1. Giza 157	=	Giza 155 x Pi 62^4/LR 64^2-Tzpp x Knott^2
2. Sakha 8	=	Indus 66 x Norteno "S" PK 3418-6s-0s-0s
3. Sakha 61	=	Inia-RL 4220 x 7C/Yr"S" CM 15430-2s-5s-0s-0s
4. Sakha 62	=	We-Gto x Kal-Bb CM 8288-A-3M-1Y-10M-1Y-1M-0s-0s
5. Sakha 64	=	Napo 63 x Inia 66-Cal/Bb S 1619-1s-1s-0s-0s
6. Sakha 69	=	Inia-RL 4220 x 7C/Yr"S" CM 15430-2s-5s-0s-0s
7. Sakha 73	=	Cno-Inia x 7C-No 66 CM 4480-1s-2s-6s-0s
8. Sakha 74	=	Kal-Bb x Y5o$_e$-Kal CM 7785-6s-2s-1s-0s
9. Sakha 75	=	Kal-Bb x Y5o$_e$-Kal CM 7785-6s-2s-4s-0s
10. Sakha 78	=	NP-Tob"S" x 8156/Kal CM 7806-15M-2Y-7M-1Y-1M-0s
11. Sakha 79	=	We-Gto x Kal x Bb CM 8288-A-3M-1Y-10M-1Y-1M-0sw
12. Sakha 80	=	Vcm x Cno"S"-7C/Kal-Bb CM 8399-D-4M-3Y-3M-1Y-1M-0s
13. Sakha 83	=	(12300 x LR 64-8156/Nor 67) Y5o$_e$-Kal$_3$ CM 15517-1L-2L-0s
14. Sakha 84	=	7C/Bb-Nor 67 x Cno"S"-7C CM 21568-8s-1s-0s
15. Sakha 85	=	[(36896-Gb 54 x Y54/5840) MP33] Tob-8156 S.1112-1s-2s-0s
16. Sakha 86	=	Kal-Bb x CC CM 15334-11s-1s-1s-1s-0s
17. Sakha 87	=	Cno-7C x Kal-Bb CM 4407-1s-1s-5s-0s
18. Sakha 88	=	WS. 1877-7C [Bb(Inia"S"/Son 64-Tzpp x Y54] CM 11836-1M-1Y-4M-1Y-1M-0s

The chemicals Benalate and Indar have been used in some comparative loss trials. In table 5, the small scale trials comparing 1976 with 1977 show that the losses in Mexipak tend to be about 20 per cent due to leaf rust in both years, whereas losses in Giza 155 were 15 per cent in the rust year of 1977. In 1978, leaf rust was not as widespread a problem as in 1977.

Large scale evaluations on Government farms were carried out using Indar, and the yields and kernel weight losses are given in table 6. The losses were substantially lower in 1978 than in 1977.

Yellow rust and stem rust are frequently observed but neither of these two diseases has been a serious problem in recent years. This has been mainly due to adequate levels of resistance to the prevalent races in the region. Other diseases are occasionally found, but they are not considered of major importance at this time.

TABLE 5. Comparison of losses caused by leaf rust of wheat in small plots in the Delta Region, 1976 and 1977. The fungicide INDAR was applied at the boot stage.

Year	Variety Treatment	Average Rust Severity Per cent	Yield kg/plot	Loss Per cent
1976	Giza 155			
	Sprayed	2.3	2.25	
	Control	31.3	2.21	2.2
	Mexipak			
	Sprayed	3.0	3.58	
	Control	86.5	2.85	20.4
1977	Giza 155			
	Sprayed	3.1	1.50	
	Control	58.9	1.27	15.3
	Mexipak			
	Sprayed	5.6	2.91	
	Control	63.5	2.21	24.1

TABLE 6. Large scale farm evaluation of leaf rust control and losses in the Delta Region 1978 with severe leaf rust on unsprayed plots.*

Variety-Treatment	Average Yield(kg/ha) Treat.	Control	Loss per cent	Av. Weight 1000 kernel(g) Treat.	Control	Loss per cent
Chenab 70						
Aerial Spray	4063	3465	14.7	51.2	44.2	13.7
Ground Spray	2880	2160	25.0	52.3	45.7	12.6
Granular	3240	2760	14.8	53.5	48.1	10.1
Giza 155						
Aerial Spray	2712	2400	11.5	45.7	41.0	10.3
Ground Spray	2604	2200	14.7	46.0	38.1	17.2
Granular	2316	1872	19.2	44.7	37.3	15.7

* Rust severities on Chenab averaged 90S, Giza 155 from 10-40S. All treated plots were 5S or less.

DURUM

The durum variety Stork "S" is now being increased and multiplied for Middle and Upper Egypt. This will be an important variety for this area. Before the introduction of improved bread wheat varieties, durum wheat was commonly grown in Upper and Middle Egypt. Even today, local durum cultivars can be readily found, and it is felt that a semidwarf durum will be able to increase production substantially for these farmers.

BARLEY

Approximately 50,000 hectares are grown under irrigation and the estimated average yield is 2.9–3.0 t/ha. There is a large area on the north coast which fluctuates greatly. The yields in the coastal area are low in most years and a crop is probably harvested only once in three years.

The barley varietal improvement program has a number of new varieties and lines available. The two varieties Giza 119 and Giza 121 now occupy 10 per cent of the barley area. The variety Bonus is the other principal variety being cultivated. The majority of the barley is used for feed or malting. The promising new lines and their yields in different regions of Egypt are shown in table 7.

The main disease problems of barley are net blotch (*Helminthosporium teres* = *Pyrenophora teres*) and leaf rust (*Puccinia hordei*). Other diseases are of minor importance. Occasionally aphid attacks are severe and sometimes barley yellow dwarf virus is present.

TABLE 7. Mean barley yield (kg/ha) in trials conducted by the Barley Research Section in 1977–78 (D trials)

	REGION			
Entry	Delta kg/ha	Middle Egypt kg/ha	Upper Egypt kg/ha	Egypt kg/ha
Giza 121	3494	3544	1966	3001
C. C. 89	3677	4096	2009	3261
C. C. 163	3346	3713	2673	3244
C. C. 243	3480	3334	2323	3044
Cr 251/14/2	3682	3192	1892	3001
Cr 257/370	3670	3413	1859	2980
Dr 264/8/4	3432	3794	1695	2973
Average	3530	3582	2087	3065

Delta = Mean of 4 locations
Middle Egypt = Mean of 3 locations
Upper Egypt = Mean of 1 location
Total = Mean of all locations

ETHIOPIA

INTRODUCTION

Barley and wheat are important staple food crops in Ethiopia. Together they cover about 25 per cent of the total crop area. Triticale has not yet reached farm production.

AREA AND PRODUCTION

During the main season, about 7.8 and 4.5 million hectares were given to barley and wheat production, respectively; average grain yields were about 7.9 and 8.5 quintals per hectare. About 97 per cent of the total barley produced was food type, the remainder being malting barley.

With wheat, about 60–70 per cent was durum and the rest, breadwheat. In addition, limited quantities of barley and wheat were produced during the short rain period, roughly equal to about 10 per cent of the main season production for the respective crops.

IMPORTS

Both barley and wheat were imported, about 0.106 million quintals and over 1.3 million quintals, respectively.

CLIMATIC CONDITIONS

The amount and distribution of rainfall was satisfactory in many parts of the Central Highlands where wheat and barley are commonly grown. The rainfall extended from June to early October with many sunshiny days. Hail storms occurred only a few times.

In many places, over 600 mm of rain were received during the crop cycle. In some parts of Tigray and Wello, the distribution of the rain was not satisfactory. Most of the rain fell in July and August and crops suffered from a shortage of moisture during heading and maturity.

Frost was serious in early November in the highlands and affected grain yield and quality. Minimum temperatures ranged from 0°C to −1.5°C in Central Shoa.

FERTILIZERS

Studies made at different sites where bread and durum wheat, barley and triticale (on experimental plots only) were grown showed that on the red soils, these crops respond more to phosphate fertilizer while on the black soils, to nitrogen. Due to high responses obtained on farmer's fields, one quintal DAP/ha ($N_{18}P_{20}$) on the red soils and one quintal DAP + 0.5 Urea/ha ($N_{41}P_{20}$) on the black soils is applied to wheat and barley.

The total amount of fertilizer is imported and subsidized by the government, and the quantity is far behind the demand. In 1978 the total fertilizer imported was about 46 thousand tons, mainly DAP (87 per cent) and the rest was urea.

Data on the application of fertilizers on wheat and barley in the 1978 cropping season are not yet available; however, the indications from the 1977 season were that only 10–17 per cent of the fertilizer demand of the two crops was satisfied.

Farmers also apply natural fertilizer to a small extent. Regarding trace elements, deficiencies in these crops have not been reported.

DISEASES

Barley

The main disease was, as usual, scald *(Rhynchosporium secalis)* which occurred mainly in the cooler and more humid areas. Frequently it occurs together with *Helminthosporium teres,* though that disease apparently prefers somewhat drier conditions.

Also, stripe disease *(Helminthosporium gramineum)* was more prevalent than in previous years. Loose smut and covered smut were widespread but the damage was not very severe. Eyespot (see below under wheat) was severe in many of the highland barley areas. *Septoria passerini* occurs occasionally and is limited to the northern parts of the country. Leaf rust occurred everywhere but it was not very severe.

Wheat and Triticale

The main diseases in the highlands are still *Septoria spp.* mainly *Septoria tritici.* It is more severe at agricultural stations than on farmer fields, probably due to other agricultural practices and the survival of the pathogen on crop residues. Last year "tan spot" *(Helminthosporium tritici-repentis)* became more important than before. Since, from the symptoms, it can be mistaken for *Septoria* it might be that some of the variety scoring done actually refers to tan spot and not to leaf blotch. The effect of tan spot on the yield is not yet assessed.

Stripe rust occurred on high, wet and high rainfall areas. Stem rust was not important, at least in most areas where surveys were conducted. Eye-spot *(Pseudocercosporella herpotrichoides)* became more severe in the highland cereal areas during recent years. Whereas the yield reduction in infected plants is in the range of 11–16 per cent when no lodging occurs, infected and lodged plants gave a yield reduction of 34–49 per cent. Newly introduced varieties such as Romany BC and Mamba were more severely affected.

INSECT PROBLEMS

In barley, the maize aphid *(Rhopalosiphum maidis)*, barley fly *(Delia arambourgi)* and armyworm *(Spodoptera exempta)* were important. The main pests in wheat were armyworm *(Spodoptera exempta)* and maize aphid *(Rhopalosiphum maidis).* Armyworm *(Spodoptera exempta)* and stem borer *(Sesamia sp.)* attacked triticale. Several pests like grasshoppers, *Epilachna* beetles, etc. were sporadic pests on the above-mentioned crops.

PRODUCTION PROBLEMS

Expansion is occurring rapidly in wheat and malting barley by state farms with mechanization. Collective farms of peasant associations are also growing. Some of the factors which limit grain yields, especially for small farmers are the lack of improved farm implements such as plows, harrows and thrashers, the short supply of fertilizers and high yielding varieties, the prevalence of weeds, and drainage problems.

SEED PRODUCTION

A national seed corporation was established in 1978. Its main function is to coordinate the production of basic and certified seeds. The actual production is handled by state farms, Arsi Rural Development Unit (ARDU), the Institute of Agricultural Research (IAR) and the College of Agriculture.

In 1978, the total seed produced by these organizations was: bread wheat – 110,040 quintals and malting barley – 14,380 quintals. The bread wheat seed would cover about 20 per cent of the total wheat area.

Released varieties of durum wheat have not reached farmers who still depend on their own varieties. The same is true for food barley although about 13 high yielding varieties were released from research stations in the last nine years. The major obstacle for outreach was a lack of seed production.

HYV

The recommended high yielding wheat varieties are being used in most cases and demand is growing rapidly.

With malting barley, the area is expanding on state farms, but not much by farmers. The main drawback for farmers is the condition of production. Malting barley production is limited now to Arsi Province with the variety Beka, although other regions are also suitable. The St. George Brewery contracts the production to ARDU which in turn contracts it to some 10–12,000 farmers.

ARDU distributes seed to farmers, inspects production, collects grain, cleans and grades it. St. George Brewery delivers the grain to its maltery in Addis Ababa. A contractor like ARDU is lacking in other regions for production by small farmers. Two varieties which were released in 1973 were not put to production mainly for this reason. The situation may be different when peasant associations are active in production.

VARIETIES

The principal wheat and barley varieties in production with their year of release are:

Crop	Variety	Year of release
Bread Wheat	Enkoy	1974
	Romany BC	1974
	Mamba	1974

con't

	K6290–Bulk	1977
	K6106–8	1977
Durum Wheat	Local cultivars	–
Malting Barley	Beka	1973
Food Barley	Local cultivars	–

INDUSTRIAL AND HOME USES

The industrial uses of bread wheat are for making bread and to a limited extent for cakes and biscuits; durum wheats are used for pasta products. Malting barley is used by breweries for making beer. At home, all types of wheats and barley are used for food in various products. Home made beverage is also prepared from any barley.

RESEARCH RESULTS

1. The major barley activities were screening introductions, hybridizations and selections, variety trials including coordination of national yield trials, maintenance of foundation seeds, etc.

Some 2028 barley nursery lines were introduced, mostly from CIMMYT, ICARDA, Brazil and Sweden. They were grown at Holetta, Mekele and other locations. About 95 per cent of the lines were not satisfactory and were discarded for susceptibility to diseases such as scald, leaf blotch, and leaf rust and for poor agronomic performance.

A total of 392 F_2 bulks from CIMMYT and 219 F_2 bulks of local crosses on food and malting barley were tested at Holetta. About 111 crosses were selected with single plant selections for plant vigor, good grain set and low disease score.

A population breeding stock composed of 245 $F_{2\text{-}3}$ bulks was also grown. About 757 grams of naturally crossed seed, which was collected from male sterile spikes, was collected. Also, 424 F_3 selections of 18 crosses, 38 F_4-F_5 malting barley lines and 215 $F_{4\text{-}5}$ food barley lines were tested. Promising materials were selected and retained viz., 28, 19 and 35 lines, respectively.

In addition, 73 progenies of BC_1 and BC_2 segregating material of 21 crosses, were handled for protein and lysine quality, of which some useful material was retained.

Two National Yield Trials (NYT) namely, the Food Barley NYT with 14 varieties and the Malting Barley NYT with 12 varieties were coordinated from the Holetta Research Station. Most varieties in the trials are lines which were advanced from the breeding programmes. Both trials were tested at some 15 locations.

The mean

The mean location yields ranged from 14–34 q/ha for the food barley and 13–39 q/ha for the malting barley. Top varietal yields were 52 and 47 q/ha, respectively. Two food barley and two malting barley varieties are ready for release. They are:

Food Barley:	EH 11/F3.A.1.B.L A Hor 880/61....
Malting Barley:	EH 8B/F4.E.L.6.L EH8B/F4.E.L.7.L which is under multiplication for basic seed.

Also, three promising malting barley lines are coming up.

Maintenance and initial multiplication of barley breeder's seed of released varieties and promising lines were undertaken. Maintenance of the local collections is handled by the Plant Genetic Resources Center.

2. The range of activities directed to bread wheats was similar to those stated above for barley.

About 2173 wheat nursery lines were introduced mainly from CIMMYT, ICARDA, Brazil and Sweden and were tested at Holetta, Kulumsa, Ambo, Mekele, and other locations. Only 5 per cent of the material was retained. The remainder was discarded for poor agronomic performance and susceptibility to *Septoria tritici.*

Ten wheat groups in early segregating generations of which three were from CIMMYT and seven from local crosses were observed. A total of 1935 single plants was selected for further study. Seven groups of F_5 generations consisting of 449 lines were also tested; three sets were from CIMMYT and the rest from local crosses. The best 72 lines were selected. Backcrossing programs for stem rust resistance and other crosses were in progress.

Four bread wheat variety trials were coordinated. They are indicated below with their number of entries, locations, and yield range over locations.

Trial	No. Varieties	No. Locations	Yield Range kg/ha
National Yield			
Trial A	12	16	2771-3270
Trial B	13	10	2657-3195
Multiline Trial	17	6	2678-4008
Pre-National			
Yield Trial	23	7	2061-3295

Several lines from local crosses looked very promising. Three varieties performed well at many locations; they may be released next season.

Released bread wheat varieties and potential breeder's seeds were maintained. The local wheat collection was maintained by the Plant Genetic Resources Center. Durum wheat national yield trials are coordinated by the College of Agriculture–Debre Zeit Experiment Station.

3. Based on previous recommendations, research on triticale was concentrated in areas where frost, poor soil fertility, drainage and in some cases low pH are serious obstacles for crop production. Experiments were conducted

in five such locations viz., Chencka, Endibir, Bedi, Sheno and Emmanuel. Holetta served as a screening site for the international nursery trials.

The lines of research were scaled down to only screening advanced nursery lines, yield trials, utilization tests and acceptability studies.

A triticale trial for Chencka was composed of the best 15 varieties from previous tests in the location. A local barley check was included. The results are not yet available.

For Endibir, the triticale trial consisted of 15 best varieties from previous tests at the location, and a local barley check. A low yield and test weight with poor grain quality were reported; the mean yield was 3289 kg/ha. The variety Bacum on a demonstration plot gave 24 q/ha, which was equal to that of Romany BC (Bread Wheat).

The triticale variety trial consisted, of 10 promising varieties from the 1977 NYT and Pre NYT, one standard check, and a local barley or wheat check to the area. It was tested at Bedi, Sheno and Emmanuel.

Lower yields were obtained at Bedi and Sheno than the previous cropping seasons, with mean yields of 2254 and 2910 kg/ha, respectively. Frost was a serious problem at the grain filling period. At Bedi, six triticale varieties outyielded the local barley check while at Sheno all varieties outyielded the local barley check. This superiority, however, was not reflected on a demonstration plot at Sheno with the variety Bacum which gave 13 q/ha compared with 11 q/ha of the local check; the seed of Bacum was highly shrivelled.

Data were not received from Emmanuel. The five best varieties were selected for further testing on the basis of their overall agronomic performance, disease resistance, yield and grain data from Bedi and Sheno.

The triticale screening observation trial included 75 varieties and was tested at Bedi, Sheno, Endibir, Emmanuel and Chencka. Results are not yet available from Chencka and Emmanuel. One variety was selected on the basis of performance at the other three sites.

The Ninth International Triticale Yield Nursery was received from CIMMYT, and consisted of 22 triticale strains, two bread wheat varieties, one durum wheat and one barley variety. It was tested at Holetta (black soil) and Endibir. Low yield was reported from Endibir with a mean of 2804 kg/ha, while a higher yield was obtained at Holetta than the previous season, with a mean yield of 3350 kg/ha. The triticale varieties outyielded the other crops at both locations; the wheats gave the highest test weight and best grain quality. Three triticale strains were selected for further testing.

In the triticale nurseries, 473 lines were tested at Holetta, of which 217 were retained for further observation.

Utilization tests and acceptability studies with triticale are in progress.

AGRONOMY RESEARCH

Agronomic experiments are conducted by a general agronomist, who works with four cereals, four pulses and three oil crops. Sowing dates and seed rates are determined for most of the crops. Studies on cultivation practices and crop sequence are in progress. Wheat and barley are normally sown from mid June to mid July and are harvested in November or December.

INTERNATIONAL SUPPORT

Assistance and cooperation from international centers like CIMMYT would be invaluable in matters of seed exchange (nurseries and early segregating materials are preferred to yield trials), staff training in breeding and crop production, workshops and seminars on special agricultural problems, information exchange via technical literature and reports, and also visits from experts to evaluate field experiments.

GHANA

INTRODUCTION

Ghana, like many other humid tropical countries, annually, spends a large sum of her foreign currency to import wheat and wheat products as well as malt for her breweries.

According to available reports, various attempts have been made since 1964 to grow wheat and barley in the country. However, none of the various experiments have led to the cultivation of these crops on a scale beyond the micro plot size. These trials normally ended abruptly.

The present cooperative International Screening Nurseries venture between the Crops Research Institute (Council for Scientific and Industrial Research) and CIMMYT started in 1976 to help Ghana select varieties which are resistant or at least tolerant to the important diseases in Ghana. The first nurseries were planted in 1977 and the second in 1978.

The results so far show that bread wheat, durum wheat, barley and triticale can grow in Ghana. However, there are very serious pathological problems involved and these should be solved before any meaningful commercial scale cultivation could seriously be considered. The most important diseases are (1) those of the inflorescence and grain; (2) those affecting the leaves.

DISEASES OF THE INFLORESCENCE AND GRAIN

All the bread wheat, durum wheat, barley and triticale varieties tested were susceptible to scab or head blight caused by *Fusarium semitectum.* The grains were generally discoloured and shrivelled. The glumes of severely infected heads were pale pink or reddish in colour and were often covered with a thick felt of mycelia. The whole ear might be completely destroyed if the attack starts at a very early stage of the development of the kernels.

However there were some differences in the degree of susceptibility. The only varieties which could produce grains of appreciable quality were Nacozari (bread wheat) and Siete Cerros (bread wheat). *Helminthosporium spp.* (notably *H. sativum* and *H. oryzae)* also attacked the heads at the end of the season. The infected seeds developed dark brown or black spots.

FOLIAGE DISEASES

Helminthosporium and Curvularia leaf blights were very serious. In some varieties, almost all the leaves were completely killed during the milk stage. The most important foliage disease of barley was caused by *Piricularia sp.* The symptoms were much similar to those of blast and completely destroyed all the plants.

All the varieties of wheat from Asia (which were received through the Grains Development Board of Ghana) were also susceptible to the important diseases mentioned above. The grains of the variety Sandal were not so much shrivelled.

In other experiments, attempts were made to control the important diseases by using fungicides. Benlate and Thiophanate NF 44 were effective against *Helminthosporium* and *Curvularia* leaf blights. Scab however remains a serious problem.

Diseases like rust, bunt, smut, mildew and *Septoria,* which are of great economic importance in the major wheat growing countries, were not found in Ghana. When these cereal crops are grown during the major season, they are virtually free from insect damage. Stem borers *(Sesamia sp.)* and the beetle *(Lagria villosa)* attack some plants during the minor season when there is not much rainfall.

TILLERING PROBLEM

Poor tillering was a general agronomic problem. A few varieties eg. Moncho "S" CM 8288–A–3M–IY–500M–0Y; Flicker "S" CM 8954–B–7M–IY–IM–0Y and Pavón "S" CM 8399–D–4M–3Y–3M–IY–0M, etc. did produce sufficient tillers.

KENYA

AREA AND PRODUCTION

In 1978, wheat was grown on 123,000 hectares which produced 196,000 tonnes at an average yield of 1.59 t/ha. Barley was grown on 32,000 ha and produced 38,000 t at an average yield of 1.2 t/ha.

FERTILIZERS

Rates of phosphates, nitrogen and copper are determined after replicated trials in all wheat areas. The recommendations take into account the previous cropping history of the farm.

There are four wheat land categories. In these categories, nitrogen applications range from 14–46 kg/ha and phosphate from 40–70 kg/ha.

Most soils are largely deficient in phosphorus, and in nitrogen to some extent.

There are copper deficient soils in the Nakuru and Narok districts. To control copper deficiency, wheat seed is treated with one kg copper oxychloride/100 kg seed. This must be followed by a foliar application of copper oxychloride at one kg/ha which is mixed with a herbicide.

WHEAT VARIETIES

Varietal development in wheat started in 1906 when Mr. G.W. Evans was appointed by an estate owner who had realized that wheat rusts destroyed most of the planted crops. The breeder released the variety Equator which was grown for four years. The breeding program subsequently grew in scope so that at present the main objectives are:

1. Shorter strawed varieties.
2. Varieties capable of sustaining rust resistance for several years.
3. Acceptable baking quality, or other stated uses.
4. High grain yields over fairly wide areas.
5. Reduction of the number of varieties for ease of handling a sufficient number for blending purposes.

A total of 132 varieties has been released since 1908 out of which 25 are still being commercially grown. Now, 10 varieties are fully recommended for production in wheat areas and another nine are recommended to be grown on a restricted basis, due to their higher rust susceptibility.

Varieties fully recommended for cultivation.

Variety	Altitude (m)	Special Notes
Africa Mayo	All altitudes	
Bounty	All altitudes	
Kenya Leopard	All altitudes	Limited area above 2700 m
Kenya Mamba	1800–2300	
Kenya Bongo	2200 and over	
Kenya Paka	1800–2400	Not above 2400 m
Kenya Tembo	All altitudes	Limited area above 2600 m
Kenya Fahari	All altitudes	
Kenya Nungu	1800–2600	Not above 2600 m
Kenya Kifaru	All altitudes	Limited area above 2600 m

Varieties restricted to less than 10 per cent of farm area.

Variety	Altitude	Variety	Altitude
Kenya Kudu	2100m and above	Kenya Swara	1800-2300m
Kenya Page	2400m and above	Fanfare	All altitudes
Kenya Kanga	All altitudes	Kenya Nyati	1800-2400m
Kenya Kiboko	All altitudes	Kenya Kuro	1800-2400m
Kenya Nyoka	All altitudes		

DISEASES AND PESTS

The main diseases of wheat and barley are stem rust *(Puccinia graminis tritici)* which occurs in all areas; brown leaf rust *(P. recondita)* in altitudes above 2,100 m; stripe rust *(P. striiformis)*; blotch *(Septoria nodorum, S. tritici and S. avenae)* which inflict losses on susceptible varieties at all levels and more particularly on poorly drained soils. Occasional diseases include loose smut *(Ustilago tritici)*; scab *(Fusarium gramineum)*, take-all *(Ophiobolus graminis)*; root rot *(Rhizoctonia sp.)* and leaf blight *(Helminthosporium trichostoma)*.

The fight against rusts continues because various races keep developing and varieties cannot be grown for many years. Incorporation of resistances will continue. Future varieties will also have improved agronomical characters.

The pests include barley bulbfly *(Hylemya arambourgi)*, dusty brown beetle *(Gonocephalus simplex)*, black wheat beetle *(Heteronychus consimilis)* and aphids *(Aphis spp)*. Damages are low.

PRODUCTION PRACTICES

Experiments have shown that the first ploughing should be done inmediately after harvesting the previous crop. This preserves and facilitates moisture penetration, provides better control of noxious weeds and ensures efficient decomposition of crop residues.

The sowing dates vary with the rainfall pattern. Most of the wheat and barley are sown in the May-July period. In the bimodal rainfall areas, wheat farmers prefer the second rain peak, which is in October.

The later maturing varieties are sown first. Seed rates vary from 75-125 kg/ha.

Herbicides such as 2,4-D; 2,4-DP; MCPA and Buctril M and others are recommended only after thorough investigations. Many weeds are very difficult to eradicate, including wild oats, rye grass, brome grass, beckeropsis, Chinese Lantern and bind weed.

In experimental fields, wheat and barley yields are relatively high. They exceed 4.5 t/ha.

WHEAT PRODUCTION AREAS

Wheat is grown in areas with both lower and higher rainfall than barley. In the marginal areas (with rainfall below 600 mm per annum), the wheat requirement for water has been calculated as between 322 and 324 mm depending on season. Wheat in these areas is a small-scale crop with the majority of farmers having only about 1.5 ha of wheat, for their own home needs. The area under wheat in the marginal lands is decreasing gradually to other food alternatives. However, new areas under extensive wheat production are being opened up and this sector may assume significance in the future.

Wheat lands with more than 700 mm of rain are therefore the major production sector in the country.

There are definite plans to greatly increase wheat production. Although the country is self-sufficient in many years, there are still occasional imports of about 10 per cent. At present only about one sixth of the wheat potential is being utilized. There are plans to extend cultivation of wheat to the Narok district where nearly 500,000 ha are considered to be suitable.

BARLEY

The requirements for barley are increasing in the country and more areas are likely to be opened up for barley production. Barley generally is grown in areas where rainfall is between 700 and 1200 mm at altitudes above 2,200 m. The rainfall should be spread over at least five months in order to have high yields and acceptable malting quality.

Four barley varieties are recommended viz., Amani, Research, Tumaini and Proctor.

GRAIN END USES

While wheat is used principally for bread, barley is used for malting; only small barley quantities fail to meet the malting requirements and they are used for animal feed. Wheat bran and barley malt are useful by-products in the food industry.

LIBERIA

Although wheat, barley and triticale are not grown in Liberia, consideration has been given to planting a CIMMYT bread wheat screening nursery.

Excluding rice, which is produced in Liberia, cereals valued at approximately 4.6 million dollars were imported in 1974. These importations included materials for feeding pigs and poultry.

Annual rainfall in Liberia ranges from 1800-4000mm. It falls from May-July and from August-October. The maxima temperature range is 30°-37°C and the minima is 17-23°C. From November-January, there are occasional cold nights below 20°C, especially on the Guinea borders.

Regarding fertilizers, there are responses to applications of N and P to rice and other crops. Zinc deficiencies are suspected in lateritic soils. Iron toxicity complexes occur in the swamps.

MADAGASCAR

INTRODUCTION

Production of wheat has been slight in past years, but it is now beginning to expand. Most of the wheat being grown is soft wheat. Hard wheat is produced very locally, where it is consumed.

A flour mill was operated in 1977 and 100 tonnes of wheat flour were produced.

Triticale experimentation has commenced, with encouraging results.

IMPORTS

About 40,000 tonnes of flour are imported annually. This importation is increasing at the rate of 7 per cent per annum.

The present cost of flour imports is equal to the value of Madagascars' pepper and cloves exports.

CLIMATE AND PRODUCTION

Wheat is grown in two environments. One is the low altitude temperate zone viz., the Antsirable-Vakinankaratra region. This is a rainy environment. Wheat is sown after the rain season and it grows from February to June, when it is harvested.

The other production region is in the High Plateau. The season there is dry and cold and wheat is sown on the residual moisture in rice fields.

FERTILIZERS

Their use is undeveloped due to the lack of available funds and a frequent insufficient fertilizer availability. Extension services are needed to motivate the peasant farmers to understand the value and benefits and the technology involved.

Wheat which is grown in the cold dry season on residual moisture in rice fields usually requires boron.

PRODUCTION PROBLEMS

There are a number of factors detrimental to an expansion of the wheat area.

Rice being purchased as a food, costs about 35 Mg Fr/kg, while wheat costs approximately 70 Mg Fr (100 Mg Fr, Madagascar Francs, = 2 French Francs).

There is an inadequate supply of seeds, problems of supplying other inputs, marketing difficulties and a lack of motivating information and advisory services.

The introduction of new varieties is very difficult because of the extremely strict quarantine service.

DISEASES

Stem rust and leaf rust cause damage to the wheat crop.

SEEDS

The supply does not meet the demand and the production of seeds is presently a serious problem. Projects are planned by national organizations to overcome this problem.

VARIETIES

In the rainfed temperate zone, the wheat varieties being grown are Romany, 763 (= Tobari 8156 x Ciano "S" II 23802-3Y-2M-1Y-0M) and Tobari.

In the rice field production areas, the same varieties are grown, (with the exception of Romany), plus FE (= K5393 = Ci 8153 x Forcor^2 x I-K^2 x Y50.

Occasionally, Florence Aurore and Ariana are grown.

PROMISING MATERIALS

Such wheat varieties include Kenya Nyoka, Kenya Fahari, Bounty and Kenya Nyati, Fifa 6 = Africa Mayo x 763, Fifa 35 = Romany x Cno "S", Inia "S". Triticale varieties of promise are TCL 10 and PM 212.

PRODUCTION PRACTICES

In the rainfed region, wheat is sown in January—February and harvested in May—June. The cycle is 100—120 days.

In the dry cold season production areas, the crop is sown in May and harvested in September. The crop cycle there is from 140–150 days. In some rice fields where there is the possibility of an extra irrigation, seeding may be very late, viz., June and the beginning of July.

CROP UTILIZATION

Wheat grain is being converted to flour at the Antsirable flour mill for bread making.

Wheat straw especially from tall growing varieties like Florence Aurore and Ariana, is used to manufacture hats.

MALI

INTRODUCTION

In the Dire and Goundam regions, there are more than 12000 ha of plains which are potentially suitable for wheat production. Much of the area consists of a topography of river banks rising steeply four meters above the level of the Niger River and almost perfectly smooth plains sloping gently inland from the top of these embankments.

This situation offers an opportunity with small pumps to lift the water to the top of the embankments and then allow it to run inland through simple farmer constructed and operated gravity irrigation systems.

Currently there is a program financed by USAID to increase wheat and sorghum production in a manner to maximize benefits to the small farmer.

In respect of wheat improvement, the goal is to focus on production techniques for the difficult Sahelian conditions. Experimentation is being conducted in the plain of Dire near the Niger River. There are difficult conditions due to the climate, aridity, hard working soils, distance from a major center etc.

Between 1975-77, experiments showed that high yields of five tonnes/hectare were possible without excessive costs, during a cycle of 4-5 months.

Studies in the 1977-78 season were conducted on determining the technical and food values of grain which had been produced in 1976-77; improving production techniques and selection of varieties; selection of new lines capable of producing higher yields and better adapted than the existing varieties in the Sahel.

TECHNOLOGICAL AND FOOD VALUES

The objective is to find varieties adapted to Sahelian specifications for high productivity, consistent yields and with a grain quality suitable for various uses of wheat. Varieties are required with high technological quality i.e. gluten strength, to replace Florence x Aurore.

Food value analyses of the wheat grains harvested in 1978 showed a very similar amino acid composition amongst lines released by Montpellier and Mexico. The lysine and tryptophan contents of grains harvested at Dire were very high.

PRODUCTION TECHNIQUE EXPERIMENTS

Different methods of preparing land systems for irrigation were investigated. The flat bed system was found to be the best.

A date of seeding trial showed that the best time is between October 15 and November 15.

When frequency of irrigation was examined, the results showed that the optimum frequency is every 10 days. A five day's frequency was shown to be detrimental to plant growth.

In the factorial NPK fertilizer trial, the results showed that valid conclusions could not be drawn from the 1978 data.

In a variety demonstration trial in which seven Montpellier lines were compared with Florence x Aurore for yield, it was found that there was no significance between varieties from Montpellier. The latter yielded more than the Florence x Aurore wheats.

Five varieties were yield tested with results as follows:

Variety	Average Yield (kg/ha)	Maximum Yield (kg/ha)
L 389	5000	5900
L 170	4930	5100
L 395	4970	5300
L 390	4330	5000
L 475	4050	4300

Certain new varieties are promising. They possess high yields and good grain quality.

From the 1976 International Spring Wheat Yield Nursery received from CIMMYT, 15 of the 50 varieties were retained because of their high productivity, earliness, good grain quality, and also their aspect (strength). The 15 varieties are:

Varieties	Average Yield kg/ha	Maximum Yield kg/ha	Cycle (days)
Carthage	3500	4800	100
Pavon "S"	3570	4300	100
Anza-Mexicali (WW5)	3100	3800	107
Mexicali C 75 (durum)	3470	3800	100
Condor "S"	4040	4300	106
Soltane	3440	4300	109
Limpopo	4200	5300	95
Flicker "S"	2900	4300	97
Maya 74	3800	4300	93
Cleopatra 74	3640	4200	95
Siete Cerros	3540	4000	92
Protor	3270	4700	92
Lachish line No. 156812	2600	3100	90
Sonalika	3470	3600	100
Tanori 71 (Re-selection)	3700	5600	106

SELECTION OF ADAPTED LINES TO SAHEL CONDITIONS

The first two years of studies have shown a close linkage between essential characters (early sprouting, daylight insensitivity, resistance to drought, grain quality etc.) in the results from Dire and Montpellier. Despite this, it is considered necessary to undertake a selection of suitable varieties at the Dire station.

Montpellier has about 30 lines at its disposal which are earlier than Mexican lines. Some of these Montpellier lines will be sent to Dire in 1979 for selection studies.

SEED PRODUCTION

To start a seed production program, the Mali National Agronomic Research organization will undertake the multiplication of improved lines.

IMPORTS

In 1976, a total of 12,000 tonnes of bread wheat for flour production were imported.

MOROCCO

CLIMATE

Cereal production in Morocco is largely influenced by the earliness, amount and distribution of rainfall. Rain which falls during March is of fundamental importance in relation to crop yields. In the 1977–78 crop cycle, drought was experienced everywhere until the end of March, when valuable rains were received. Despite this rain, grain production did not reach the predicted levels.

AREA, YIELD AND PRODUCTION

The crop statistics for 1977–78 are:

	Area (1000 ha)	Av.Yield (quintal/ha)	Production (1000 quintals)
Durum Wheat	1,297.1	11.1	14,408.6
Bread Wheat	456.5	9.5	4,355.9
Barley	2,388.6	9.7	23,261.9
TOTAL	4,279.2	–	42,280.8

Barley continued to be the main cereal, followed by durum wheat and bread wheat.

DURUM WHEAT

Since 1970–71 when 1,517,000 hectares were grown, there has been a decline in the area. In 1977–78, only 1,297,000 hectares were sown.

Generally the average yield is low—less than 12 quintals /hectare. In 1977–78 it was 11.10 quintals/hectare, which was higher than the two previous seasons. The crop needs a large amount of water in March, and is very sensitive to water deficits. In regions where the cherqui (hot air stream) is encountered, yields are very low especially at Taza, Kenitra and Nador.

However, good yields were obtained in the following regions. The yield results in quintals/hectare are shown in brackets: Meknès (17.3); Khénifra (13.8); Settat (13.3); Benslimane (13.5) and Khouribga (13.6).

Durum wheat production in 1977–78 was 30.9 per cent of the total cereal production. Although higher than the previous year, it was less than in 1975–76 due to a reduction in the area sown.

BREAD WHEAT

As with durum wheat, a reduced area was sown in 1977–78. Regarding regional distribution, 13.9 per cent was grown in Safi, 9.6 per cent in Settat and 7 per cent in El-Kelaa. These are the main regions where bread wheat is grown.

Generally the average yield is low. In the last eight seasons, the highest yield was 11.5 quintals/hectare which was in 1975–76. However in 1977–78, the average was 9.5 quintals/hectare, with the results, in quintals/hectare, being obtained in the following regions: Tanger (29.2); Fès (21.2); Meknès (17.4) and Ben-Mellal (16.7).

The area sown to bread wheat has declined from 561,700 hectares in 1972–73 to 456,000 hectares in 1977–78.

BARLEY

In 1977–78, over 50 per cent of the total sown cereal area consisted of barley. It plays a major role in animal nutrition. For human nutrition, it is of secondary importance.

The main barley growing areas are Agadir (10.7 per cent of the crop), Settat, Safi, Essaouira and Marrakech and El-Kelaa.

Barley yields are much higher than the other cereals. Because it matures earlier than other crops, it escapes the cherqui hot air streams.

The overall average yield in 1977–78 was poor–9.7 quintals/hectare. However the following regions produced better results; the quintal/hectare figures are shown in brackets: Khénifra (19.6); Tetouan (17.9); Tadla (17.8); Benslimane (15.4) and Meknès (14.1).

Lowest barley yields were at Oujde (3.2); Rabat (3.1) and Figuig (0.4).

In the last five seasons, there have been considerable fluctuations in barley production and average yield/hectare, as indicated in the following table:

	Area (1000 ha)	Production (1000 quintals)	Av.Yield (quintal/ha)
1973–74	1,972.6	23,870.0	12.1
1974–75	1,819.1	15,853.1	8.7
1975–76	2,117.5	28,604.0	13.5
1976–77	2,316.2	13,450.0	5.8
1977–78	2,388.6	23,261.9	9.7

MOZAMBIQUE

AREA AND PRODUCTION

In 1978 there was only a very small area of about 1000 ha of bread wheat under production with a yield average of about one t/ha. Thus the total production was near 1000 t.

IMPORTS

As yet, there is no real wheat production industry in Mozambique. Consequently, wheat has to be imported. In 1978, it amounted to approximately 120,000 t.

CLIMATE

Conditions were generally normal. At some places, excessive rains caused damage by water stagnation.

FERTILIZERS

Fertilizer use is only characteristic for state and private farms, but varies greatly on availability. The recommended doses are: 100 kg N, 50 kg P_2O_5, 50 kg K_2O per ha in soils of medium fertility.

WHEAT EXPANSION PROBLEMS

The most important problem precluding expansion in area is the need for irrigation. Areas where wheat can be grown under rainfed conditions, are limited.

DISEASES AND PESTS

In 1978, the following wheat diseases were observed: leaf rust, stem rust, mildew, loose smut, *Helminthosporium* (?), *Septoria and Fusarium.* The rusts were the most important diseases.

Aphids and stem borer *(Chilo suppressalis)* caused problems.

SEED INDUSTRY

There is no special seed industry for wheat. Seed is passed from state enterprises to the farmers.

There are plans for developing a seed production industry.

VARIETIES

The principal varieties being grown are 148 (Angola), 151/70 (Angola) and Inia 66. The latter, a HYV, does not appear to offer any advantages over the other varieties.

PROMISING MATERIALS

The 1978 season results showed that the most promising varieties were Anza, Yecora 70, Soltane, Helene S13, Pavon 76, R 204 and Zaragoza.

PRODUCTION PRACTICES

Wheat under irrigation is sown during April and May. Rainfed wheat is sown in February–March. The wheat harvest is from August–October.

Fertilizer practices, weed control, rust research and variety testing are being investigated.

GRAIN END USES

The only uses are for bread and macaroni.

INTERNATIONAL SUPPORT

The national program would be assisted by receiving many wheat varieties from CIMMYT for evaluating rust resistance and regional adaptation.

NIGERIA

INTRODUCTION

For centuries wheat has been traditionally cultivated under irrigation around the shores of Lake Chad, during the cold dry harmattan period. Being a temperate crop, wheat can be grown in the northern areas where temperatures during the harmattan are low enough for adequate tillering and heading. At present, wheat cultivation is limited almost entirely to the northern areas of the country between latitudes 10-14° N and altitude 240-360 m. Most of the areas are marginally suitable for commercial wheat production because the period during which temperatures remain below the critical limit of 32°C is severely restricted at all the present major irrigation sites.

The high temperatures during heading cause reduction in yield. Most of present recommended varieties average 2 tonnes/hectare, though some have yielded over 4 t/ha in certain years. There is an urgent need to find varieties which can withstand higher temperatures during heading and yield around 4 t/ha. If wheat is planted at the recommended time (usually the second half of November) and the recommended cultural practices are observed, varieties could produce 4 t/ha of grains under Nigerian conditions.

The area under wheat cultivation at present, is estimated to be about 8000 hectares. It will increase to 200,000 hectares as the water from the irrigation schemes around Lake Chad, Kano, Kaduna and Sokoto becomes available during the next few years. At present most of the wheat consumed in the country is imported from outside and it is envisaged that with good varieties, most of the wheat needed would be produced locally.

DISEASES

The majority of the wheat varieties are heavily attacked by *Chilo* species in the Ngala area. Wheat diseases like rusts, smut and root rot do occur in Nigeria but none of these were found on wheat in 1978 in the Lake Chad area.

PROMISING LINES

The research on wheat started about a decade ago and several hundred varieties have now been evaluated at the Institute for Agricultural Research, Samaru and other places. Recently thousands of short strawed Mexican varieties were included in this program. Several promising lines i.e. Pj62, Super X, Mexipak, Inia "S" - Soty x Czho, Zambezi, Bb 4 "5" (Cajeme 'S') Cal-CC x Son/Nr, UQ 105 and Anza have been identified to be high yielding.

NEW VARIETIES

The newest varieties released are Indus 66 and Inia 66 for the Chad Basin area, and Siete Cerros for Kano State. In 1971 (Lee-N10B) Gb 55) and Sonora 63 were realeased for northern Nigeria.

FERTILIZERS

On all the irrigation schemes, fertilizer is used. It is subsidized and is imported in bulk by the Government. In Chad Basin, a basal dose of 100 kg/ha N and 40 kg/ha P_2O_5 is recommended and is used by all the farmers.

QUALITY

Quality tests carried out by the flour mills of Nigeria, Lagos, show that the protein contents of Indus 66 and Inia 66 range from 11.6 - 12.91 per cent depending upon the percentage flour extraction. These varieties are suitable for blending with higher quality protein wheat for bread making.

BARLEY

Barley has been grown around Lake Chad as forage crop, but all the malt used in beer production is imported. The Nigerian Breweries supplied seeds of 15 barley varieties to the Institute for Agricultural Research, Samaru and to the Lake Chad Research Institute, Maiduguri for testing in the Kano river project and Lake Chad areas. The yield of most varieties was comparable with that for wheat.

Last year, 1000 lines of barley sent by CIMMYT were evaluated at the Crop Research Station, Ngala and in these trials several of the barley lines outyielded recommended wheat varieties. It appears that barley for malt production has a great future in the Chad Basin area.

TRITICALE

As yet, no commercial triticale crops are grown in Nigeria, but last year 250 lines were evaluated at Ngala. It appears that several lines will outyield recommended wheat varieties. They were less attacked by stem borers than bread and durum wheat varieties. It seems that some triticale varieties will need to be further assessed for their performance, in larger plots.

RHODESIA

SEASONAL CONDITIONS

The 1978 winter was generally a cold one, especially during June and July when the mean maximum, mean minimum and the number of frosty nights were appreciably lower than those of the 10 year mean. However, May was warm, August was mild and September was hotter than normal. These factors resulted in the mid May planting giving better yields than the early May plantings, and overall the yields were higher than those attained during 1977.

Temperatures rose sharply during the latter part of September and October and this caused a premature ripening of some crops. Heavy rain fell at most sites about mid October, and this not only hampered harvesting operations, but also caused a fair amount of damage. Test densities were affected in most cases and at some sites, the grain sprouted in the ear, thus giving rise to undergrade wheat.

WHEAT VARIETIES

Rhodesia, for the first time in four years produced enough certified seed of the varieties Limpopo and Gwebi to satisfy the country's needs. About 55 per cent of the area was planted to Gwebi 35 per cent to Limpopo and 10 per cent to other varieties (Tokwe, Devuli, Shashi and Oldafo 30). At the start of the season Torim 73 was released, and certified seed should be available in 1979. It is expected that in time, Torim 73 and Gwebi will account for 90 per cent of the sown area.

FERTILIZERS

Fertilizer supplies were more than adequate with all farmers making heavy applications, especially nitrogen. The average application rate is 120 N: 60-80 P_2O_5: 40 K_2O kg/ha. The most successful farmers usually use very high nitrogen levels, i.e. 160-180 kg/ha and some get yields up to 10 tonnes/hectare.

The 1978 crop was the biggest ever produced in Rhodesia and has resulted in a large surplus. The national yield again exceeded 4 tonnes/hectare, with the top yields being in the region of 8 tonnes/hectare. The high production is mainly due to the expansion of irrigation schemes and also due to better yields being obtained with the variety Gwebi (selection from Yecora 70). No further expansion is anticipated for the coming season because of the surplus produced in both 1977 and 1978.

PROMISING MATERIALS

A number of locally bred varieties have shown a lot of promise in trials to date. They are more resistant to stem and leaf rust, and could become very popular once released. The majority of CIMMYT varieties like Pavon 76, Nacozari etc., yield very well here, but unfortunately are too tall and lodge very badly under sprinkler irrigation and are thus non starters.

RESEARCH

Agronomic research was conducted on row spacing, seed rates and on fertilizer applications, notably nitrogen x phosphate and rates of nitrogen. With nitrogen, it was found that there was a linear increase in yield with N up to 300 kg/ha, but was only economical up to about 180 kg/ha. Time of application is also important and it appears that the best split seems to be half before planting, a quarter at six weeks and a quarter at 10 weeks.

DISEASES

Disease is not a serious problem in Rhodesia as a whole, but it is a problem in the lowveld which accounts for about 25 per cent of the national crop. Stem rust was again bad during 1978 and most crops were affected. Limpopo is fairly resistant, but Gwebi is susceptible. However, Gwebi could be classed as a slow ruster, only getting infected in the soft dough stage.

Leaf rust was also bad and none of the varieties grown are resistant. As a result of this, the main emphasis in the breeding programme is on disease resistance. Only one international known variety, Zaragoza 75, gives good resistance to both leaf and stem rust. This variety also yields very well, but unfortunately it is too tall for sprinkler irrigation and lodges badly.

BARLEY

The general conditions for barley production are basically the same as for wheat, with the main difference being the levels of nitrogen application. The main variety grown is the Australian variety Diamant, which makes up about 90 per cent of the total crop. Barley yields are on a par with those of wheat, but could be higher if nitrogen application did not have to be limited.

All the barley grown in Rhodesia is used for malt and none for feed purposes. In this respect, the country is again self sufficient. All barley is grown under contract to the maltsters, and thus production is limited to the capacity of the malting plant. If it were not for this, barley production would increase because production costs are slightly lower due to the lower levels of nitrogen application, which are 60-80 kg/ha.

Disease is no problem in barley production.

TRITICALE AND DURUM

These two crops are not grown at all in Rhodesia.

SENEGAL

The durum wheat variety Giorgio in Senegal. The production of durum is being examined for Mauritania for making cous-cous, a basic staple food.

INTRODUCTION

The early work regarding the introduction of wheat in Senegal goes back to 1966, and this work was conducted by the Institut de Recherches Agronomique Tropicale (IRAT).

From 1968, studies were conducted by the Project de Recherches Agronomique with FAO support, which has carried on further varietal trials and research concerning cultural practices viz., selection of land (type of soil), planting dates, plant population density, land preparation, fertilizer rates, cultivation, weed control, irrigation dates, plant protection, etc.

On the basis of this work, from 1970, a working variety was determined—Mexipak, which came from CIMMYT.

AREA AND PRODUCTION

In Senegal, the development project contemplates a wheat area of 5,000 hectares by 1981. At present, the wheat crop is restricted to bread wheat.

Durum wheat is contemplated for Mauritania for cous-cous making, which is a basic staple food.

Barley farming is contemplated for a later stage, and this will be for beer production.

Presently, wheat is cultivated in areas averaging from 30–80 hectares, for experimentation and to familiarize farmers with the techniques of this crop.

Yields obtained up to now are of the order of 3.5–6.0 t/ha in areas of 4–8 ha for seed multiplication within the experiment stations and from 2–4 t/ha by farmers in the irrigated districts.

WHEAT IMPORTS

Senegal has a high consumption of bread made from wheat flour. Annually about 100,000–125,000 tons of wheat are imported, part of which are re-exported to neighboring countries (Mauritania and Mali).

Studies concerning the potential of the Fleuve Valley in Senegal, demonstrate that 450,000 ha can be irrigated.

On the basis of the present average yields, it is considered that an area of 40,000 ha would be enough to produce the necessary wheat for human consumption in this country.

CLIMATE

In the Senegal region, it is Sahelian, and is determined by the existence of a long and heavy influence of the northeast anti-cyclone, which displaces dry wind (air) masses from the Sahelian zone. Also there is a shorter period, when masses of monzonic wind from the southwest, charged with humidity, determine the occurrence of a rainy period.

Under these conditions, two seasons are characterized by a dry season of 8–10 months, dominated by the anticyclone from October to June, and a rainy season of 2–4 months from July to September.

The first part of the dry season is temperate with temperatures falling to 10°C at night.

The wheat crop season starts during the second half of November, when temperatures are favorable for rooting and tillering. Wheat maturity occurs at the end of February and early March, when temperatures begin to increase.

Wheat yields depend strongly on the occurrence or absence of a hot dry wind named the harmattan, which flows from the northeast and comes from the Sahara. It determines a strong evapotranspiration and a physiological disequilibrium in the plants. The presence of the harmattan during the maturation of wheat produces extreme seed shrivelling. Wheat kernels decrease in volume and weight e.g. the weight of 1,000 grains, which is normally 38–48 grams, decreases to 28–32 grams.

FERTILIZERS

The Senegalese State maintains a policy which favors fertilizer use. Prices are quite low, due to the State subsidizing the difference between the acquisition price and selling price. Therefore, fertilizers constitute a stimulus to obtain high yields.

The fertilizers in use are urea (46 per cent N), ammonium phosphate (16 per cent N and 48 per cent P_2O_5), triple superphosphate (45 per cent P_2O_5), potassium chloride (60 per cent K_2O), and other different formulae of major elements (N–P–K).

Agronomic research is trying to determine the best formulae and methodology to use fertilizers. Research is also being conducted on the use of micro elements.

PRODUCTION-INCREASE PROBLEMS

The expansion of the wheat crop in the Senegal basin is a problem related to the evaluation and utilization of the river valley. From 1980 on, when the first dam starts to operate for agricultural use, the wheat area will increase in importance.

The difficulties encountered will be:

(a) The price of wheat, which is not now at an incentive level for the farmers. Since 1970, this price has been 43 Francs CFA/kg, or 220 dollars/t. During the same period, bread prices have doubled.

(b) Wheat competes with rice, which is the basic staple food for the population of the valley. Since the rice crop season coincides with the wheat season, farmers are not stimulated by the present wheat price.

(c) Expansion of the wheat crop is slowed by the absence of mills. Producers send their production to Dakar, the capital of the country, where most mills are located. The distance from the production area to Dakar is 600 km, and this makes transportation costs expensive.

(d) Wheat requires a perfectly flat land, for it is very sensitive to water accumulation. However, rice is less sensitive and its yields are not as influenced by land irregularities.

(e) *Cyperus rotundus,* a tropical weed, invades irrigated plots after 4–5 years of cultivation. This weed strongly decreases productivity. It can be controlled by the application of Round Up, a glyphosphate herbicide; however its use is not yet fully extended among the farmers.

PLANT PROTECTION PROBLEMS

Until now, wheat has not suffered from diseases. This situation is due to the weather conditions of the country: scarcity of rains, reduced moisture in the air (20–40 per cent), high solar radiation and temperatures unfavorable to parasitic bacteria and fungal development.

The only disease observed so far has been loose smut *(Ustilago tritici)* in certain wheat varieties coming from Israel. These varieties are being discarded.

Regarding insect pests, there is sometimes a light attack by a species of *Haplodiplosis,* which deposits its eggs between the superior leaves at the stem. The larvae establish themselves in the superior node and eat the stem growing point, and later the dry spike.

The attack is minimum, 0.01 per cent, but attention is required to avoid expansion of this pest.

The animals which most destroy crops are rats. Awnless varieties of wheat are attacked by *Quelea, Euplectes, Plocetis, etc.).*

Plant protection problems are not now a restriction to the wheat crop.

SEED PRODUCTION

Until now, the only seed producer is the Project PNUD/FAO, entitled "Développement de la Céréaliculture", which uses an 18 ha area to conduct studies on the main problems related to wheat production. Also, it carries out multiplication there of the best varieties from CIMMYT.

There is also the Société pour l'Aménagement et l'Exploitation des Terres du Delta (SAED) which can multiply the basic seed offered or developed by the Senegal center of agronomic research.

For the future (1980 on), the establishment of a seed center within the basin of the Senegal river has been contemplated. This center will be established with FAO support, and the pertinent documents are already being determined.

At the same time, the establishment of an experimental station is being undertaken within the Schem of l'Institute Sénégalais de Recherche Agronomique (ISRA). This station is located within the Valley of Senegal, and a first collection of CIMMYT wheat and triticale varieties is now being studied.

It is felt that the problem of seed production will be solved without any difficulty.

PRINCIPAL VARIETIES

After three years, the first series of varieties being grown in the Senegal Valley consists of Mexipak, Siete Cerros, Chenab 70 and SA 42.

YIELD TRIALS

The following yields were obtained at the FAO Center in Guédé:

Varieties	Campaigns	Yields (kg/ha)	Average
Mexipak	1971-1978	2,554-6,056	3,847
Siete Cerros	1973-1978	2,692-5,625	3,780
Chenab 70	1975-1978	2,769-4,112	3,427
SA-42	1975-1978	2,723-4,636	3,706

The only durum variety tested was Cocorit 71, which yielded 2,870–3,120 kg/ha.

The triticale line Navojoa "S" yielded 3,200–3,780 kg/hectare.

During the last three seasons (1976–77, 1977–78 and 1978–79) several other trials were conducted, with the following results:

Varieties	Yield (kg/ha) 1976-77	Yield (kg/ha) 1977-78	Type of trial
Anza or Mexicani	3,760	3,612	Statistical
K-230-Coyacán	3,069	3,167	Multiplication
Jupateco 73"S"	3,488	3,308	Statistical
Tzpp-Pl x 7C	4,250	4,000	Statistical
Tanori 71 Resel.	3,175	3,560	Statistical
Toluca	2,385	3,683	Multiplication
Nuri 70	1,857	2,715	Multiplication
Mochis 70	–	3,106	Multiplication

Included amongst the most promising varieties are Tzpp-Pl x 7C, Canario "S" and Npo-Tob "S" x 8156/Kal-Bb. The trials conducted in 1978-79 show other potential varieties. Work is being continued.

AGRONOMIC RESEARCH

Preliminary trials have been conducted in the Senegal Valley to verify new cultural practices and the correct techniques of application, in respect of the best date of planting, planting rates (300–600 grains/cm^2), the best method of planting, irrigation rates and an irrigation calendar; response to nitrogen fertilizers and the reaction of wheat to various soil types.

In summary, the agronomic research has reached a stage to respond to problems of wheat in the region.

INTERNATIONAL COOPERATION

CIMMYT has provided very important material for wheat research. Collections of 50 varieties in three replications are being used to select varieties adapted to the environment of the Senegal River.

SOUTH AFRICA

AREA AND PRODUCTION

Small grain statistics for the 1977-78 season are:

Crop	Area (1000 ha)	Production (1000 t)	Yield (t/ha)
Wheat	1705	1750	1.03
Barley	114	66	0.58
Oats	552	89	0.16
Rye	62	4	0.06
Durum	–	4	–

The low yields of barley, oats and rye resulted from these crops having been utilized as green grazing or being harvested for feeding livestock.

Because of the limited extent of arable land (only 11 per cent of 1.22 million ha is arable) it is doubtful whether the present area of winter cereals can be increased by more than 20 per cent in the foreseeable future.

Local consumption of wheat is approximately 1.65 million tonnes.

IMPORTS AND EXPORTS

There is self sufficiency in small grains with the exception of barley malt, of which 26,343 t were imported. Minor quantities of barley and oats have been exported. About 0.25 million tonnes of wheat were exported and the minor carry over amounted to approximately 0.8 million tonnes.

CLIMATIC CONDITIONS

The rainfall distribution was generally favourable in the northern areas but conditions in the western Cape were almost catastrophic. There, only 34 per cent of the normal crop was realised. The result was that 86 per cent of the national wheat was produced in the summer rainfall areas. The contribution of the Orange Free State was 59 per cent of the total yield.

FERTILIZERS

They are freely available and from time to time are exported to neighbouring countries. There are straight fertilizers and a wide range of N P K mixtures. Zinc is included for certain areas.

Except in the sandy soils of the Cape Coastal Belt where copper deficiencies are experienced, winter cereals do not react to micronutrient applications. The application of N varies according to crop rotation systems, time of planting, production potential and cultivar response. The average rate would be about 12 kg N and 16 kg P per hectare. Potassium is seldom applied because the vast majority of soils analyse above 90 ppm K. Under irrigation (normally representing 9 per cent of the national wheat crop) 120–140 kg N and 26 kg P per hectare are applied.

Fertilizer prices increased last year to 60 and 106 dollar cents/kg. for N and P respectively. The subsidy on N and P averages 5.6 per cent. Potassium is not subsidized and costs 25 dollar cents per kg.

DISEASES AND PESTS

Stem rust is the most important winter cereal disease. Leaf rust and *Septoria* (only in the South Western Cape) are common, but apparently they do not have a marked effect on yield. Due to economic considerations a major emphasis of the breeding effort is placed on achieving stem rust resistance. Currently very promising material with *T.timopheevi, T.agropyron* and *T.durum* resistance is available.

Other pathogens are some root diseases, such as *Geaumannomyces, Fusarium, Rhizoctonia* and *Periconia.* The latter is believed to be the problem organism in the Springbok Flats in Northern Transvaal with its deep vertisols. The only solution after successive wheat crops seems to be the introduction of a crop rotation system. Under favourable conditions for the pathogen, stem rust and root diseases can be disastrous and yield can be reduced by 50 per cent or more. Research on the root disease problem is being undertaken in collaboration with the Plant Pathology Department of the University of Pretoria.

The occurrence of insect pests was mainly limited to the Eastern Free State where wheat aphid species caused havoc during September/October last year, which resulted in a 50 per cent yield reduction. The symptoms were dwarfing and yellowing of the leaves. The folded leaves protect the aphids from contact insecticides. Systemic aphicides gave erratic results. The species involved were *Diuraphis muehlei* (now discovered for the first time), *Sitobion avenae* (common brown wheat aphid), *Schizaphis graminum* (common wheat aphid), *Rhopalosiphum maidis, Acyrthosiphon dirhodum* (grass rose) and *Myzus persicae.*

The aphids were present in an area where approximately 22 per cent of the national wheat crop was produced. University of Cape Town research workers were able to identify barley yellow dwarf virus in some samples

SEED INDUSTRY

The Small Grain Center at Bethlehem negotiated an agreement with a central cooperative to supply it with 14 tonnes of breeder's seed of a newly released cultivar, and 14 t of breeder's seed of an existing cultivar, should pure seed of the latter be in demand.

The central cooperative then multiplies the seed for distribution to the ordinary farmer's cooperatives.

HYV

They contribute approximately 35.8 per cent of the national crop (Inia 17.05 per cent, T4 7.8 per cent, SST3 6.96 per cent and Zambesi 3.98 per cent). These varieties have been grown for the past decade and still form the mainstay, especially of irrigated wheat production.

PRINCIPAL VARIETIES

The four above mentioned HYV's plus Scheepers 69 (29.73 per cent) and Betta (21.06 per cent) represent the six leading varieties totalling 86.6 per cent of the South African crop.

PROMISING MATERIAL

The following varieties are promising and they are in the final stages of multiplication for release in 1978:

1. Dipka	Flameks/Minturki** 4/T.timopheevi
2. Gouritz	Flameks/Minturki** 4/T.timopheevi
3. Flamink	Flameks/Minturki** 4/T.timopheevi
4. Zaragoza	Mengavi/8156 (CIMMYT)
5. SST 101	Betta/Pawnee//Cheyenne/Minn. III. 54–12
6. SST 102	Betta** 2/Agent

All these varieties contain S Tt1 as the major component for stem rust resistance.

Categories 1, 2 and 3 are intermediate spring wheats, 3 is also an irrigated wheat, and 4 and 5 are winter and intermediate dryland wheats.

Other promising materials are Nordum(durum wheat D 4487 from North Dakota) and Diamant (a winter barley from Germany).

PRODUCTION PRACTICES

Planting times generally vary from April to August/ September. The only exception is the Northern Transvaal (Springbok Flats) where wheat is planted during February/ March and harvested in July. The rest of the crop is harvested from November to January. In the Orange Free State, about 80 per cent of the wheat is planted from April/ June (winter) to June/July (intermediate) on moisture conserved during the rainy season (October–March). The precipitation during the winter months is negligible. Due to the existence of a dry surface layer at planting time, producers have to use a certain type of press–wheel planter in order to facilitate the positioning of seed in the moist area.

RESEARCH

There are agronomic research programs relating to tillage, rotation systems, nutrition and herbicide screenings.

Cultivar evaluation as an extension of the breeding program, is being continued on a national basis.

GRAIN USAGE

All the wheat produced is for human consumption and is utilised in the form of bread (60 per cent brown bread), cakes and pastries, cookies and semolina products.

PROBLEMS

Recurring problems in South Africa are stem rust, leaf rust and *Septoria* diseases. Recent aphid infestations and a possibility of barley yellow dwarf virus infection needs closer investigation.

INTERNATIONAL SUPPORT

South Africa is already heavily dependent on CIMMYT germ plasm and many new lines have been developed from this material. The triticale program is now underway and this material will be carefully examined in the future.

SUDAN

PRODUCTION AND AREA

The total area under wheat in 1978 season was 592,000 feddans* distributed as follows:

Region	Feddans
Gezira	465,000
Girba	80,000
Rahad	10,000
Northern Province	29,000
White Nile Province	11,000
Nile Province	6,000
Khartoum	1,000
Total	592,000

* Feddan=0.42 hectares

The production from this total area was estimated at 31,720 tonnes with an average yield of 0.451 t/feddan, which is equivalent to l.07 t/ha.

There were several reasons for the low yield. They included:

(1) The late establishment of the crop was due to the shortage of tractors and implements, and/or the unavailability of gasoline. More than 70 per cent of the area grown under wheat was planted after the end of November, a date which is very late for optimum planting. Research findings have indicated that more than 40 per cent of yield is liable to be lost if the sowing of wheat is delayed beyond the second week of November.

(2) Poor land preparations and levelling.

(3) Unavailability of irrigation water in time for applications in Gezira and Girba.

(4) Marked effects of weeds in the Girba area.

Some progressive farmers who managed to plant at the optimum time obtained yields of more than one tonne per feddan. But the late establishment of the crop beyond the first week of December was a major factor in the reduction of wheat yields in the 1978 season.

CLIMATE, DISEASES AND PESTS

The season was quite normal with no marked fluctuations in temperatures.

There was no serious incidence of diseases and pests.

RESEARCH PROGRAM

The research program for wheat in 1978 included wheat observation nurseries provided by international organizations such as CIMMYT and ICARDA. The program also included local crosses or selections screened from previous material derived from different sources. Yield performance tests were also conducted at various sites where wheat specialists are available.

The National Variety Trial comprising the most promising 12 lines in stock was planted at Shambat, Gezira, Girba, Sennar and Hudeiba.

TANZANIA

AREA

Wheat is grown in both the Northern Highland and the Southern Highland regions.

In the Northern Highlands, the wheat growing districts with the number of planted hectares shown in parenthesis are: West Kilimanjaro (7,692); Monduli and Arusha (1,619); Mbulu, Oldeani, Karatu (3,239); Mulbadow–Basotu–Setchet in Hanang (9,716). The total area under production is 22,266 ha. The undeveloped potential area in the Loliondo district is 20,000 ha.

The total area in the Southern Highlands is 2,929 ha. The leading district is Njombe with 1,776 ha.

IMPORTS

In 1977-78, Tanzania imported all of its malting barley and 40 per cent of its bread wheat requirements.

CLIMATE

Seasonal conditions were favourable for wheat production in 1978.

FERTILIZERS

Fertility levels of the major nutrients in the wheat growing districts in the Northern Highlands are very high. In four years of NPK trials, there has been no response by wheat. However, in the volcanic ashy soils around Arusha, manganese deficiency extending over 20,000 ha has been reported. The deficiency is being corrected by drilling 10 kg Mn/ha as manganese sulphate mixed with an equal amount of N, as sulphate of ammonia.

In the Southern Highlands, N and P limit wheat production. There is no response to K. The current recommendations per hectare are 20-40 kg P_2O_5 and 40–60 kg N.

Copper deficiency has been reported in wheat at Mbeya. Copper sulphate has been recommended at 0.5–1.0 kg Cu/ha, as a foliar application.

OTHER PROBLEMS

These include capital investment for land development, farm machinery production input requirements, infrastructure development in new areas and weed control.

DISEASES AND PESTS

Diseases which materially reduce yields and quality in Tanzania are stem rust, stripe rust, *Helminthosporium* blotches, *Fusarium* and *Septoria* blotches.

Stripe rust is severe on approximately 8,000 ha and *Helminthosporium* blotches reduce yield, quality and germination on about 16,000 ha. *Septoria* blotches infect approximately 5,000 ha. Common root rot is found across all areas, but it has never materially affected yield.

Stripe rust and *Septoria* blotches have caused losses of 100 per cent in insolated fields. Normally they do not exceed 20 per cent. In 1977 *Helminthosporium* blotches, mainly *Cochliobolus sativus tritici* resulted in losses of up to 40 per cent on approximately 2,800 ha in one area.

Stem rust is always a major threat. However, all licenced varieties carry a high degree of resistance and there has been no major epidemic for several years.

Some losses occur yearly from insects especially armyworms. They are controlled with insecticides.

Quela spp of birds have caused losses ranging from 30–90 per cent in some areas. An FAO Quela control unit is currently working on the problem.

SEED INDUSTRY

The Tanzania Seed Act 1973 is the basis of the development of the seed industry, which is a public enterprise.

A Seed Multiplication Program is now operational. There are Foundation Seed Farms in the major crop zones. For wheat seed, Breeder Seed from the Lyamungu Agronomic Research Center is passed onto the Arusha Foundation Seed Farm for multiplication.

The Tanzania Seed Company takes over the seed and contracts it out to some wheat farmers in the area. Both private and state farms are eligible wheat seed growers.

The Tanzania Seed Certification Agency is located with the Seed Laboratory at the premises of the Faculty of Agriculture, Forestry and Veterinary Sciences at the University of Dar es Salaam, Morogoro.

VARIETIES

Improved varieties are sown in the majority of the wheat production areas. The area sown is expanding slowly but will accelerate as seed multiplied by the Foundation seed farms becomes more available.

The expansion rate is about 4,000 ha per year and will rise to a Tanzania total of around 80,000 ha, all of which will be seeded to improved varieties.

The principal varieties are:

* Tai, Heb Sd x Wisc–Sup x Fenfere 'S'
* Mbuni, Trophy x K6106-1
* Kororo, Y50E–8156R x Kalyan

* Nyati AFM x Romany
  Kweche, LR x Son 64
* Trophy, T–K_2 x Y50
  Mamba, (AFM x P_2)F6
  Kosi, Tob 66/3 SRPC 527–67//C18154–Fr
  Joli, Trophy x K6106–16A

The variety Mamba, due to its susceptibility to some strains of stem rust, is limited to use in 3,000 ha in the Southern Highlands. Kozi and Joli are being multiplied, but are not yet in general use.

The five varieties preceded by an asterisk are those in greatest use. They were released in 1975. Trophy has been in use for about eight years.

PROMISING MATERIALS

To date these are Alondra 'S' lines and crosses.

PRODUCTION PRACTICES

Those in use are not new, being mainly standard techniques centred about good soil preparation, proper timing of all operations and good weed control. Fertilizers (NPK) are required in the Southern Highlands.

The time of planting increases from south to north. The average time is the last week of March to mid April. The time of harvest is 140 days later, plus 10 days during the dry period.

RESEARCH

Such activities have been directed to soil fertility, farm management (economics) and to crop and soil management (agronomy).

INTERNATIONAL SUPPORT

The bulk of the material under test in Tanzania is derived from CIMMYT (Mexico and Kenya) and from ICARDA. It is considered that better material is being received each year. The introduction of the *Helminthosporium* nursery from CIMMYT is expected to provide the disease resistance required for varieties in Tanzania.

ZAMBIA

Matthew Monamwenge, Assistant Plant Scientist and Freddie Mative, Technician, examining trial plots at the National Irrigation Research Station, Nanga, Zambia.

AREA AND PRODUCTION

Zambia produced about four per cent of its wheat requirement in 1978 on 1600 irrigated ha and 100 rainfed ha. Neither durum nor triticale was grown and only two farmers grew barley.

IMPORTS

Between 90,000 and 150,000 tonnes are imported each year.

CLIMATE

In January, February and early March, rains were too heavy for good wheat production. The crop was heavily infested with *Helminthosporium sativum* and showed signs of water logging. However the rains stopped one month earlier than usual in the Northern Province.

This caused drought stress at filling time, especially for the long season Jupateco which made up most of the area. Senora outyielded Jupateco. In the Central and Southern areas where irrigated wheat is grown, the rain continued into late April and May. This prevented seed bed preparation and seeding at optimum times and consequently reduced the area intended for wheat to less than that sown in 1977.

FERTILIZERS

Since much of the soil is leached, heavy fertilizer rates are used in wheat production. It was available, but at times fertilizer is scarce. Lime will likely be required on fields sown to rainfed wheat. At present the lime source is about 1000 km from the area there making lime expensive.

PRODUCTION PROBLEMS

The cost of machinery and equipment is excessive and foreign exchange is scare. These two factors limit the increase in hectarage of irrigated wheat. Yields are high and the price is about 15 per cent above the world price, delivered in Lusaka. Higher subsidies might help to offset high costs.

H. sativum, a leaf and head blight, limits the growing of rainfed wheat in Central Zambia at present. Improved varieties may make it possible to grow rainfed wheat between Lusaka and Mbala.

DISEASES

One farmer had substantial losses in 1978 due to leaf rust. Most fields had traces of leaf rust but it did not build up on varieties other than Tokwe and Umnati. Ten per cent or more of the wheat suffered from mildew. Others sprayed to control it. A change in the irrigation pattern is expected to reduce losses to mildew. *H. Sativum* caused some losses in the rainfed wheat. Nematode damage was present in spots in some rainfed wheat fields.

SEED INDUSTRY

Seed is produced by farmers under contract. Basic seed production is contracted by the Seed Services Section of the Research Branch (at the Mount Makulu Research Station, Department of Agriculture) and certified seed is contracted by the National Agricultural Marketing Board. Much wheat seed is passed from farmer to farmer because of the newness of the industry and the time required to produce basic and certified seed. There are plans to produce certified seed in the year of release, in future. This will speed up the process of getting new varieties into production.

HYV

The area of HYV's will probably increase by 50-60 per cent in each of the next three years.

PRINCIPAL VARIETIES

Varieties grown	No. years since release
Zambezi	5
Mexipak	3 (not released officially)
Jupateco	2
Emu	1
Tanori	1
Limpopo	1
Sonora	1 (not released officially)

PROMISING MATERIALS

It is planned to release two lines imported from Tanzania, which originated in Kenya. They are 6290-17 and W 3697, and each is suitable for both irrigated and rainfed production.

Other promising materials are lines from Alondra 'S'/ Kalyansona and Karbas/3/CC-Inia//Cno/E.Gau-Son-64 plus.

Lee/RL2564/Fr/3/IAS 54	Fahari
Chanter/Jar	Kanga
RR68-WW15/Bj	Kiboko
Kuret M12-Ti 71	Kifaru
Chiroca S	Inia//Tob 'S'/Napo
Cno-7c/CC/Tob –	K1/Rend/Son 64
Cocoraque 73	Cno/Inia//B6
W66648-6	2193/Ch35/3/An/Gb56/An64

PRODUCTION PRACTICES

Irrigated wheat production in the Southern Province commences with seeding in April and ends with harvest in August. These operations take place in the Central Province in May and September respectively.

Rainfed wheat is produced in the Northern Province. It is sown in February and harvested in May.

GRAIN END USES

Wheat is used for bread and the varieties are of acceptable quality. A small percentage is used by Asians for chapati. Some pasta products are manufactured but so far, semolina is imported. Some suitable varieties of durum wheat have been selected.

PATHOLOGY RESEARCH

All varieties must have resistance to leaf and stem rusts. Rainfed wheats must have a high level of resistance to *H. sativum. Septoria* is a minor disease in rainfed crops and mildew, in irrigated crops. Disease screening research is being actively undertaken.

BARLEY

It is grown by 2-4 growers each year on contract with the brewing company but their malting facilities are limited. Most malt is imported. Plans are to grow barley on a large scheme for the breweries who will increase their malting facilities when production warrants it. A very small production is used for feed for cattle and for special foods for Asians.

TRITICALE

Varieties are resistant to *H. sativum* and rusts and they yield higher than wheat. Plans are to follow the example of Kenya to get triticale into production for use in bread making. Hundreds of small farmers are growing wheat on small areas of up to one ha. They may find that triticale is more suitable because of its better tolerance to acid soils and lower levels of management.

INTERNATIONAL SUPPORT

Useful material is received from a number of international organizations. Valuable assistance and co-operation is received from the CIMMYT operations based in Kenya.

Americas

ARGENTINA

A wheat multiplication plot of the variety Marcos Juárez, INTA being harvested on a farm in Pergamino, Argentina.

AREA AND PRODUCTION

In Argentina, the following areas were planted to small cereals in 1978: bread wheat 5,220,000 ha; durum wheat 250,000 ha; malting barley 470,000 ha; forage barley approximately 497,000 ha, and triticale about 20,000 hectares (for grazing).

Bread wheat production was 7,360,000 tonnes with an average yield of 1.6 t/ha.

EXPORTS

Argentina normally exports cereals. In 1978 a total of 1,442,900 t of bread wheat, and 184,000 t of durum wheat were exported. Bread wheat was exported mainly to USSR, Brazil and Peru; durum wheat was exported chiefly to Italy and Chile.

FERTILIZERS

Even when the farmers are aware of the good response of wheat to nitrogen fertilizers in the regions of Marcos Juárez, Pergamino and Balcarce, this practice is spreading at a low rate.

In 1977/78, a total of 6,000 t of urea and diammonium phosphate was applied to the wheat crop to cover about 70,000 ha.

In the Marcos Juárez and Pergamino regions, fertilizer recommendations for depleted soils are: 40 kg/ha N (anhydrous ammonia 82 per cent N, or urea 46 per cent N); in the southeastern region, 40-50 kg/ha N and 50-60 kg/ha P_2O_5 are recommended.

There were no problems in the fertilizer distribution for wheat in 1978. However, fertilizer use is limited in Argentina, possibly due to the facts that for many years there was no need for fertilization and that there was insufficient knowledge of the benefits to wheat planted in fields where monoculture had been practiced for many years. Fertilizers are not subsidized. The application of minor elements is now in the experimental stage.

EXPANSION OF WHEAT CROP

The possibility of increasing wheat production in Argentina rests not in the expansion of area, but in increasing the yield per unit area.

DISEASES

In the two wheat seasons viz., 1977/78 and 1978/79, the incidence and severity of *Fusarium* shows that this disease may become as much a problem as the rusts and *Septoria.*

Damage has occurred in Argentina. This disease is more prevalent under humid conditions during the wheat flowering stage.

SEED PRODUCTION

Cereals and oilcrop seed production in Argentina have been organized under regulations issued by the Ministry of Agriculture many years ago. There is a system of "fiscalized" seed production. The highest proportion of fiscalized seed production is in hands of private seed producers.

Fiscalized seed is commonly used by farmers, who do not have any problems to obtain seed of the different varieties released for commercial cultivation.

The INTA Experiment Station every year multiplies seed of its own varieties.

VARIETIES

Wheat breeding has been a permanent activity in Argentina for many years. Periodically, new varieties are added which improve yield, disease resistance and industrial quality. There were 19 varieties released in 1978.

The following varieties are of Mexican origin and they are outstanding for their yield potential: Marcos Juárez Inta, Leones Inta, Dekalb Lapacho, Dekalb Tala, Diamante Inta, Precoz Paraná Inta, Surgente Inta, Norquim Pan and Buck Ñandú, plus the following with traditional germ plasm: Buck Cencerro, Buck Namuncurá, Buck Napostá and Buck Manantial.

HIGH YIELDING VARIETIES DEVELOPED BY INTA WHEAT PROGRAM

Since 1961, when the cooperative CIMMYT-INIA Wheat Program started, several varieties have been developed in the different experiment stations participating in the program: They are:

1971.Precóz Paraná Inta	E.E.R.A. Paraná
1971.Marcos Juárez Inta	E.E.R.A. Marcos Juárez
1974.Leones Inta	E.E.R.A. Marcos Juárez
1974.Diamante Inta	E.E.R.A. Paraná
1974.Caldén Inta	E.E.A. Bordenave
1975.Surgentes Inta	E.E.R.A. Marcos Juárez
1976.Balcarceño Inta	E.E.R.A. Balcarce
1979.Saira Inta	E.E.R.A. Marcos Juárez
1979.Chaqueño Inta	E.E.R.A. Saenz Peña
1979.San Agustín Inta	E.E.R.A. Balcarce
1979.Labrador Inta	E.R.R.A. Pergamino

The new INTA varieties with Mexican germ plasm have had a great acceptance by farmers. They are being widely distributed. One of the outstanding varieties is Marcos Juárez Inta, which in 1976/77 produced 59.2 per cent of the wheat yield and in 1977/78, produced 90 per cent.

RESEARCH

Wheat research is mainly in the fields of genetic breeding plant pathology and industrial quality to a lesser degree. Agronomic research relative to breeding, is of recent origin.

GRAIN END USES

Bread wheat (*Triticum aestivum*) production goes to the milling industry for bread making, while durum wheat (*Triticum durum*) is used in the pasta making industry.

Most of the bread wheat is for domestic consumption, while the bulk of the durum wheat is exported.

Two types of barley are planted viz., malting barley *(Hordeum distichon)* and forage barley *(Hordeum vulgare).* Malting barley goes to the beer industry, while forage barley is used by the animal industry.

Triticales are just beginning to be used as a forage cereal for winter grazing in competition with rye. The use of triticale for the milling industry is not yet well defined.

INTERNATIONAL COOPERATION

A close relationship has existed between CIMMYT and INTA since the inception of CIMMYT. As a result of this cooperation, 12 varieties have been developed by the experiment stations of INTA. Another useful contribution from CIMMYT has been the training given to Argentinian scientists.

BRAZIL

AREA AND PRODUCTION

The statistics for the areas and production of bread wheat in 1978 in the various States, and the total for Brazil, are:

State	Area (ha)	Production (t)
Rio Grande do Sul	1,220,555	1,502,697
Paraná	1,345,093	1,003,484
Sao Paulo	174,963	91,429
Matto Grosso do Sul	38,303	32,261
Minas Gerais	10,994	12,020
Santa Catarina	4,457	3,767
Goias		12
Federal District		105
Total	**2,794,365**	**2,675,775**

Consumption of wheat in 1978 was 5,921,000 tonnes.

CLIMATIC CONDITIONS

In Rio Grande do Sul, Santa Catarina and South Central Paraná they were very favorable for wheat production. The winter season and early spring were cool, with enough rain, high insolation and a lower than normal relative humidity. All these factors determined the conditions for only a limited attack of diseases and aphids, and favored high yields of wheat and other cereals in this region. Some farmers received average yields of 3.5 t/ha. A rather strong frost on August 30th, and a large number of rainy days at the end of October and in November caused damages which limited yields in some areas of that wheat producing region.

In the South Central wheat region, constituted by Northern and Western Paraná, South western Sao Paulo and Southern Matto Grosso do Sul, an intense drought occurred which substantially reduced the yield, especially in Sao Paulo and Northern Paraná. Strong frosts which occurred in mid and late August caused heavy losses in Western Paraná.

In the Central Wheat Region, formed by the areas having more than 600 m of altitude in the States of Minas Gerais, Goias and the Federal District, the weather conditions were normal.

FERTILIZERS

Fertilizer production and distribution are well organized in Brazil, and there are no limitations on their use. The government does not subsidize fertilizer prices, but the part corresponding to fertilizers in the loans for crop production receives a special treatment. There is no interest to be paid on that part.

Generally, farmers use 200-300 kg/ha of NPK formulae of which 10-30-20 is an example. In many holdings, an application of nitrogenous fertilizer is used with 20-40 kg N/ha.

PROBLEMS AFFECTING WHEAT AREAS

Marked variations in wheat yields are determined by diseases, pests, frosts and moisture stress. These factors make wheat a high risk of damage crop which in turn limits its expansion. In the Southern Wheat Region, including Rio Grande do Sul, Santa Catarina and Central Southern Paraná, research recommended for the first time in 1978, the application of fungicides and all the techniques previously recommended for areas where wheat or barley have been planted for a minimum of two years. It is considered that in this way, both productivity and yield stability can be increased.

In the Central Southern Region, the major limitations are frosts and lack of moisture. Many farmers are starting to use aspersion irrigation, which requires a high investment or for which the widest use is limited.

In the Central Region, wheat farming presents the lowest risk with irrigation. The wheat crop there depends on more investments in irrigation and more intensive technical assistance.

Economic factors have also been limiting the expansion of wheat. Although wheat prices in Brazil are higher than those in the international market, they do not allow a good profit margin as an incentive for farmers.

DISEASES AND PESTS

Leaf rust attacks were not intense in 1978 in the several wheat regions in Brazil. The National Wheat Research Center (CNPT) identified two new races of stem rust which will make more complex the development of resistant cultivars.

Continued resistance is being given to all stem rust races by genes Sr22, Sr24, Sr25, Sr26 and by combinations of genes 7a + 8 + 11, 7a + 9e, 7a + T_t2 and 7a + 8 + 9b. A virus with symptoms similar to wheat mosaic was also observed. It attacked cultivars which have been shown to be virus resistant. It has not yet been identified.

The National Wheat Research Center has been developing research projects aimed at the identification of better sources of resistance to stem rust, leaf rust, *Oidium*, barley yellow dwarf virus, wheat mosaic virus, *Septoria nodorum*, *Septoria tritici*, *Helminthosporium sativum* and *Gibberella zeae*. Information on results of this work has been published in the Annual Technical Report of CNPT, Brazil.

Aphids are the main wheat pests in Brazil. Farmers usually use 2-3 applications of insecticide for control. In 1978, the CNPT in collaboration with the FAO and the University of California started a biological control program. Parasites and predators of aphids were introduced from France, US, Iran and Chile, and about 200,000 were liberated in farmers' fields during harvest of 1978. It is expected that the effects of this program will be noticed in 3-4 years, in terms of decreasing the losses caused by these pests and in terms of decreasing production costs.

In the Central South and the Central Regions, considerable losses have occurred due to attacks of soil insects especially *Elasmopalpos lignosellos.* Control of this pest is difficult especially in years with moisture deficiencies.

SEED PRODUCTION

Seed production is conducted by private companies under the control and supervision of state commissions which are directed by government institutions. There is seed available, and the quantity and quality are not limiting factors for wheat production. As new cultivars are recommended by research agencies, they are quickly multiplied by seed producers in order to supply farmers in a short time period.

The most available cultivars for the 1978 season in Rio Grande do Sul were:

Cultivar	Years of release or recommendation	Seed available (60 kg bags)	Per cent
Nobre (S 31)	1969	960,637	44.84
Jacuí (S 63)	1970	247,605	11.56
IAC 5-Maringá	1977	242,729	11.33
Cotipora (C 3)	1965	197,960	9.24
IAS 54	1970	110,032	5.14
C 33	1973	97,694	4.57
Frontana	1942	57,693	2.70
IAS 55	1972	45,200	2.11
IAS 64	1973	28,295	1.32
Glória	1977	20,606	0.97
Others	–	133,917	6.22
Total		**2,142,368**	**100.00**

In the State of Paraná, the second largest wheat producing State in Brazil, the supplies of seed for use in the 1979 season were:

Cultivar	Seed available (bags 50 kg)	Per cent
IAC 5-Maringá	2,147,640	36.78
INIA 66	1,036,640	17.74
Jupateco	798,080	13.67
Tanori	708,860	12.14
BH 1146	632,720	10.83
LA 1549	216,560	3.71
Paraguai 281	202,200	3.46
Cotipora	20,000	0.34
Tobari	9,380	0.16
IAS 57	7,180	0.12
Others	59,720	1.02
Total	**5,838,980**	**100.00**

BARLEY

Production is concentrated in high altitude regions or cooler regions in the States of Rio Grande do Sul, Santa Catarina and Paraná. Its expansion to warmer regions is limited by the increase of protein content in those regions, and which is a limiting factor for beer manufacture.

Rio Grande do Sul is the main barley producer in Brazil, with approximately 74 per cent of the national production, followed by Paraná with 19 per cent and Santa Catarina with 7 per cent.

Barley acquired by the beer companies in 1974 was 15,343 t and by 1978 it had grown to 87,165 t.

In addition to the barley produced in the country, imports in 1977 amounted to 234,919 t with a value of 64,940,217 U.S. dollars.

Weather conditions in 1978 were favorable for barley production.

BARLEY VARIETIES

The cultivars in commercial production are Continental (FM 404), Antarctica 01 (Volla), and FM 424. They are characterized by good resistance to prevailing diseases in Brazil, good industrial quality and tolerance to aluminum toxicity.

The National Wheat Research Center (CNPT) is responsible for the coordination of the National Barley cultivar trials, which are grown in 17 localities in several states in Brazil. Results obtained in Passo Fundo (RS) in 1978 are listed in the following table. The results show high yields in all the barley and wheat cultivars included in the trial.

Cultivar	Yield kg/ha	Commercial classification 1 st.	2 nd.	3 rd.
CNT 10 (Trigo)	3772	–	–	–
FM 434	3739	80.0	14.1	5.9
FM 437	3697	67.9	27.1	5.0
Antarctica 05	3664	46.6	41.2	12.2
FM 424	3636	69.8	24.5	5.7
FM 420	3556	50.9	37.0	12.1
Antarctica 03	3417	63.1	29.5	7.4
Antarctica 04	3331	47.0	38.5	14.5

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Antarctica 01 (Volla)	3317	36.6	45.6	17.8
IPB 258	3217	21.9	50.2	27.9
Continental (FM 404)	3067	39.3	42.3	18.4
Jacuí (Trigo)	2845	–	–	–
IAC 5-Maringá (Trigo)	2792	–	–	–
IPB 1219	2561	37.5	41.7	20.8
IPB 1	2792	46.2	42.2	11.6

BARLEY DISEASES

The National Wheat Research Center is conducting research projects to develop new sources of resistance to *Helminthosporium sativum, Helminthosporium teres,* barley yellow dwarf virus, and stem rust. Results of this work are published in the Brazilian Annual Technical Report of CNPT.

BARLEY PRODUCTION LIMITATIONS

The capacity of the malting industry has been the factor limiting expansion of barley production. A national program for barley production and malting self sufficiency is being developed. New malting plants will be started in 1980 at Porto Alegre and Guarapuava.

TRITICALE

Triticale is not yet a commercial crop in Brazil. The National Wheat Research Center, FECOTRIGO, the Federal University in Pelotas and other agencies are conducting research programs in triticale, for breeding or selecting cultivars adapted to ecological conditions in Brazil.

Results obtained in 1978 have identified some lines derived from CIMMYT introductions which have good kernel characteristics, and higher yields than wheat cultivars. More than one t of seed of this material is available, which will be multiplied and observed with a view to formulating recommendations in the next two or three years for the commercial use of triticale.

INTERNATIONAL COOPERATION

CIMMYT has been collaborating with Brazilian research agencies in several ways viz., supplying genetic material; growing Brazilian material in Ciudad Obregón, Mexico; training Brazilian technicians; and providing technical assistance to Brazilian agencies for conducting research programs.

CANADA

PRODUCTION AND AREA

Wheat production in Canada in 1978 exceeded the long term average. The estimated wheat production is shown in the following table:

Crop	Area (ha)	Production (tonnes)
Spring	8,985,000	17,960,000
Winter	136,000	374,000
Durum	1,453,000	2,811,400
Total	10,547,000	21,145,400

The quality of the crop was average with more than 60 per cent of the hard red spring wheat grading in the top two grades. Protein content, based on 13.5 per cent moisture, averaged 13 per cent. Exports of wheat from the 1977 crop year, which ended July 31, 1978, exceeded 15,240,000 tonnes.

VARIETIES

Most wheat varieties are developed by public plant breeding programs, although some private companies are breeding winter wheat. Approximately 25 public wheat breeders at 16 universities and federal research stations have programs to breed varieties of red spring, winter, durum, utility and feed wheats. Promising experimental lines undergo extensive national and regional tests to assess yield and quality, and if they are found superior to existing varieties, are licensed for production. At present, Canada does not have a Plant Breeder's Rights Act.

The most important hard red spring wheat varieties are Neepawa, Manitou and Sifton which are grown on 72 per cent of the spring wheat area; the durum varieties Wakooma and Wascana represent 79 per cent; while the winter wheat varieties Fredrick and Yorkstar are grown on more than 80 per cent of the winter wheat area. Pitic 62, the only CIMMYT variety licensed in Canada, was grown on about 17,000 hectares in 1978.

RESEARCH ACTIVITIES

Current research is aimed at improving yield, disease resistance, and maturity while maintaining high quality. Varieties are also being developed which pose different baking characteristics and flour quality to enable Canada to meet changing market demands. Associated research includes studies with remote sensing to determine grasshopper infestations, control of wheat mosaic virus through the genetic control of the mite which transmits the disease, resistance to post-harvest sprouting and the chemical identification of varieties.

The CIMMYT program has provided Canadian breeders with useful germ plasm for their programs and it is hoped that this cooperation will continue.

COLOMBIA

INTRODUCTION

In 1978, the small cereals program conducted research at the National Agricultural Research Center (CNIA) in Tibaitatá, and at the Obonuco (Nariño) Experiment station.

Research was conducted in wheat, barley and triticale, with emphasis on testing and selecting superior materials for yield, quality, adaptability and resistance to prevailing diseases.

WHEAT YIELD RESULTS

The highest average yield in trials and small multiplication plots in Tibaitatá in 1978 was 8,010 kg/ha, and was achieved with the variety 67. Varieties Nos. 67, 20, 62, 42, 71 and 31 yielded more than 5.5 tonnes/ha, while Bonza 63, the check variety, yielded 3.612 t/ha. The improved check variety Icatá ranked second with 6.371 t/ha, which confirms its excellent yield potential. The average yield of the 100 varieties included in the first four trials was 4.5 t/ha. All the selected varieties, except V 16, yielded above this average.

During November-December, 1977 and January-February, 1978 temperatures dropped to –7.0°C, 5.2°C, and –6.4°C, respectively, which decreased yields drastically. In that period the highest yielding varieties viz., Nos. 49, 53, 42, 73 and 65, yielded over 3.0 t/ha, the variety 49 being the highest with 3.586 t/ha, overyielding Bonza 63, the check variety by 30 per cent. Icatá, the improved check variety, yielded only 2.501 t/ha in 1977, while in 1978 it yielded 6.371 t/ha. This difference of 3.870 t/ha (155 per cent) between the two consecutive productions in 1977 and 1978 was due to heavy frosts.

DISEASES

During June 1978, the occurrence of an apparently new race of *Puccinia striiformis* was detected at the San Jorge Experiment Station which is at 3,000 m elevation. This pathogen was attacking commercial plantings of the improved varieties Icatá, Engativá and Tiba. In July 1978, the same pathogen was detected in Tibaitatá attacking the variety Icatá, although in a less virulent way.

The evolution of this rust will be monitored so as to avoid an epidemic explosion of the disease in the major wheat producing areas. The purpose is to avoid the occurrence of an epidemic similar to that of yellow rust in barley in June, 1978 which caused drastic losses in yield and quality in commercial plantings in the first semester of 1976. That year, barley plantings in the Bogotá Sabana (Bogotá plains) had to be declared a disaster area, and the National Government exonerated the credit debts of barley producers, in 1976.

SEED PRODUCTION

In the Nariño Province, the small cereals program is multiplying three promising wheat varieties, with the purpose of registering at least two of them, and releasing them in 1979 to Caja Agraria (the Colombian Agricultural Bank), which distributes seed to farmers. They will replace some of the present varieties. These promising varieties are Nos. 7, 10 and 24, whose average yield has been 3,022, 3,036 and 3,299 kg/ha, respectively, while Tota, the check variety, yielded 2,679 kg/ha. The new varieties therefore outyielded Tota by 18.2, 13.3 and 23.1 per cent respectively.

VARIETIES

The three new varieties viz., Nos. 7, 10 and 24 have shown a better resistance to the prevailing diseases (rusts) than Bonza and Tota. However, variety 24 showed a moderate susceptibility to stem rust *(Puccinia graminis tritici)* in the first semester of 1978. Other characteristics of the new varieties are: test 79-82 kg/hl, flour extraction 76-80 per cent, water absorption 70-77 per cent, leaf volume 600-638 cc and protein contents 7.6-10.8 per cent.

Test weight or physical quality of the wheats selected in the first four trials in Tabaitatá 1977 was higher than that of the improved variety Samacá, which reached 76.25 kg/hl, while Hard Red Winter, an imported wheat, reached 82.5 kg/hl, which is higher than all the tested local varieties, except the variety No. 96, which had a test weight of 83.5 kg/hl—the highest of all varieties.

In regard to the milling quality, given in terms of flour extraction, it was observed that all the selected wheat varieties were higher than the checks including Hard Red Winter (imported check), which reached 76 per cent.

The nutritional quality, as related to protein percentage, showed a variation from 11–13 per cent, which is within the limits for a good flour for bread making. Variety No. 8 had a 9 per cent protein content which is good for cookie making.

Loaf volume, the main characteristic of bread quality, was 763 cc for Hard Red Winter, the imported check, and 680 cc for the national check Samacá, and 753 cc for Bonza. However, Hard Red Winter was significantly lower in volume than all the promising varieties, the lowest of which had 862 cc, i.e. a volume 100 cc higher than Hard Red Winter.

The highest volume corresponded to variety 77, with 1075 cc,—an excellent volume. Varieties 5.40 and 77 had volumes above 1000 cc, and these will be good for mixing with inferior wheats to improve their quality.

Seven regional trials of varietal adaptation were conducted in the municipalities of Yacuanquer, Pasto, La Cruz and Guaitarilla, all in Nariño Province, during the first semester of 1978. The promising varieties 7, 10 and 24 yielded an average of 2,980, 3,101 and 3,509 kg/ha, respectively, which are 97, 101 and 114 per cent comparisons with the yield of the best check Bonza (3,076 kg/ha). The high yield potential of the varieties 10 and 24 was confirmed in Mohechiza, a community of the municipality of Yacuanquer, where they yielded 6,320 and 6,250 kg/ha under good conditions of soil and management.

PROMISING MATERIALS

In regard to the introduction and evaluation of local and foreign germ plasm, wheat and triticale materials sent by CIMMYT, from Mexico and Ecuador, were studied. Of these, the selected wheat varieties Nos. 36 and 4 yielded over 4,700 kg/ha, while the check variety Bonza yielded 3,183 kg/ha. The triticale variety No. 16 was also selected. It yielded 4,661 kg/ha being 37 per cent superior to Bonza check, (3,411 kg/ha).

From the VEOLA and ELAR nurseries sent by CIMMYT from Ecuador, more than 200 wheat varieties were selected. The outstanding are: Antizana, Brochis "S", Gv "S" x Bv-har.59, Alondra, Chimborazo, Atacazo, Era, Quetzal and Chinoli. The triticales which were selected are Beaver-Arm, Mapache, MZA-Cin (Var.974), Lobo "S"-(Var 1033, Cml-Pato (Var. 1002), and Coyote-Octo Bulk 50 (Var. 1089).

At the Obonuco Station a total of 2,664 nursery varieties and lines of wheat were tested. From these, 63 varieties were selected to be included in the crossing nursery, which the program maintains in Nariño as a permanent germ plasm bank. This used to incorporate useful characteristics into the commercial varieties.

CHEMICAL CONTROL OF RUSTS

It was found that Indar applications were effective for controlling leaf rust, *Puccinia recondita,* when applied at 400 cc at 40 days after planting, and at 300 cc at 60 days after planting. Dithane M-45, at rates of 2.5 kg/ha in five applications also offered an almost complete control of leaf rust.

SEED PRODUCTION

The production of basic seed of the wheat improved varieties Bonza 63, Tiba and Sugamoxi in Tibaitatá amounted to 8,005 kg. Yields were low (1,067 kg/ha) due to late plantings and to a frost on August 17, 1978, which dropped the temperature to $-7^{o}C$.

Commercial plantings of Engativa yielded 3,140 kg/ha on 11.8 ha. The improved wheats Sugamoxi and Tota were planted on three ha and produced 6,489 kg with an average yield of 2,163 kg/ha. No fertilizers were used in these plantings.

BARLEY

Materials were selected from the world collection and from international nurseries. In the first semester of 1978, 19 increase plots, 92 small plots, and 231 barley varieties with good tolerance or resistance to yellow rust were planted. It is expected to multiply some of the naked varieties for human consumption in 1979.

The barley nursery for the Andean Zone (VEOLA-barley) containing materials from Colombia, Chile, Ecuador, Peru and Bolivia, was evaluated. Most of the germ plasm was susceptible to yellow rust; however, some materials showing rust resistance were selected, viz., CI-9622 and CN7-DC 23 from Colombia; Tracura 50-(Aut-B2-Tol) Car-Apam, and CI-15198 from Chile; Dorada Duchicela, Gal-PI 6384, Desc. Colec. Ecuador 4229 from Ecuador; Erc (4)-148, UNA 189A and Dorado Dística from Peru, and Palestina, Nuda, Abyssinian, Plerci and CI 3917 from Bolivia.

At Obonuco Station, 444 varieties from the Fifth IBON and VEOLA were selected, and more than 40 varieties were selected as for a germ plasm source.

BARLEY DISEASES

In the municipality of La Cruz, a regional trial was established with four barley varieties resistant to yellow rust. Outstanding varieties were PM 4 and PM 11 with a yield of 2,450 and 2,100 kg/ha, while the checks 124 and Mochacá yielded 2,050 and 1,950 kg/ha, respectively.

Fungicides were evaluated for the chemical control of yellow rust in barley. Bayleton, liquid or wettable powder, is still the most effective chemical for controlling *Puccinia striiformis,* in barley, as it has been in previous years.

Sicarol (a wettable powder) follows Bayleton in effectiveness. Results achieved by research in the chemical control of yellow rust in barley have contributed positively to increased barley production, breaking previous yield records and making the farmer feel more confident in his barley crop.

During the first semester of 1978, several chemicals were tested for controlling seed borne pathogens. KWG 0.159, at rates of 100, 150 and 200 grams per 1,000 kg of seed, showed the highest residuality. It is considered promising to control the initial stages of *Puccinia striiformis* in barley.

BARLEY FERTILIZATION

Two foliar fertilizer brands were tested. It was found that the number of applications should be decreased to only one during tillering, which seems to be the most appropriate time for these fertilizers to work more efficiently. Applications after heading did not increase yields, and only increased the cost of barley production.

More research is required in the area of foliar fertilization, especially in low fertility soils, where nitrogen and rainfall are limiting.

BARLEY SEED PRODUCTION

In a plot of 10.5 hectares established in Tibaitatá 33,800 kg of basic barley seed were harvested at an average yield of 3,219 kg/ha. Also at Tibaitatá, 7.7 ha were planted to the commercial barley variety 124 from which 21, 514 kg were harvested at an average yield of 2,794 kg/ha. No fertilizer was applied to these plantings.

ECUADOR

AREA AND PRODUCTION

Cereal production has been steadily decreasing in the last 10 years. Ministry of Agriculture figures indicate that in 1978 wheat was sown on 44,000 hectares with a production of 42,000 tonnes. Barley was on 40,000 hectares with a production of 28,000 tonnes.

IMPORTS

As a consequence of these low production levels, Ecuador had to import 240,000 t of wheat and 20,000 t of barley, just to keep up with the demand from the milling and malting industries respectively.

CLIMATE

The season was characterized by long periods of drought during the planting season and a heavy rainfall (twice the normal) during the harvest. The drought was discouraging for many cereal producers who decided not to plant, while others who took the risk were severely affected. These factors reduced cereal production. The heavy rains at harvest time (July, August and September) adversely affected both the quantity and quality of the crops.

FERTILIZERS

The recommendations for soils low in N and P, which is the general situation for cereal soils in Ecuador, are: wheat, 80 kg N, 90 kg P_2O_5 and 20 kg K_2O/ha; barley, 60 kg N, 80 kg P_2O_5, and 20 kg K_2O/ha. However, only 30 per cent of the farmers use fertilizers, and generally they use closed formulae such as 10-30-10, or 18-46-0 at a rate of 90 kg/ha for barley and 113.5 kg/ha for wheat. These fertilizers are available in the cities both in traders' stores as well as in the stores of Banco de Fomento (the Agricultural Department Bank).

However, the farmers believe that these inputs should be made available to them in the rural areas, through special input stores. Since 1975, the Ecuatorian Government has given farmers a coupon for 20 sucres to exchange for seed, and a coupon for 30 sucres to exchange for fertilizer, for each 45 kg of wheat produced.

In Ecuador little or nothing was known about minor element deficiencies for cereal cultivation until recent years. It is now considered from some observations in certain areas where cereal crops do not grow well that minor element deficiencies may be the cause.

FACTORS LIMITING CEREAL PRODUCTION

Among the major problems limiting cereal yields are: little use of machinery for soil preparation, planting and harvesting; low levels of fertilization; small use of herbicides; a high weed infestation and the high cost of inputs and labor, compared with a low price for a kilogram of grain (as compared with other crops). This makes the crop unable to compete with a resultant decrease in the wheat area.

DISEASES

The barley area has also decreased due to the presence of *Puccinia striiformis* which in 1978 affected yields considerably (the average yield was only 680 kg/ha). In addition to the rust problem, barley yellow dwarf virus is a very serious disease, especially in Northern Ecuador. The virus vector, aphids, infested barley heavily during the dry season.

Wheat varieties being planted in Ecuador are stripe rust resistant, so wheat yield decreases are not as severe as in barley because most of the farmers plant traditional barley varieties or malting varieties which are highly susceptible to stripe rust.

SEED INDUSTRY

Seed production in Ecuador is the responsibility of a mixed economy (Government-private) agency. However, a high proportion of the seed planted by farmers (especially barley) is still produced by farmers without proper care. This causes mixture problems, low germination and diseases.

In malting barley, the beer manufacturers distribute certified seed to farmers. Government policy is towards increasing the use of certified seed by farmers.

PRINCIPAL VARIETIES

Eighty five per cent of wheat producers use improved wheat varieties, while in barley only 25 per cent of the area is sown to improved varieties for human consumption and malting purposes. It is expected that the use of improved barley varieties will be increased since the traditional varieties are highly susceptible to stripe rust, while the improved varieties are resistant.

The most widely grown wheat varieties are Atacazo 69, Romero 73, Crespo 63, Cayambe 73, R-Pizan, Chimborazo 77 and Antizana 77. Use of the last two is limited due to inadequate seed being available. In barley, the traditional varieties most used are Rio Bambeña, Latacunga and Afuntaqui. In 1978, there was a considerable increase in the area sown to the improved variety Dorada 71. Another improved variety, Duchicela 77, is also being promoted.

PROMISING MATERIALS

The wheat breeding program has nominated some promising lines such as Cotopaxi, Sangay, Saraguro, Tungurahua, Imbabura and Altar. The barley breeding program has developed promising lines such as Terán and Convenio, the former for human consumption and the latter for malting.

AGRONOMY

A research program in wheat production has been implemented. Attention is being given to transferring to farmers the technology generated by research centers, and to detecting problems being experienced by farmers. The program commenced in the Cayambe-Otavalo area, a cereal producing region, where a series of on farm verification trials is now in progress. Cultural practices and fertilization are also being researched.

GRAIN END USES

Wheat is consumed as bread and in soups (grits, broken kernels). Barley is also used in soups (grits, broken kernels) or is milled to a flour (machica). It is also used to produce beer and to a lesser extent, as an animal feedstuff.

INTERNATIONAL SUPPORT

CIMMYT's presence in the Andean Region, and especially in Ecuador has strengthered the breeding programs and aided staff development via training. Such overall assistance has increased the quality of research in Ecuador.

GUATEMALA

Wheat crossing by technicians at Labor Ovalle, Quetzaltenango, Guatemala.

AREA AND PRODUCTION

Small and intermediate farmers in terms of holding sizes, grew 40,000 ha of bread wheats under rainfed conditions. Durum wheat, barley and triticale are not produced commercially.

Bread wheat grain production is about 50,000 t, which meets only 40 per cent of the population's consumption.

FERTILIZERS

Fifty per cent of wheat farmers use chemical fertilizers viz., 100-120 kg N and 60-70 kg P/ha. They usually use the formula 20-20-0, with a cost of 9.00-9.50 U.S. dollars for each 45 kg, in the local market. The national (Agricultural) Bank provides a subsidy for the fertilizer. There are commercial firms which import the raw material from abroad for fertilizer manufacturing.

In recent years, deficiencies of the minor elements boron and zinc have been noticed in farmer fields. Analyses are being carried out to determine the extent of this problem at the farm level.

PRODUCTION PRACTICES

Planting dates for regions at 2,400-3,000 meters altitude are in June, and harvest is made during November and December.

In regions at 1,600-2,400 meters altitude, two planting dates are practiced: one in May to harvest in September; the other in August to harvest in January.

Early plantings return the highest yields.

PROBLEMS AFFECTING WHEAT EXPANSION

There is strong competition for area, from maize. It has therefore become necessary to test wheat in new areas in the mountains, and this results in increased costs, especially during harvest.

DISEASES AND PESTS

In 1978 there were late (off-season) rains during October and November which favored a high incidence of *Ophiobolus, Alternaria* leaf spots, and *Helminthosporium,* which decreased yields significantly. Also, aphids attacked wheat and blackened the stems and spikes.

SEED PRODUCTION

Certified seed is produced through a public institution, which in turn supplies improved seed to farmers. Foundation and basic seed production is the responsibility of the ICTA Wheat Improvement Program. Registered seed is produced in the different regions.

Due to low prices, certified seed production is now at a low level.

A high proportion of small farmers keep their own seed from year to year. Some farmers still plant low yielding varieties which are susceptible to diseases.

HYV

A high proportion of the bread wheats now planted are high yielding improved varieties, whose area has been increased by 15 per cent in recent years. It is felt that more research is needed to test varieties in new regions where wheat can be planted, and to evaluate the new high yielding varieties there.

PRINCIPAL VARIETIES

Name	Years of release (in Guatemala)
Nariño 59	1961
Xelaju 66	1967
Tobari 66	1967
Azteca 67	1970
Altense 73	1974
Maya 74	1975
Gloria 74	1975
Quetzal 75	1976
Reina 76	1977
Chivito 77	1978

PROMISING MATERIALS

Chivito 77
Guatemala

Labor Ovalle 77: (Tob-Nar)Cal x Sr [(Ch53 x Nor 10-B) Y54] L.R.C.V. 17 x S.47.
CG-6013-E-10-5X-10-1X

Nar 59 [(Yt54A^2 x N10-B)kt54] x Son64 x Y50$_E$ x Gto/ Inia) (Cno-Son64)
CG-4145-12X-10-1X-0X

Jupateco 73 x Kal-Blue bird
CM-28211-5X-10-0X

(Cno"S"-Gallo) (Cno"S"-7 Cerros)
CG-4096-1X-1X-0X

Jupateco 73-Cardenal
CM-28202-1oX-10-10X-0X

Inia-Olsen x Inia-Bb & Y50$_E$-Kal^3
CM28935-1X-20-1X-00

Labor Ovalle 76
Guatemala

Bolillo "S"/Son64-K1-Rend x Blue bird
CM-29948-7X-30-1X-00

Kavkaz(Cno"S" x Nad-Chris/Son64-K1-Rend x Blue bird)
SWM-2887-2X-20-2X-20-1X-00

Kavkaz-Sparrow "S"
SWM-2890-9X-10-20-2X-00

AGRONOMY

Levels and the interaction of N, P and K were evaluated at the farm level. The best results were achieved with 110-40-110 kg/ha.

The Guatemalan Wheat Program cooperates in technology transfer work in the different wheat production areas.

INDUSTRIAL USES OF BREAD WHEAT

The milling industry processes all the national wheat production, and elaborates flours for bread making for internal consumption. Imported wheat is mixed with the national wheat, in order to produce different flours needed by the national bread making industry

By-products such as bran, are used for feed.

RESEARCH ACTIVITIES

In regard to quality, research is directed to improving wheat towards a strong gluten to obtain a higher bread quality.

INTERNATIONAL COOPERATION

For many years, the Guatemalan Wheat Program has had a close cooperation with CIMMYT, which has provided training to the technicians working in this program. CIMMYT also provides a wide array of genetic materials which assists the Guatemalan program to continue the development of high yielding, adapted varieties.

In addition, twice a year the CIMMYT wheat program supports the visit of Guatemalan technicians to Obregon and Toluca, where they participate in the harvest and select materials for the national program (segregating material, and advanced lines).

Selection of materials in the Quetzaltenango and Chimaltenango regions for determining the best varieties for these regions, was assisted by visiting staff from CIMMYT.

PERU

AREA AND PRODUCTION

In 1977-78, the area sown with wheat was 120,000 ha from which 115,000 tonnes were produced at an average yield of 958 kg/ha. In the previous season, the statistics were 130,000 ha, 130,000 t and 1000 kg/ha, respectively. The decrease in yield in 1977-78 was due to the drought in the Northern Sierra.

IMPORTS

A total of 790,000 t of wheat were imported. Human consumption accounted for 843,000 t. The other major uses were 30,000 t for feed and 12,000 t for seed.

AGRICULTURAL PRODUCTION SYSTEM

Under Decree Law 21169, wheat is a crop subjected to national planning within the Agricultural Production System in Peru. The System is a concerted effort for production between the Government and the farmers. Producers commit themselves to plant a programmed area and to comply with the regulations from the Ministry of Agriculture and Food. The Ministry in turn, commits itself to provide technical assistance through the pertinent agencies, and to supply the inputs and services required by farmers.

The system involves a selection of farmers according to their capability and size of holding, and according to resources available to the government to meet the commitments. For this reason, coverage of the system in relation to the total wheat area is only 12-16 per cent.

In 1976-77 and 1977-78, wheat production was planned as shown in the following table:

Food region	1976-77 ha	1976-77 Production (t)	1977-78 ha	1977-78 Production (t)
I. Piura	950	1425	789	1183
II. Chiclayo	5689	8429	5709	8463
III. Trujillo	9842	15209	9529	14265
V. Ica	1600	3419	2062	3814
VI. Arequipa	644	1662	689	1960
VII. Tacna	280	658	300	720
X. Huancayo	2907	6105	2568	5136
XI. Cuzco	3657	6002	3606	5720
XIII. Ayacucho	4235	8470	5432	10864
Total programmed	29,804	51,359	30,684	52,098
Total executed	18,000	24,000	19,000	24,000
Per cent executed	60	47	61	46
Programmed yield/ha	1723		1698	
Actual yield kg/ha	1333		1263	

PRODUCTION ZONES

Wheat production is concentrated mainly in the Sierra, especially in the Provinces of Ancash, La Libertad, Cajamarca, Junín, Cuzco y Ayuacucho. About 4 per cent of the total area is located mainly in the coastal part of the Provinces of Ica, Arequipa, Tacna y Lima. Technology used in these areas in intermediate; in Lima Province it is low.

PRODUCTION PRACTICES

In the coastal area it is possible to plant wheat almost the whole year round. Water is a limiting factor, as is also high temperatures in some cases, during the summer, which accelerates the vegetative cycle and decreases yields.

In the Sierra area, wheat plantings are subject to rainfall and frosts. In some closed valleys, irrigation is available.

Planting and harvesting times in the Sierra main producing areas are:

Province	Planting time	Harvesting time
La Libertad	December-February	June-September
Ancash	December-February	June-September
Cajamarca	December-February	June-September
Junín	November-January	May-August
Cuzco	October-December	May-August
Ayacucho	November-February	May-September

SEED PRODUCTION

In the coastal areas, farmers exclusively use seed of improved varieties developed by the Government Research Program at the Regional Agricultural Research Centers (CRIA's). In the Sierra, traditional varieties of the white or amber durum type with a large kernel are preferred.

It is estimated that 20-30 per cent of the total wheat area is planted to improved varieties. However, farmers in the Sierra are used to keeping their own seed, and eventually improved varieties lose purity.

The research organizations (CRIA's) produce the foundation seed of improved varieties, which is multiplied through official seed producers. In reality there is not good control at this stage, and seed may reach farmers in poor conditions of quality and purity. Scarcity of equipment for seed processing and selection is another factor which also influences bad quality. Weeds, especially wild oats, adversely influence wheat production in Peru.

There are no good figures on area and seed production at the national level. Available information is not precise, and therefore is not quite reliable. It was estimated that in 1976-77, about 800 ha of wheat were planted by official seed producers in the country, with a production of 1,100 t, of which only 60 per cent was used as seed i.e. 650 t for an area of about 5,500 ha.

The variety Ollanta is the most widespread in use and it is estimated that about 25 per cent of the above mentioned seed production, i.e. 162 t, corresponds to this variety. Other important varieties are: Huanca, Cahuide, Siuchi, Huascarán, and Cajabamba. The area mentioned above does not include foundation seed.

During the 1977-78 season, the plantings were similar to previous years, with the same tendencies.

FERTILIZERS

Total consumption of NPK was 143,767 t of which 55.8 per cent was from national production and 44.2 per cent from imports.

Farmers may obtain credit for fertilizer purchases from the Agrarian Bank, a government agency. Since 1975 a national fertilizer pricing policy has operated whereby prices are fixed and are stable all over the country, with a 40 per cent government subsidy in operation.

It is estimated that wheat is fertilized in Peru at an average level of 40-30-0, and that more organic manure is used than chemical fertilizer. These low levels are due to a series of factors which include a rather broken, irregular topography of the holding, which makes the use of mechanical equipment difficult; a dominance of many small farms in the land tenure system; low socioeconomic level in the farming sector; high weather risk for agricultural production; difficulties for technology transfer; low access to the fertilizer distribution network and a scarcity of mechanical equipment with a high cost of maintenance.

A fertilizer demonstration project and a fertilizer distribution project, both of which were supported by the FAO, conducted 303 demonstrations with three fertilization levels in three representative areas in Peru, between 1973 and 1977 with the following results:

Treatment	Yield kg/ha	Value/cost relationship
0-0-0	1075	–
60-40-30	1789	3.46
120-80-60	2217	2.76

Value equals the yield increase due to fertilizer use, multiplied by the wheat price, and *Cost* is the value of fertilizers applied to obtain such an increase.

DISEASES AND PESTS

Rusts are a major limiting factor in wheat production. In the coastal areas, both leaf rust *(Puccinia recondita)* and stem rust *(Puccinia graminis tritici)* are prevalent, while in the Sierra, yellow rust *(Puccinia striiformis)* and stem rust are the major diseases. Barley yellow dwarf virus is also increasing steadily along with dry leaf and root rot. The main insect pest is aphids, and up to two applications of insecticides are necessary for their control.

NEW VARIETIES

The variety Participación was released in the Coast in 1975. In 1978, a new variety was released, Costa 78, a cross of Bb x 7C. Other promising lines are:

[Son 64 (Tzpp-Nai)] x Hv. Fron II-14299-5L-1L-1L-3L; Kal/Bb 26992-30M-1Y-1M-3Y-0M-L-L; Sr/Tr256 CM-4041-1Y-0M: Cno "S" and Cj 71.

In the Sierra area, besides the lines mentioned above, outstanding bread lines are:

CAE PW 329 x Fw-K58-N(UU50-18)
II-4290-1L-1L-2J-2C2-1C2
CAB x K340-Mt
II-19303-1L-1L-J-C2-3C2
(Fr-McM/Kk-Y) x 908-Fn A.8
Ch-7146-1J-2L-L-J-6C2-1C2
Son 64/2/450E/Gto/3/No 66"S"
F523528
Mh-Gb-Th-StC-Fr
II-9196-L-15L-2L-2L-2L-3L
Cno "S"/Inia "S"
II-23959-525-1M-2Y-0Y-PC-73
Tz PP"S"/Son 64/3/LR/2-T2PP/3* SnaE
II-22429-16M-1Y-4M-1Y
LR64 x Son 64 x Napo 63
II-22402-7L-1J-2C2

Among durum lines, outstanding materials are:

Rali"S" 31810 x D67.2/Magh"S"
CD13873-D-1Y-5M-0Y-1L
Meni"S" - Mach "S"
CD3879-29Y-2M-2Y-2M-0Y-L
Gdo V_Z471-Br"S" x Pg"S"/D67-2-Gta"S"
CD12511-3Y-0M-0Y

COMMERCIAL ASPECTS

A guaranteed (floor) price of wheat produced in Peru is periodically set, according to production costs. The Public Organization of Agricultural Services (EPSA) is in charge of acquiring wheat at the official prices, and channels it to large mills where it is processed into flour and flour by-products. More than 80 per cent of the milling infrastructure is located in Lima. However, EPSA obtains only 1,000-2,000 t/year because wheat reaches higher prices in the domestic market, where prices vary according to supply and demand.

Wheat is also used by a small domestic industry for some locally consumed products. A more or less significant volume is acquired by traders, who sell it to small mills for feed manufacturing.

CREDIT

Under the conditions and geographical location of the wheat crop, most of the farmers use their own resources for producing their crops. In 1976-77 however 5,000 wheat ha were financed; the figure was 4,700 in 1977-78. Most of the credit financed areas were in the Coast, plus a few in the Sierra having no irrigation.

MECHANIZATION

Agricultural machinery is used mostly in the Coast, plus some localized areas in the Sierra. This machinery is used mainly for land preparation. Animals are used sometimes for land preparation and for threshing. Seeding is carried out by broadcasting. The crop is hand harvested.

U.S.A.

AREA AND PRODUCTION

Statistics for acres harvested, bushels per acre and total production in bushels, for the years 1976, 1977 and 1978 are:

EXPORTS

The total number of bushels of wheat exported from June-May in each of 1975-76, 1976-77 and 1977-78 were 1,172.9 million, 949.5 million and 1,123.9 million respectively.

	Acres Harvested			Bushels per acre			Production (bushels)		
	1976	1977	1978	1976	1977	1978	1976	1977	1978
		1,000 acres			Per cent			1,000 bushels	
All wheat	70,771	66,461	56,839	30.3	30.6	31.6	2,142,362	2,036,318	1,798,712
Winter wheat	49,460	48,664	38,909	31.5	31.6	32.1	1,559,923	1,537,113	1,248,272
Durum	4,584	3,025	4,024	29.4	26.4	33.1	134,914	79,964	133,328
Other spring wheat	16,727	14,772	13,906	26.8	28.4	30.0	447,525	419,241	417,112
Barley	8,297	9,564	9,233	44.9	43.9	48.4	372,461	420,159	447,008
Triticale	No dependable statistics available								

Barley exports fluctuate viz., 1975 it was 14 per cent of production, six per cent in 1976 and 18 per cent in 1977.

CLIMATIC CONDITIONS

Since only 5.2 per cent of the harvested acreage is irrigated, production is highly dependent upon climatic conditions. Overall, seasons have been favorable in the last three years and so production was high.

The acreage sown fluctuates considerably, depending on price and the government farm program.

FERTILIZERS

They are in good supply and are used on most wheats grown in the eastern U.S. and the eastern part of the Plains States. Less fertilizer is used in the western part of the Plains States (Texas through North Dakota), where rainfall is less.

The following table shows estimates of the fertilizers used on harvested acres of wheat in the U.S. in the 1972-78 period:

	Any Fertilizer	Acres Receiving N	Acres Receiving P_2O_5	Acres Receiving K_2O	Rates per acre Receiving N	Rates per acre Receiving P_2O_5	Rates per acre Receiving K_2O	Total U.S. Harvested Acreage
	Per cent				Pounds			
1972	63	62	44	15	46	37	38	47,284,000
1973	64	63	45	17	48	38	36	53,869,000
1974	66	66	46	20	46	38	37	65,368,000
1975	63	63	43	21	46	35	35	69,391,000
1976	71	71	50	21	51	37	37	70,771,000
1977	65	64	44	19	53	39	41	66,216,000
1978	61	61	38	16	52	35	34	56,532,000

DISEASES AND PESTS

Stem rust losses were insignificant in 1978, but leaf rust caused alarming losses in the following States:

	State	Per cent	Bushels
Winter wheat	Arkansas	4.0	462,500
Winter wheat	Idaho	3.0	1,361,100
Winter wheat	Illinois	3.5	1,281,800
Winter wheat	Oklahoma	7.0	10,974,200
Winter wheat	Oregon	2.0	1,017,200
Winter wheat	Tennessee	5.0	405,300
Winter wheat	Texas	1.3	711,200
Winter wheat	Washington	8.0	11,237,000
Spring wheat	Washington	8.0	1,149,000

Leaf rust on barley in Oklahoma caused a two per cent loss, which translates into 55,500 bushels.

Stripe rust on wheat took its toll as evidenced by:

	State	Per cent	Bushels
Winter wheat	Oregon	5.0	2,543,000
Winter wheat	Washington	5.0	7,023,000
Spring wheat	Idaho	4.0	1,293,400
Spring wheat	Oregon	10.0	525,600
Spring wheat	Washington	10.0	1,436,600

Yellow dwarf virus in wheat and barley is a serious disease.

The principal insect pests were hessian fly and green bug on wheat, and cereal leaf beetle and green bug on barley.

SEED INDUSTRY

It is a highly organized private industry plus quasi-public agencies (various State Crop Improvement Associations).

HYV

All leading U.S. varieties are high yielding. Virtually all varieties grown in California and in the Pacific Northwest are semidwarf. More than half of the Hard Red Spring Wheat acreage but only a small part of the Hard Red Winter Wheat and Soft Red Winter Wheat (Eastern U.S.) acreages is in semidwarfs.

All leading Hard Red Winter and Soft Red Winter varieties, however, are moderately short and much improved in straw strength over leading varieties of 10-15 years ago. The semidwarf acreage is expanding in the very large Hard Red Winter region and probably will continue to expand. Semidwarfs are likely to take over more of the eastern part of the spring region.

PRINCIPAL VARIETIES

Barley

Variety	Acreage in 1978		Date of Release
Larker	1,951,000 (U.S.)	6 row malting barley	1963
Beacon	991,300 (U.S.)	6 row malting barley	1973
Steptoe	804,375 (U.S.)	6 row feed barley	1972
Klages	515,585 (U.S.)	2 row malting barley	1973

1978 Durum Acreage

Variety	Acreage	Date of Release
Ward	1,498,400 (North Dakota only)	1972
Rugby	434,600 (North Dakota only)	1973
Crosby	330,600 (North Dakota only)	1973
Cando (semidwarf)	291,000 (North Dakota only)	1975

1978 SRW Acreage

Variety	Acreage	Date of Release
Arthur 71	282,600 (Indiana only, but indicative of Eastern Region)	1971
Arthur	216,000 (Indiana only, but indicative of Eastern Region)	1968
Abe	173,700 (Indiana only, but indicative of Eastern Region)	1972
Oasis	55,800 (Indiana only, but indicative of Eastern Region)	1973

1978 HRS Acreage

Variety	Acreage	Acreage	Date of Release
North Dakota		Montana	
Olaf (semidwarf)	2,207,600	433,300 (leading HRS)	1973
Waldron	1,784,300		1969
Ellar	460,000		1974
Butte	311,400		1977

HRW Acreage

Variety	Acreage	Data of Release
1978 Kansas		
Eagle	2,599,000	1970
Scout	2,214,800	1963
Centurk	1,130,000	1971
Triumph	666,700	1940

Variety	Acreage	Date of Release
1979 Nebraska		
Centurk	1,242,000	1971
Scout & Scout 66	762,000	1963–1967
Buckskin	153,000	1973
Lancer	144,000	1963

1977 Leading Varieties in Pacific Northwest

Variety	Acreage	Date of Release
Gaines & Nugaines (soft white winter)	35.9 per cent of total 3 state acreage	1961–1965
McDermid	15.6 per cent of total 3 state acreage	1974
Hyslop	14.9 per cent of total 3 state acreage	1970
Moro (white club)	7.5 per cent of total 3 state acreage	1965

PROMISING MATERIALS

The most promising durums are the new semidwarfs with strong gluten.

Summarized, the new bread wheats are:

HRW Higher protein along with high yield and disease resistance.

HRS Higher protein particularly in semidwarfs, along with high yield and disease resistance.

SRW Maintained low protein with high yield and disease resistance.

Western White High yield, maintained low protein in soft types and high protein in hard types, along with disease resistance.

The most promising barleys are the semidwarfs or at least shorter types with stronger straw and higher yield.

AGRONOMY

A new agronomic technique is limited tillage or no tillage to try and combat erosion, particularly in the Pacific North West. Associated with this technique are some serious weeds, diseases and pests.

AFGHANISTAN

INTRODUCTION

Agriculture is the pivot around which the economy of Afghanistan revolves. It contributes more than 50 per cent to the national product and earns an average equal to about 75 per cent of the labour force. Afghanistan has a total area of about 65 million hectares, of which only a small amount (12 per cent or 7.8 million ha) is arable, and about 50 per cent of this area cannot be cultivated due to lack of water and it therefore remains fallow.

Crop production is dominated by cereals (wheat, maize, rice and barley which occupy about 87 per cent of the area cropped. The remainder is divided between fruits, vegetables and industrial crops.

AREA AND PRODUCTION

Wheat is grown in all parts of Afghanistan from about 300--2,700 m elevation where even irrigated or rainfed farming is possible. It accounts for 69 per cent of the total area under cereals and contributes 64 per cent of cereal production. Both winter and spring wheats are grown. The area under wheat cultivation (all types) is 2,348,000 ha with a production average of 2,802,000 tonnes. The average yield per hectare is quite low being 1.2 t/ha, taking into account all types, as shown in the following table:

Wheat	Area Cultivated (1,000 ha)	Production (tonnes)	Average Yield (t/ha)
Improved varieties	433	894.14	2.06
Local varieties	865	1330.86	1.5
Rainfed	1050	588.00	0.5
Total	**2348**	**2813**	**1.2**

There is no information available about the average yield of specific types (bread wheat, durum, and irrigated production).

Barley ranks fourth in production among the cereal crops, being exceeded by wheat, maize and rice. The average harvested area, during 1978 was 314,000 hectares and production was 357,000 tonnes taking into account both irrigated and rainfed crops. Barley is planted in the spring or fall in Afghanistan, wherever winters are not severe. Best yields are obtained when barley is fall planted.

Barley is not widely used for human consumption, but it is used primarily as livestock feed, especially for work animals. It is the most important feed crop in Afghanistan, and in some cases, it is used for human food. At higher elevations, barley is the only crop grown exclusively. Naked types are preferred where barley is almost exclusively used for human food. In these areas, some people make a special preparation called Gadulla from a naked barley and food legume mixture.

Triticale has not been grown commercially todate, but there is a potential for triticale production in the country where naked barley is consumed by human beings. Either winter barley or a spring type could be sown in the spring.

PRODUCTION PLANS

In the Five Year Plan of the Government, increased production has been given top priority. Yield per unit of land is the main objective as there is little scope for expanding the area under cereals. In order to meet the goal it will be necessary to strengthen the research program all over the country. This task could be fulfilled by continuing a well programmed project by a group of highly specialized scientists.

The government in considering the development and modernization of agriculture and animal husbandry is giving a priority to the implementation of land reforms, reclamation of arid lands, and the expansion and improvement of irrigation systems and grazing lands.

IMPORTS

In good crop growing years, the need to import wheat is negligible. In 1978, a few thousand tonnes were imported.

CLIMATE

The climate is diverse and generally continental, characterized by a hot dry summer and cold wet winters with wide temperature fluctuations. Rainfall varies considerably from year to year and also with altitude and locations.

During the last crop year, the precipitation average was below normal (308 mm), with unusual rainfall at crop maturity (wheat) and harvest, which caused floods and lowered production.

FERTILIZERS

Afghan soils are highly calcareous and low in organic matter due to continuous cropping and grazing of crop residues. There is no evidence of trace element deficiencies in winter cereals. The main limiting elements are nitrogen and phosphorus, which are supplemented as nitrogenous and phosphatic commercial fertilizers. The nitrogen source is urea, which is imported, and which is subsidized by the Government.

Fertilizer use is mainly restricted to improved varieties, because there is no response by local cultivars. In addition, the farmers may not have cash in hand to buy fertilizers. The government is now paying attention to the supply of agricultural inputs through the Agricultural Bank and cooperatives, and removing distribution by dealers in provinces and districts.

The recommended dosage is 80 kg N/ha and 50 kg P_2O_5/ha for irrigated wheat. There is a sufficient supply of fertilizer in the country at the present.

The following table shows the type of fertilizers which were sold for use on various crops, in 1977-78:

Fertilizers	Tonnes
Urea	63,426
Diammonium phosphate	34,101
Triple superphosphate	2,427
Potassium sulphate	31
Superphosphate	40
Ammonium nitrate	1
TOTAL	**100,026**

PRODUCTION PROBLEMS

Yields per unit area have not gone up much due to the lack of irrigation facilities, inadequate fertilizer consumption and the non extension of improved varieties to the farmers, which in turn is due to the lack of an organized seed industry in the past. Fertilizer and wheat prices are fixed by the government at subsidized rates before sowing time in order to encourage the grower to apply for fertilizers and improved seeds.

Weeding of winter cereals is not common among farmers, because they consider weeds as a source of feed for livestock after harvest. Only a few farmers may weed by hand. 2,4-D is available in the country. Research and extension work is proceeding with weed control.

Local varieties mostly lodge, but improved released varieties are mostly semidwarfs and do not lodge.

DISEASES AND PESTS

Rains during the spring helped the natural infection of rusts, *Helminthosporium* and *Alternaria.* It was observed that certain locations have a high incidence for certain diseases, for example, Baghlan for screening wheat and barley varieties for *Helminthosporium* and *Alternaria;* Jalalabad for powdery mildew and rusts; Kabul for scald and yellow rust of barley under spring sown conditions.

Spring planted materials get rust infection severely as compared with fall planted material. Chenab 70, a widely grown variety, was badly infected by Karnal Bunt (*T.indica*) at Lagman province. Armyworm and Sinpest were the major insects which damaged crops. There has been no scientific study to find out the extent of damage done by rusts, foliar diseases like *Helminthosporium, Alternaria* and powdery mildew, and army worms. The most important diseases are rusts.

SEED INDUSTRY

Only two years, ago, an organized seed production program, the Afghan Seed Company, was started by the government. By now the Company has developed three large farms with 2,000 hectares under cultivation. During this crop season, they have multiplied the seeds of new varieties like (Darul Amon-1), (Herat-1) and others. The Company has a plan to multiply the seed of improved varieties through contract farmers, in the near future. Varieties like Kavkaz, Bezostaya, Mexipak 65, Chenab 70 and Bakhter (E_1 314) which have lived more than their life are still with the farmers. The government hopes that the limiting factor of the seed industry will soon be overcome.

VARIETIES

Improved varieties of wheat have been identified and released to farmers, but so far only a small percentage of land is covered by these varieties. With the implementation of the new five year plan and the availability of improved seed, the area under high yielding varieties and total production could be increased, the latter to three million tonnes.

Strengthening research and the operations of the Afghan Fertilizer Company should raise still further, the area under improved varieties.

The old varieties have become susceptible to diseases and they are poor in seed quality and purity. They are Mexipak, Chenab 70, Bakhter (E_1 314), Bezostaya, and Kavkaz. Some are older than 10 years.

PROMISING MATERIALS

Spring Wheat:

- HB 102–100 (D.A–1)
- Espigas (Herat–1)
- 7C–on x Inia B.Man.
- Son 64 Ros [(Tzpp–Knott 42)](Bamiyan–1)
- Nacozari

con't

K4500/4
Winter Wheat:
Martonvasar–2 (D.A–2)
GKF–8001
Durum Wheat:
GS "S" x Cr"S" 2244
Barley:
As 54–Trax (Cer–Toll)^2 Avt. Toll x B_3 Vt./Pre/toll
Triticale:
Rahum
Navojoa

PRODUCTION PRACTICES

Work is going on to evolve a complete package of practices, especially for wheat. Wheat is sown generally in the fall, October–December, depending on different areas. Winter wheats give better results when they are sown earlier in the autumn. In areas where the winter is very severe and the crop cannot stand winter, or in some places farmers do not have the time for fall sowing, spring sowing is practised. Varieties which flower early have yielded better under spring sowings.

GRAIN END USES

Home made leavened bread called Nan is generally made from wheat flour for family consumption. There are many kinds of Nan in the country. Even durum is used for special Nan preparation.

There is also macaroni and pasta products consumption in the country, mostly made from imported flour. Work is going on to identify durums with a better semolina quality.

Consumers mainly prefer amber wheat for making Nan. Most of the exotic winter wheats are Hard Red Winter Wheats, from our breeding material and Spring x Winter (CIMMYT)–Oregon State University. Some amber winter hardy selections have been picked up.

Barley is used mainly for feed.

RESEARCH RESULTS

Interesting information obtained on the basis of experimental data has indicated that dwarf durums are better yielders than winter wheats. The two best lines of durum wheat have been identified. Early flowering varieties of spring sown wheat were the top yielders.

In general, diseases were more severe on spring sown material than fall sown. Under an epidemic of field infection of stripe rust, a few barley resistant lines were identified. The promising lines of barley have outyielded local barley by 44 per cent. Some tolerant lines of local wheats to armyworm were detected and they are under further study.

INTERNATIONAL SUPPORT

Assistance given by international centers such as CIMMYT is invaluable in respect of (1) the distribution of diverse germ plasm for selection of strains suitable for local conditions, and (2) the provision of training opportunities and visiting scientist programs.

BANGLADESH

Drs. Anderson, Biggs and Borlaug from CIMMYT, discussing wheat improvement with Bangladeshi scientists at a regional station in Bangladesh.

AREA AND PRODUCTION

Wheat is the crop which receives the most attention by the Bangladesh Agricultural Research Institute.

Only bread wheat is under cultivation. The acreage is increasing very fast and in the 1977-78 season about 457,000 acres were cultivated with a total production of 343,000 tonnes for an average yield equivalent of 1.814 t/ha.

Barley covered only 62,000 acres and the production was about 17,000 t for an average yield equivalent of 0.68 t/ha. Durum wheat and triticale are not yet under cultivation.

CLIMATE

Bangladesh is situated between 20.50°N and 26.50°N latitude and 88.50°E and 92.50°E longitude. The climate is sub-tropical with an annual precipitation of 210 cm, the maximum being in July (40.89 cm) and the minimum in December (0.50 cm). The precipitation is comparatively low in the western part of the country. The average temperature is 26°C with a maximum of 31°C and minimum of 20°C. On the other hand, the day length ranges from 10.3–13.4 hours, with its effective sunshine being highest in December (9.4 hours) and lowest in July (4.8 hours).

Wheat is grown during the winter months from November–March. There is very little rainfall during the growing period of the crop. The relative humidity varies from 61–82 per cent. The average temperature, precipitation, day lengths and sunshine periods are given in the following table:

	Nov	Dec	Jan	Feb	March
Temperature °C (Maximum)	29.8	27.4	26.1	30.3	34.0
(Minimum)	16.8	12.8	8.9	14.8	16.8
Precipitation (cm)	3.5	0.5	1.8	3.0	4.3
Day length (hours)	10.5	10.3	10.5	11.1	12.0
Sunshine period (hours)	8.4	9.4	9.2	9.0	9.2

VARIETIES

The principal varieties now in production are Sonalika, Inia 66, Tanori 71 and Jupateco 73. Of these, Sonalika alone was widely cultivated throughout the country. This variety was in its fifth year in cultivation. Inia 66, though released in 1973, came into large scale cultivation in 1978; Tanori 71 and Jupateco 73 have been in cultivation since 1975. Cultivation of Tanori 71 was restricted to the eastern zone only because of sporadic head sterility in the western zone.

Promising strains

The promising strains coming up in the programme are:

HD 832-5-5 x Bb–suitable for dry land as well as partial irrigated conditions, (BAWI).

HD 1981-100 Ja-0I–suitable for both dry land and irrigated conditions, (BAWZ).

(Jar"s"-Nor) CC-7C x CC-Tob–suitable for early seeding irrigated conditions.

Cno"s"-7C x Kal-Bb–suitable for irrigated conditions only.

(S 227 x Up 302) S308–suitable for dryland and low irrigations.

IMPORTS

Bangladesh could not meet its wheat, barley and rice needs and consequently had to import about 1,635,000 tonnes of food grains of which 1,333,000 tonnes were wheat.

PRODUCTION PRACTICES

New agronomic practices such as fertilizer application, irrigation, etc. are being applied by farmers. Wheat is sown from mid November–late December and harvesting is in March.

SEED INDUSTRY

Production of improved seeds has received increased attention. The World Bank came forward to assist the cereal seed project in 1975. Now a production system and processing centres have been organized. Minimum facilities for processing were established with the assistance of the Federal Republic of Germany in five of the eight centres in the project. The project's seeds are now linked up with the farmers but the supply of seeds is still insufficient.

Seed production is presently managed by the Bangladesh Agricultural Development Corporation (BADC), which is an autonomous organization financed completely by the government. Of the total requirement of 17,000 tons of seeds, BADC supplied 5,000 tons to the farmers. Of this, 2,200 tons were produced locally and the rest was imported.

Seed exchange from farmer to farmer is still the main source of seed supply in the country. Farmers who cultivated wheat at least for two years were able to preserve seeds in good condition.

FERTILIZERS

Urea, Triple Superphosphate (T.S.P.) and Muriate of Potash (M.P.) were used by the farmers. The internal production of urea was 226,205 tons and T.S.P. was 37,756 tons. In addition 255,948 tons of urea, 112,301 tons of T.S.P. and 37,401 tons of potash were imported to meet the requirement.

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FERTILIZERS

Urea, Triple Superphosphate (T.S.P.) and Muriate of Potash (M.P.) were used by the farmers. The internal production of urea was 226,205 tons and T.S.P. was 37,756 tons. In addition 25,5948 tons of urea, 112,301 tons of T.S.P. and 37,401 tons of potash were imported to meet the requirement.

For wheat cultivation 11,000 tons of urea, 6,000 tons of T.S.P. and 2,000 tons of M.P. were made available and were fully utilized by the farmers. The recommended fertilizer dose was 100:80:60, 80:60:40 and 60:60:40 kg NPK/ha for fully irrigated, partially irrigated and non-irrigated conditions respectively.

The progressive farmers used the recommended rate of fertilizer but average farmers used only half of the recommended dose and sometimes less. The farmers in low lying areas, particularly where lands are enriched by siltation due to flood waters do not use any fertilizer.

DISEASES AND PESTS

In this season, diseases such as leaf rust caused by *P. recondita* as well as a leaf spot complex caused by *H. sativum, Alternaria* sp., *Diplodia* sp. and *Bipolaris* sp. were observed. The leaf spot complex affected Kalyansona, Sonora 64 and Sonalika. On the other hand, leaf rust was recorded on Kalyansona, Sonora 64, Jupateco 73 and slightly on Inia 66. The infection was particularly severe under late seeding conditions.

There was very little infestation of loose smut caused by *U. tritici.* An exact assessment of yield reduction due to these diseases could not be ascertained. It could however, run to 5–10 per cent approximately.

No important insect problem was noticed in the wheat crop. Infestations by wire worms, cut worms, aphids and stem borer were reported in some locations.

HYV

High yielding varieties of wheat were widely accepted by the farmers and these created a great impact on overall production. The yield of wheat which was only 0.4 tons/acre in 1975 rose to 0.8 tons/acre in 1978 (100 per cent increase). The local varieties were almost replaced by high yielding varieties and as a result, about 90 per cent of the total cropped area was covered by these modern varieties. The area is rapidly expanding.

GRAIN END USES

Grains are used for both home and industrial consumption as follows:

Home Use:

1. Hand made chapati or Roti, from flour.
2. Parata. It is prepared in the same way as roti. Roti is made thinner with a small quantity of butter, ghee or soybean oil spread over it. It is then folded to make it thick, and is fried in oil or butter.
3. Luchi. A small amount of butter or ghee is added to the dry wheat flour and mixed well. Then a small quantity of salt and an appropriate quantity of water are added to the mixture and a soft dough is prepared. It is then fried in oil or butter in a pan.
4. Puri. It is prepared in the same way as luchi except that it is stuffed with mashed potatoes, eggs, cooked minced meat, cooked pulses, etc.
5. Singara and samosa. A roti is prepared with wheat flour and cut into smaller pieces. Then cooked minced meat, fried potatoes, cooked vegetables, etc. are stuffed into the pieces which are then made triangular and fried in butter or ghee or oil in a pan. This is a popular snack in Bangladesh.

Industrial Use:

Wheat is used for commercial bread making and confectionary products like biscuits, cakes, pastry, etc.

PRODUCTION PROBLEMS

The problems in expanding the wheat acreage and yield were identified as follows:

1. Supply of seeds: The internal seed production was short and even though seeds were made available through import, the demand could not be met.

2. Credit: The credits on such inputs as fertilizers, irrigation, etc. were inadequate.

3. Support price: The floor price was fixed at par with that of paddy. It is felt that it should be fixed at a level between the rice and paddy price, if not, at par with rice.

4. Procurement grains: The procurement of grains did not meet the target set for the season. Eleven thousand tonnes of grain were procured through the Food Department.

5. Tube Wells: Their development needs to be accelerated if the wheat area is to expand into regions with a high water table.

INTERNATIONAL SUPPORT

International Centres, like CIMMYT and ICARDA are assisting the national program by providing research materials, equipment, training facilities and technical guidance.

INDIA

Dr. J.P. Singh and an extension officer examining the different arrangements of wheat and sugar cane in rotation near Hoshangabad, Madhya Pradesh, India.

INTRODUCTION

The All India Coordinated Wheat Improvement Project continued to operate at 33 centres spread over the entire country. Also, many other centres assisted in the program by laying out trials, nurseries and other experiments. The project made significant advancements in its different disciplines.

PRODUCTION

The wheat crop was a record and it was estimated to be about 31.3 million tonnes. This is 2.0 million tonnes more than that of 1976-77 and 2.5 million tonnes more than that of year before last—both of which were records.

An estimated 5.5 million tonnes of wheat were procured from the produce of 1977–78. Besides building up sizeable buffer stocks of wheat, India could also export some wheat during this year.

CLIMATIC CONDITIONS

The season was more or less very favourable for the wheat crop. Between October 1st and the end of December, there was excess or sufficient rainfall in all parts of India, except Western Rajasthan, Gujarat and Haryana. Adequate moisture at sowing time helped rainfed wheat sowings. Mild winter weather persisted for a longer period resulting in proper grain filling. The rains interfered as usual, in harvesting and threshing operation in eastern states.

FERTILIZER POSITION

There was no shortage of fertilizer.

DISEASES

In general, wheat diseases were light or negligible. Karnal bunt of wheat caused by *Neovossia indica,* which used to be of minor importance, became important in the most productive north western plains zone. Barley yellow dwarf virus is becoming serious in some pockets of the Uttar Pradesh hills.

PRINCIPAL VARIETIES

The most dominant variety of the country today is Sonalika. The second important variety is Kalyansona. Other varieties under cultivation were: C 306, PV 18, WG 357, WG 377, Arjun, WL 711, WH 147, WH 157, Raj. 911, A-9-30-1, Raj 1114, Raj 821, Janak, UP 262, K 68, K 65, NP 846, VL 401, Malwa Raj, Shera, Hyb. 65, Meghdoot, J-24, J-1-7, A 206, NI 5439, NI 747-19, Malavika, N 59, MACS 9, Bijaga Yellow, UP 301, UP 215, CC 464, HD 2189, Choti Lerma and HD 2135.

GERM PLASM COLLECTION

The National Bureau of Plant Genetic Resources organized a collection of local wheat germ plasm in Madhya Pradesh and Gujarat. While most were found to be susceptible to rusts, some of them could be very useful genetic stocks for drought resistance, grain quality, etc. This work is to be extended to the hills and valleys of Uttar Pradesh, Madhya Pradesh, Jammu and Kashmir.

VARIETAL IMPROVEMENT

The All India Wheat Workshop which was held in 1978 identified the wheat varieties for the areas and conditions as given below. These varieties are being extensively tested on government farms, farmers' fields, in agronomic experiments and they are being multiplied in a big way during 1978-79.

Variety	Parentage	Area	Conditions
KSML 3	Eight lines of Kalyansona deriving rust resistance from seven sources	North Western Plains Zone (Jammu, Punjab, Haryana, Western UP, Delhi, Northern M.P., Rajasthan except Kota and Udaipur Divisions)	Timely sown, irrigated, good fertility conditions
MLKS 11	Eight lines of Kalyansona deriving rust resistance from six sources	As above	As above
KML 7406	Nine lines of Kalyansona	As above	As above
HD 2236	HD 2119 x HD 1981	Central zone— Madhya Pradesh with the exception of the northern alluvial area, Gujarat, Kota & Udaipur Division of Rajasthan and the Bundalkhand area of U.P.	As above
Lok—1	S 308 x S331	As above	As above
HW 135	(NP 882 x S308) E 4928	N.E.Plains Zone-Eastern U.P., Bihar, W.Bengal, Orissa, Asam, Manipur, Tripura, Meghalaya, Arunachal Pradesh, Nagaland	Late sown, good fertility, irrigated conditions
HP 1303	(V 17 x SN 204) x C 306	As above	Timely sown, irrigated, good fertility conditions
HW 517	Bb-CC/Cno'S' -No.66-Pi 62	S. Hills	Timely sown, restricted irrigation, and good fertility conditions

The first three above mentioned varieties are multilineal varieties of Kalyansona. India is the first country to identify and release multilineal varieties of dwarf wheats for commercial exploitation.

So far no triticale variety has been found to meet the requirements of a cultivar.

WHEAT NATIONAL GENETIC STOCK NURSERY (NGSN) 77–78:

This nursery which consists of *T. aestivum and T. durum* strains as older entries and having resistance to different major diseases coupled with good grain and quality characters and desirable plant type, has been serving as a crossing block. The addition of new entries to this nursery each year for evaluation and identification of new promising material for characters of economic value brings enrichment in variability.

During 1977–78, this nursery consisting of 291 entries (old and new) both *T. aestivum and T. durum* were grown at 33 locations. Besides resulting in the confirmation of promise of older entries for resistance to one or more of the other important wheat diseases and some of the other desirable agronomic, grain and quality traits, there were new genetic stocks of promise from new entries picked up for further evaluation and use. Forty varieties of 54 older entries continued to maintain promise for various combinations of desirable characteristics, while 30 entries out of 235 new entries showed field resistance to 2–3 wheat rusts.

INTERNATIONAL NURSERY TRIALS

During 1977–78, 10 nurseries and trials were received, consisting of four bread wheat, three durum and three triticale. These were planted at 22 research stations and observations were taken. The filled-in data books were forwarded to CIMMYT during June 1978. The following were observed as the most promising entries regarding yield and rust resistance:

IBWSN: Nos. 14, 31, 34, 19, 221, 233, 235
ISWRN: Nos. 168, 468, 1023, 1073
6th Multiline: Nos. 18, 19, 34, 68, 71, 84, 88, 89, 97, 121, 122, 123, 156, 171, 174, 175, 217, 218
C.B. (BW): Nos. 3, 5, 23, 52, 53, 54, 88, 92
EDYT (Yield wise): Nos. 2, 7, 12, 13, 15, 18
Multiline Yield Trial: Nos. 12, 14, 24, 27, 31, 34, 36

Comparative observations of durum and triticale nurseries planted at different stations were not compiled and therefore, the pooled performance of the entries could not be determined.

WHEAT AGRONOMY

The new wheat varieties were thoroughly tested for their performance under different crop production conditions. Practice packages for the exploitation of the fullest yield potential of commercial wheat varieties under different conditions were formulated.

The other important findings in this discipline were:

Besides Tribunil, the herbicides Dosanex and Expt. 300 also showed promise for controlling grass weeds. However, proper dose and correct time of application in different agro-climatic conditions has to be determined before suitable recommendations on their use can be made.

Direct seeding of wheat into unploughed land in between the rice rows gave very good results. The findings are being confirmed.

PATHOLOGY

Varieties in different nursery trials and tests were screened against important wheat diseases. Trap nurseries and plant pathological screening nurseries were grown at a number of centres. Experiments were conducted to find out the efficacy of different fungicides for control of seed borne as well as foliar diseases.

Besides Vitavax, it was found that Bavastin was effective in controlling loose smut diseases. At selected centres, experiments were laid out to find possible tolerance mechanisms operating in some wheat varieties. The findings are inconclusive.

A disease survey programme was carried out. Rust race analysis work indicated that races 17, 21, 21A, 40, 40A and 117A-1 of stem rust; 10, 11, 12, 12A, 77, 77A, 104, 104A, 162 and 162A of leaf rust and 13, 19, 20, 20A, 31, 38, 38A and 9 of stripe rust were present in India. Of these, 21, 117A-1 and 40A of stem rust; 12, 104 of leaf rust and 20, 38 and 9 of stripe rust (only in southern hills), were the most predominant.

WHEAT ENTOMOLOGY

Tests were conducted to determine the efficacy of different chemicals in controlling field pests like stem borer, brown wheat mite, army worm, cut worm, etc. Varieties were also screened against stored grain pests.

NEMATOLOGY

Screening of varieties against *Heterodera avenae and Anguina tritici,* finding suitable chemicals, surveying nematodes in different areas and laying out demonstrations on chemical control of nematodes were undertaken. Packages of practices for control of ear cockle and molya diseases were formulated.

WHEAT PHYSIOLOGY

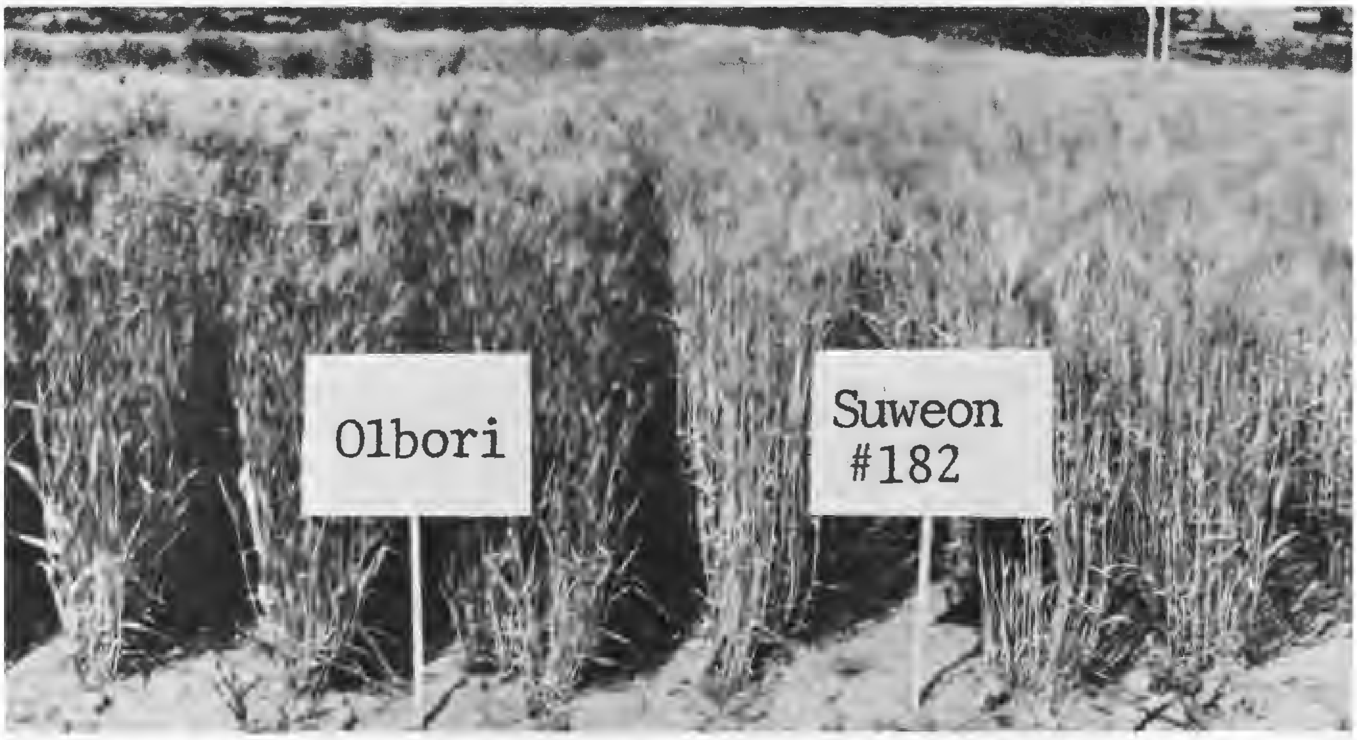
A National Drought Screening Nursery (NDSN) was organized for the first time in the Wheat Project. It was raised at 28 locations. The studies revealed that selective parameters have to be different for different environments.

Material of the Regional Trials was screened for physiological components of yield. It was observed that higher ear number was related to smaller leaf size and higher grain weight for ear, to bigger leaf size.

WHEAT QUALITY

In addition to protein and Pelshenke tests conducted with coordinated trials material, varieties were also evaluated for chapati,bread making and milling qualities. Quality tests with durum wheats for macaroni making and other characteristics were also carried out. These tests resulted in the identification of a number of high protein varieties having good chapati making properties.

Suweon No.215 (left) a new semidwarf wheat variety is earlier in maturity than Chokwang (right), in Korea.



A new barley variety Suweon No.182 (right) and a leading variety Olbori (left) at maturing time, in Korea.

WHEAT VARIETY IMPROVEMENT

Breeding Program

Wheat breeding was conducted at Suweon and Yunchun located in the northern area and at Milyang and Mooan located in the southern area.

Varieties such as Chokwang, Chugoku No.81, Olmil, Suweon No.210, and extremely early maturing No.215 and Suweon No.216 were used as female parents and the crosses were made to correct the defects of those varieties.

For improvement of extreme earliness and photo-insensitivity, spring wheat varieties such as Sonora 64, Ciano, Sharbati Sonora, Toluca 73 and Blue Bird from CIMMYT and Chugoki No.81, Gokuwase No.2, and Kanto No.75 from Japan were used as major parents in crossing.

In winter x spring crosses made since 1970, erect plant types, early maturing, dwarfness, good quality and high yielding were the major selection criteria. However, those extreme early maturing ones have raised questions on winter hardiness and grain plumpness. This is due to the large grain size and long maturing period under such humid high temperature conditions during the maturing periods, which is a typical weather condition in Korea. Another defect of those progenies is susceptibility to scab diseases.

Winter wheats, including the IWWPN supervised by the University of Nebraska, have been used as materials for the improvement of winter hardiness. Also the deep crown varieties such as Bezostaia and Kavkaz were crossed for breeding the cold tolerance wheat varieties. A total of 408 cross combinations were made in 1978 and also 417 winter x spring cross combinations, which were sent from CIMMYT.

A total of 314 combinations of F_1 were selected from 710 combinations, and 133 combinations from CIMMYT, based on earliness, winter hardiness and disease resistance.

F_2 bulk populations were planted at three different locations viz., Suweon, Mooan and Yunchun. Individual F_2 were planted only at Suweon. From the F_2 population, a total of 4,395 heads was selected at Suweon; 1,853 early maturing plants were selected at Mooan and 438 winter hardy wheat plants at Yunchun. Yunchun is located about 100 km north of Suweon. It is a good place to screen the winter hardiness due to its cold temperature and less snow during the winter, when compared to Suweon.

Earliness

In order to breed extremely early maturing wheat varieties, an effort was made to find out the gene sources of photo insensitivity with winter growth habit grade III–IV, rapid regrowing, instant flowering and maturing under relatively low temperatures and rapid filling of grains during 30–35 maturing periods under Korean environmental conditions. Varieties Suweon No.215 and Olmil are such photoinsensitive materials with winter growth habit grade III–IV, whereas varieties Lindon and Daws have characteristics growing under the low temperature. An attempt is being made to accumulate these traits rapidly into a desirable wheat variety by recurrent selection methods.

Several varieties and advanced lines were evaluated for photosensitivity, degree of growth habit and earliness continuously last year. Most of the early maturing and winter hardy varieties have winter habit grade IV and the varieties of lower than grade II, were susceptible to cold damage.

The degree of vernalization required by winter wheat varieties was found to be different depending upon the breeding site as indicated in figure 1.

As shown in figure 2, the variety Changkwang released in 1959 is typically photosensitive and medium in earliness while Sinkwang, Wonkwang and Chokwang released from 1969 to 1976 are photoinsensitive and early.

The pedigree of Suweon No.215 and Suweon No.216 is Strampelli x 69D-3607/Chokwang and it was speculated that the earliness of these varieties originated from the transgressive segregation.

Drought Tolerance

Wheat is mainly cultivated in the uplands even though a large area is available for wheat in the paddy fields in central and southern Korea.

Because drought is a frequent problem in most wheat growing areas, there is a need to produce drought tolerant varieties to minimize yield decrease and stabilize wheat productivity.

A screening test was designed to differentiate the drought tolerance of important breeding materials. The test results suggest that early maturing varieties and lines are tolerant to drought and all the late maturing varieties tend to be susceptible to moisture stress. Milyang No.10 and No.8 were found to be susceptible, Chukoku No.81 was moderate and Suweon No.211, Suweon No.212 and Suweon No.216 were found to be resistant to drought damage.

Spike Sprouting Resistance

Screening for sprouting resistance in the spike was made on selected breeding lines and varieties.

There was a positive correlation between the germination rate and the average germination time. In comparison between land race and current varieties, the former tended to ease in sprouting compared with the latter. Suweon lines were more susceptible to sprouting than Milyang lines, in general. Resistant varieties selected from this screening test were Chukoku No.81, Milyang No.8 and No.10, and Suweon No.208. Lines derived from BbNo.1 x Changkwang/Sturdy were extremely susceptible to sprouting in the spike.

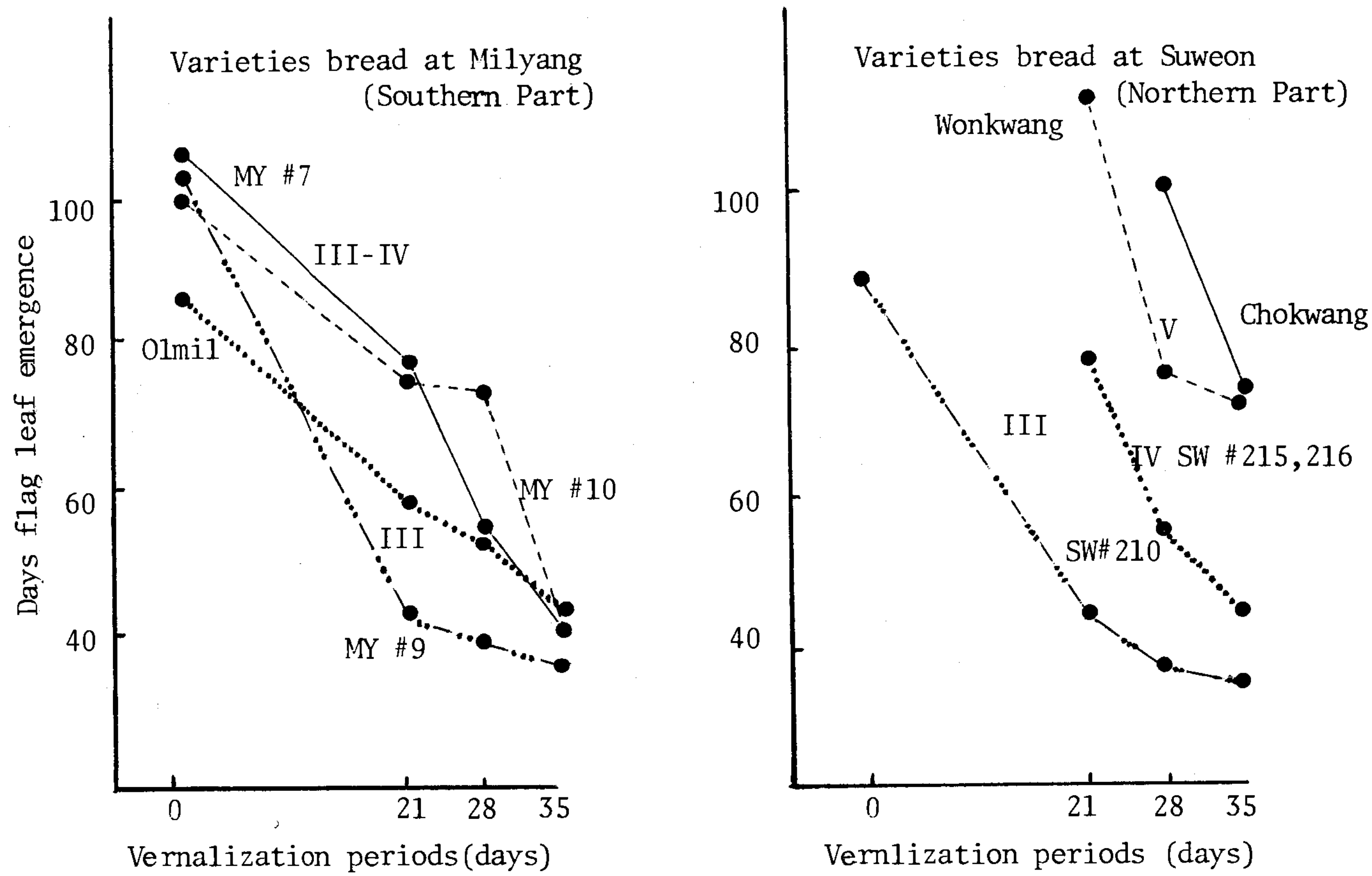


Fig. 1. The growth habit of the wheat varieties from different breeding site.

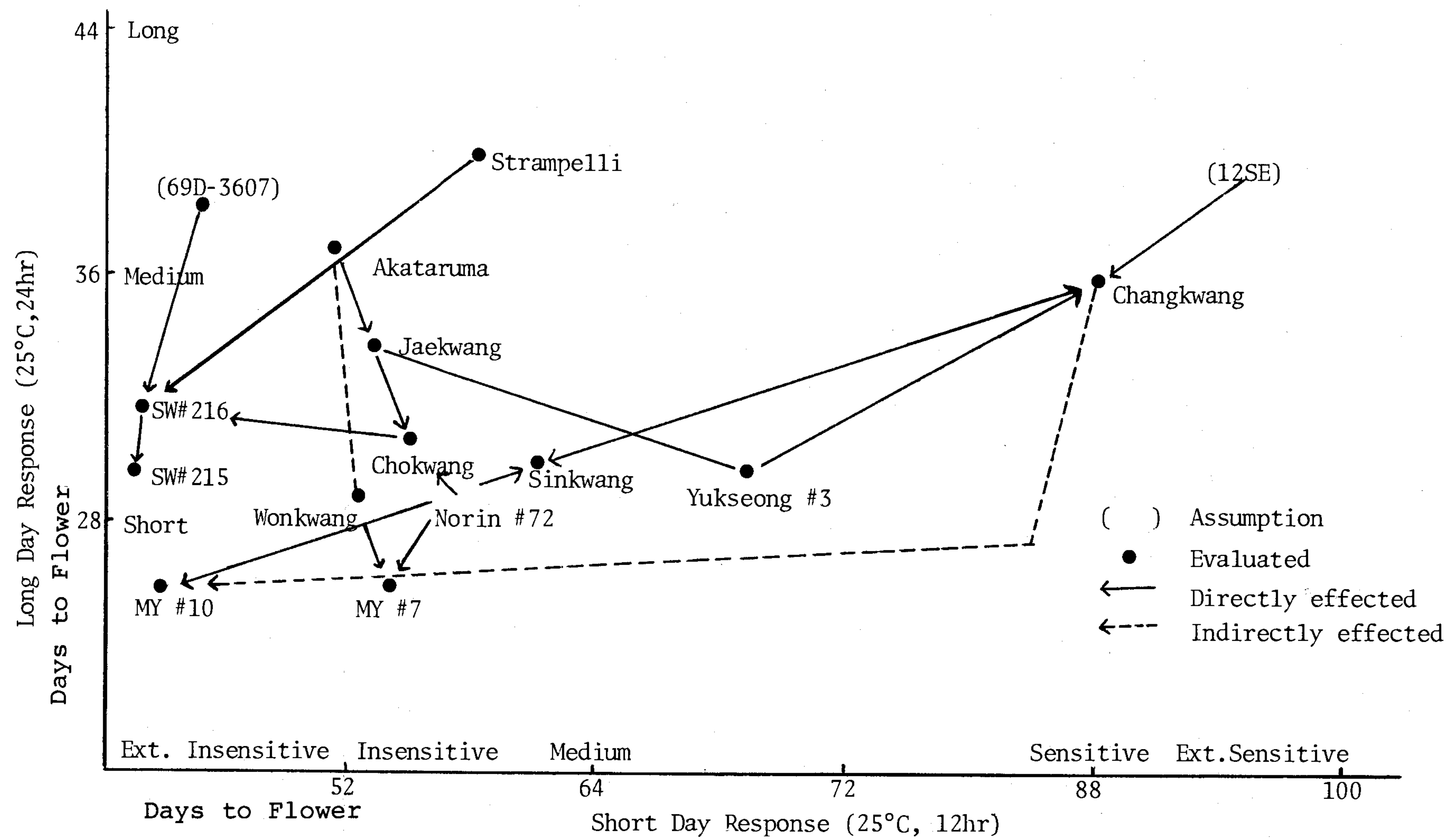


Fig. 2. Varietal Changes of the Daylength-Sensitivity in Korean wheat varieties.

Disease Resistance

One of the economically important diseases of wheat is the scab caused by *Gibberella zeae* during the ripening period, specially under high humidity or rainfall. It frequently results in reduced grain weight and can be toxic to animals being fed the infected grain.

The epidemics of this disease differ from year to year. For example in 1963, it caused a 49.9 per cent contamination in wheat and a 42.9 per cent contamination in barley. The annual damage rate from the disease is usually one tenth of the total wheat production.

The results of screening for scab resistance, among the 253 tested varieties/lines, resulted in no resistant varieties/lines being selected for the crossing parents, because most of the tested varieties/lines were infected more than 60 per cent.

Powdery mildew is widely distributed everywhere in Korea and causes yield losses from 5–15 per cent.

A screening test was carried out in the greenhouse to get the resistant germ plasm with 421 varieties/lines originating from different regions at the seedling stage by inoculation with the causal organism, *Erysiphe graminis* f. sp. *tritici.* Oasis, Maris Huntsman and Double Crop, originating from the United States, showed a highly resistant response, but leading Korean varieties and newly improved lines were highly susceptible. The varieties selected from the resistant response were put into the breeding program to breed resistant varieties.

Three rust diseases viz., stem rust, leaf rust and stripe rust occur on wheat in Korea. Stem rust is the important disease to be controlled with resistant varieties.

Yield losses from stem rust differ in relation to the intensity of attack, year to year. Stem rust screening tests were conducted in the greenhouse on 328 wheat varieties/lines by inoculation with *Puccinia graminis* f. sp. *tritici* at the seedling stage. Thirty two out of 328 varieties/lines originating from different regions were highly resistant. They included Oasis, Lindon, Bordenarce, CI 14034, Double Crop and others.

Twenty-six varieties/lines were resistant and the remainder were susceptible. The varieties from the United States showed resistance but the varieties and lines improved in Korea were very susceptible to stem rust.

Yield Trials

In a preliminary yield trial, the lines in the pedigree of Strampelli x 69D-3607/Chokwang and 23584-Inia x Wonkwang were 2–6 days earlier than the check variety Chokwang. Suweon No.218 which appeared to be high yielding and early maturing was selected from the cross Strampelli x 69D-3607/Chokwang and will be included in the 1979 regional performance trial.

The thousand grain weight of SW No.218 is 46.9 grams, which is 6.9 grams heavier than Chokwang. However, there are some problems in grain plumpness due its large grain size under unfavorable climatic conditions, like high humidity and undesired precipitations.

Suweon No.217 was outstanding in the advanced yield trial. Its parentage is SW No.185 x Sharbati Sonora/Caprock. This line will also be included in the regional performance trial in 1979. Suweon No.217 yielded higher in the drill seeding plot than the conventional seeding plot due to its erect plant type. SW No.217 and SW No.218 are both soft wheats with good milling properties.

Suweon No.215 was an outstanding line in eight locations of the regional performance trial. Suweon No.215 is an extremely early maturing variety being six days earlier than Wonkwang. It is semidwarf, lodging resistant, has a high level of cold tolerance and there is no danger of winter killing of it in northern central Korea. It is susceptible particularly to stem rust and powdery mildew, but it escapes infection quite frequently due to its extreme early maturity. It has a growth habit of grade IV, which is a typical winter type, and it is photoinsensitive. There is no visible stem elongation during the winter, but regrowth is so rapid with increased temperature, that the number of florets per spikelet tends to decrease.

Suweon No.215 tillers less than the standard variety. There are 33 grains per spike, which is six less than the check. The thousand grain weight averages 43.8 grams which is heavier by 9.8 grams than the standard variety. Grain yield is similar to the check variety as shown in the following table:

Variety	Maturing date	Culm length	Disease reaction: Powdery mildew	Disease reaction: Rust	Growth habit	Photo-sensitivity	Crude protein per cent	Grain yield t/ha
Wonkwang	June 21	75	S	S	IV	MI	9.9	5.4
SW No.15	June 15	64	S	S	IV	I	12.6	5.6

MI – Medium Insensitive I – Insensitive

Suweon No.215 was recommended by the Crop Registration Committee to be released for paddy fields in the southern area and the upland throughout the country in 1979.

Milyang No.9 bred by the Youngnam Experiment Station seems to be suited to paddy fields in the southern area because it matures 6–7 days earlier than Chokwang, even though the grain yield was 10 per cent lower than the check variety.

Flicker "S", a semidwarf variety introduced from CIMMYT, was renamed Mockpo No.4. This variety showed good performance at Mooan in 1978, and will be included in the regional performance trial. It yielded 9 per cent higher and expressed a similar maturing date to Chokwang.

International Wheat Nurseries

The International Bread Wheat Screening Nursery (IBWSN) and the International Winter x Spring Wheat

Nursery (IWSWN) have been tested since 1973. These nurseries contribute very much to improve the agronomic characteristics, diseases resistance and grain quality of the Korean wheat breeding program. However, there are some defects in the spring x winter crosses such as susceptibility to scab disease and sprouting in the heads.

A total of 299 IWSWN lines was tested at Suweon in 1978. Most of the lines were relatively weak to cold damage and late in maturity, compared with the check variety Chokwang. The lines presented in the following table are desirable in terms of plant type and tillering capacity.

Agronomic characteristics and grain yields of promising IWSWN lines tested at Suweon, 1978:

Variety	Winter survival per cent	Maturing date	No. grains per spike	Plant height cm	Weight 1,000 grains g	Per 10a Grain yield kg	Index per cent
Chokwang	85	June 24	47	67	45	465	100
SWD 70417-0410-3P OP-0P	40	June 28	56	68	37	465	100
SWD 71164-06M-1H-0P	30	June 28	55	63	34	476	102
SWD 71167-01H-01H-0P	40	June 23	56	60	32	385	104
SWD 71167-07H-1H-0P	50	June 23	51	70	37	506	109
SWD 71220-20H-01H-0P	40	June 24	53	50	40	209	45

Baking Studies

Decreased loaf volume and poor bread are generally obtained with soft wheat flours. As the environmental conditions in Korea are suitable for soft wheat production, baking studies with soft wheat were conducted in 1978. The effect of artificial protein sources (skim milk and defatted soybean), and bread improvers (potassium bromate,ascorbic acid, potassium iodate and iodoacetic acid) on bread quality of soft wheat are shown in figure 3.

Relatively large loaf volumes and good bread were achieved with 2 per cent soyflour and 3 per cent skim milk additions. A good large bread was obtained with increased bread improvers. With the use of soft wheat flour, the loaf volume decreased as the level of soft flour in the blend was increased. Based on loaf volume, bread texture and flavor, at the 30 per cent level, the soft-hard wheat bread was quite acceptable.

BARLEY VARIETY IMPROVEMENT

Breeding Program

In order to classify parents for the crossing program, a total 371 varieties was categorized on major characteristics, into the following groups: leading varieties, early maturity, short culm, disease resistance, colo resistance and naked barley varieties, etc.

Techniques aimed at providing a current heading date were tried in the field. In the greenhouse, heading date was controlled by using two different seeding dates. A total of

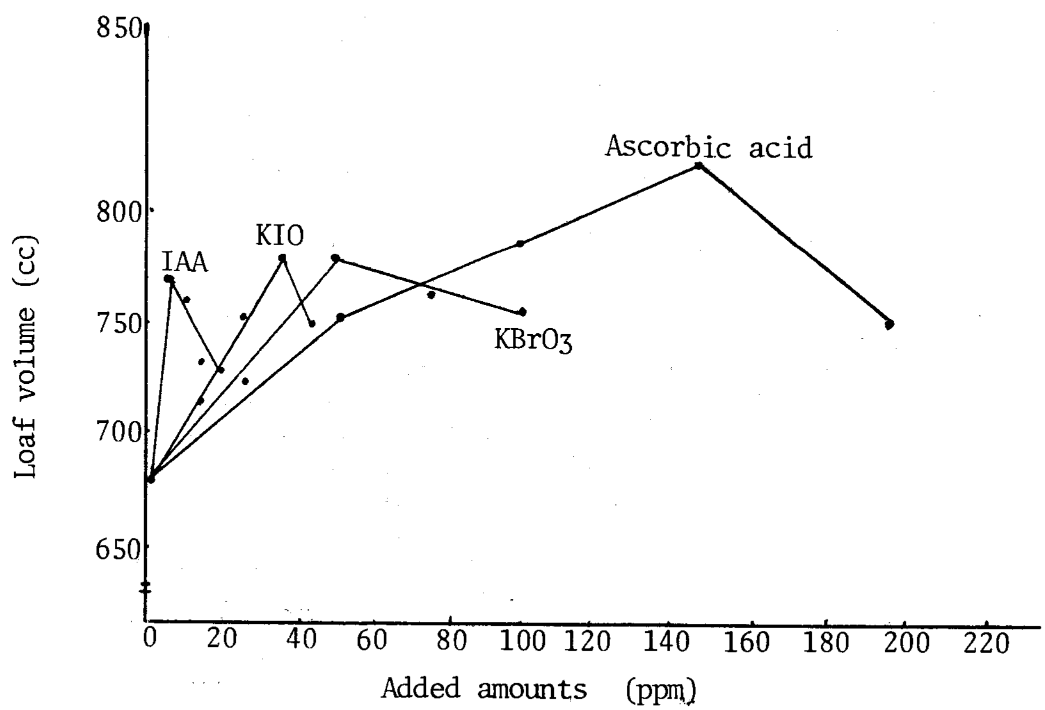


Fig. 3. Loaf volume changes in increased potassium bromate, ascorbic acid, iodoacetic acid and potassium iodate concentrations.

442 cross combinations was made in the greenhouse and field, and 465 combinations of F_1 plants were individually grown and 355 combinations were selected for further advancement.

In F_2 plants, a total of 8,773 was selected. The F_3, F_4, F_5 and F_6 generations were composed of 8,473 lines and from them 1,482 lines were selected. From the F_4, F_5, F_6 generations, 100 promising lines were selected for their early maturity, high yield and uniformity. They will be entered in the preliminary yield trial next year.

Cold Tolerance

A total of 298 varieties and lines was submitted to cold tolerance tests. Among them, SB 7218-B-15-1 (Boanjin x Chilbo/olbori), Dongbori No.1, Suweon No.186 and Suweon No.189 were very cold tolerant lines. Eight other lines, including MY No.6-9-111-13, YB 39-38-10-1 and YB 340-3B-23, were comparatively cold tolerant.

Wet Soil Tolerance

A total of 144 bred lines of barley was submitted for wet soil tolerance testing in plots which were irrigated from the 5th–20th April. From these lines, SB 72273-B-24-3 (Ginomeo/Suweon No.165 x Olbori), SB 72581-B-13-1 (Gizeh 134 x CI 13790) and SB 71107-B-50-5-0 were comparatively wet soil tolerant. There were some difficulties in classifying the degree of wet soil tolerance because of a serious drought after the sowing and boosting stages.

Grading Growth Habits

A total of 90 barley bred lines and varieties was submitted to this test. Most of the land races and recommended varieties were found to be growth habit IV. The majority of the recently bred lines belong to growth habit I or II.

Breeding for a New Waxy Barley Variety

In order to improve the taste of boiled barley, the back cross breeding method was applied to transfer the waxy endosperm gene (wx) into the leading barley varieties. In greenhouse experiments, 18 cross combinations were made in 1978 and 1,915 individual plants were obtained from these combinations. Also, 52 lines from three combinations of BC_3 F_3 waxy plants were grown but none was selected.

In the field experiment, 69 lines from nine combinations of F_3, 11 lines from four combinations of BC_1 F_5, 107 lines from eight combinations of BC_2 F_5, and 21 lines from five combinations of F_5 plants were selected. From them, 35 superior lines will be entered into the preliminary yield trial in 1979.

Breeding for High Yielding Lines of Barley by Male-Sterile Facilitated Recurrent Selection

Genetic populations, suitable to Korea, were introduced into male sterile populations in order to establish populations for recurrent selection. From the bias source and male sterile populations, 321 early maturing, moisture tolerant and many tillering individual plants with excellent plant type, were selected in 1978.

Yield Trials

The regional performance trials were carried out at 33 locations (Upland: 18, Paddy: 15) with 13 lines. In yield, Suweon No.182, Suweon No.183, Suweon No.186 and Suweon No.188 (covered barley), Suweon No.185 and Suweon No.187 (naked barley) were higher by 11–40 per cent as compared with Olbori on upland fields. On paddy fields, Suweon No.186 and Suweon No.188 were higher by 3–11 per cent as compared with Olbori.

The result of the barley regional performance trial showed Suweon No.182 to be two days later than Olbori in the heading date, and three days earlier than Olbori in the maturing date.

Culm length of Suweon No.182 is shorter than Olbori and Kangbori. In winter hardiness and disease resistance, Suweon No.182 is stronger than Olbori and Kangbori. Also, Suweon No.182 has more grains per spike and more spikes per square meter than Olbori, but a lower 1,000 grain weight than Olbori.

Suweon No. 182 has more spikes per square meter and a higher 1,000 grain weight than Kangbori, but less grains per spike than Kangbori. The average yield potential from 1976–78 of Suweon No.182 was 9 per cent higher than on the upland field at 18 locations, and 8 per cent higher on the paddy field at 15 locations, than the check varieties at each site.

Milyang No.12 bred in Milyang was grown in the regional performance trial from 1976–78. The traits of Milyang No.12 appeared to be suitable to paddy fields in the southern part. In maturity date, it is five days earlier and its yield is 7 per cent higher than Kangbori on the paddy fields.

A new naked barley line, Mockpo No.51, was included in the regional performance trial in 1977. It yielded 12 per cent higher as the mean value than the check varieties of each location, even though the maturing date is similar to the check variety.

One of the promising malting barley varieties, MI No.30182 was evaluated by the Mockpo Branch Station. MI No.30182 proved to be a superior variety because it yielded about 12 per cent higher than Golden Melon on the southern sites in the applied regional performance trial. The maturing date is three days earlies than Golden Melon through the trials from 1976–78.

Survey of Barley Production Farms

According to the results of the 9,075 barley growing farms surveyed in 1978, 66 per cent of the farmers have cultivated barley for their own consumption. Also it was found that 92 per cent of farmers were practising ordinary drilling on the upland fields. Seeding preparation was made by cattle and appropriate equipment in more than 81 per cent of the surveyed farmers. In paddy cultivation, 61 per cent of the farmers were practising high ridge broadcasting methods in seeding and 57 per cent were utilizing motor tillers for seed bed preparation and seeding.

CULTURAL PRACTICES

To increase wheat and barley productivity potential per unit area in Korea, wheat and barley cultivation research has been concentrated on the improvement of cultivation practices for the newly developed varieties, on the establishment of stabilized high production practices and on mechanized labor and power saving cultural methods.

Experiments on seeding date, seeding rate and fertilizer application level in several regions were carried out to establish stabilized high yielding cultivation practices for the newly developed wheat variety Chokwang, in Korea.

a. **Seeding date:** Optimum seeding dates by region were found to be October 11 in the central northern area and central area, and October 15–25 in the southern area.

b. **Seeding rate:** The optimum sowing rate was found to be 160–170 kg/ha in uplands and 210-230 kg/ha in paddy lands of the central northern area, and 150–170 kg/ha in uplands and 180–200 kg/ha in paddy lands of the southern area. In both areas, the seeding rate was higher in paddy lands than in uplands.

c. **Fertilizer application level:** A reasonable fertilizer application level was 150–100–80 kg/ha of N-P_2O_5-K_2O in the uplands of the central northern and central area, and 200–120–90 kg/ha in paddy of the whole area. Heavy fertilizer application was more effective in paddy land than in upland, in Korea.

Stabilized High Yielding Cultivation

To establish stabilized high yielding cultural practice techniques, the effects of drought treatment by growth stage of wheat and barley on yield components and grain yield were investigated by using the wheat variety Chokwang and the barley variety Gangbori.

The experiment was carried out in an artificially controlled precipitation house and doubled PVC pots with a surface area of 0.22 m^2 were used to control soil moisture content and ground water level.

During the drought treatment period, drought treatment pots were drained completely and soil moisture in the pots was removed by using a vacuum pump. Optimum soil moisture was maintained, except in the drought treatment period.

The most severe grain yield reduction occurred in the 20 days drought treatment from May 10–30 (heading date: May 9), causing a 66 per cent grain yield loss as compared with optimum soil moisture maintained in the pot for the whole growth. Sterility of 45–53 per cent of the barley spikes appeared in the March 16–May 1 drought treatment pots, and in the April 1–May 1 drought treatment pots.

Grain yield reduction by drought treatment was mainly due to few grains per spike and sterility in the period before heading, and to the light weight of 1,000 grains in the period after heading.

The most severe grain yield reduction occurred in the 20 days drought treatment from May 10–30 (heading date: May 16), causing a 73 per cent grain yield loss as compared with the optimum soil moisture maintained pot for the whole growth stages. Other drought treatments in the other growth stages also induced grain yield reduction. Water stress around heading time produced the most severe grain yield loss as compared with other growth stage water stress.

Grain yield reduction by drought treatment was mainly due to few grains per spike in the growth stages from just after wintering to booting and due to few grains per spike and also particularly to the light weight of 1,000 grains in the growth stages around heading.

In conclusion, the most severe injury by drought occurred in the before-and-after-heading stages for 15–20 days. The results indicated that optimum irrigation must be provided around the booting, flowering and doughing stages and also throughout the entire growing season to obtain maximum yields of high quality grain under the Korean climatic and soil moisture conditions.

Paddy Land Seeding and Fertilizing Rates

Using a rotary screw seeder attached to a power tiller, the optimum seeding rate for the newly developed barley varieties Olbori and Bunong, was found in a seeding rate trial to be 160 kg/ha, which resulted in a 11–15 per cent increased grain yield.

Also it was determined from fertilizer trials that the optimum application rate was 150–100–80 kg/ha of N-P_2O_5-K_2O, which increased the grain yield by six per cent.

PAKISTAN *

AREA

The total area sown to wheat in 1978 was estimated to be 6.4 million hectares, of which approximately 4.8 million hectares were irrigated. The remaining 1.6 million hectares were rainfed, much of which receives rather limited moisture (200–400 mm) each year. Most of the rain falls in the spring monsoon season, but the wheat crop is produced during the winter season. Thus the problem of water conservation in these areas is of great importance.

Barley is a minor crop in Pakistan grown on only 172,000 hectares per year. It is not preferred as a food crop and therefore, the demand is small.

Triticale is not yet in commercial production. Trials have indicated that it has a place in Pakistan, particularly as a combination forage–grain crop.

PRODUCTION

Wheat crop yields reached a peak in 1976-77 when an estimated 8.9 million metric tons were produced. The average yield was 1.42 t/ha. However in 1977-78, yields declined significantly, the total yield being an estimated 7.5 million metric tons and 1.15 t/ha, for average yield.

WHEAT IMPORTS

A rapidly increasing population coupled with higher prices for corn and other food grains has increased the demand for wheat. In 1977-78 Pakistan imported approximately 1 million metric tons of wheat. Due to the severe yield decrease in 1978 the government was forced to import 2.2 million metric tons for the 1978-79 food year.

CLIMATE

Climatic conditions for the 77-78 crop year were probably better than average. Timely rains were received. An early February frost caused some damage to early maturing varieties in the foot hill regions. These varieties had been seeded too early due to lack of proper information. Above average temperature occurred very late in the season, but nearly all the wheat was mature and a large part of the crop had already been harvested. Climatic conditions were favorable for the development of rusts.

FERTILIZERS

More total tonnage of fertilizers was available in the 77-78 crop year. Total nitrogen increased from 250,000 metric tons in 76-77 to 266,000 metric tons in 77-78, while phosphatic fertilizers increased from 65,600 to 77,100 metric tons. Overall estimates are that total fertilizer usage per hectare increased from 47.8 kg in 76-77 to 51.7 kg in 77-78. The N:P ratio decreased from 4.8:1 to 3.5:1. A ratio of 2:1 or less, is considered optimal.

While total estimated usage apparently did increase, there is considerable doubt as to the actual amounts applied to wheat and the effects achieved. A large part of the fertilizer was not available at the proper time and shortages were common. In addition, late applications probably resulted in a less efficient uptake and utilization.

Fertilizer prices were subsidized by the government but the unrealistic price of wheat left little incentive to increase fertilizer usage.

Recommended dosages vary according to soil types, available moisture and cropping system. Recommended rates for low rainfall areas are 50 kg/ha of each of N and P_2O_5. In high rainfall regions and also under irrigated conditions, the recommended kg/ha rates are 100 N and 50 P_2O_5. Actual usage is generally much below the recommended rates.

There is increasing evidence that some trace elements, particularly zinc and copper, are becoming limiting. These areas are localized but they need to be delineated and treatments applied. In general, wheat has not responded to potassium.

PROBLEMS

The major constraint against expanding the area sown to wheat, is the lack of time. More and more farmers are trying to intensify cropping. Wheat is following rice, cotton or sugarcane. With the present available methods, farmers do not have time to remove a crop, prepare the soil and seed again. Wheat is therefore competing with the other crops, even though it is the major crop grown during the winter (rabi) season. Prices received for wheat versus other crop prices and the return versus cost of inputs, such as seed and fertilizer, influence the area devoted to wheat.

Weeds continue to be a major problem. There are small efforts to introduce and test herbicides. The Pakistan Agricultural Research Council is planning to create staff positions for trained weed control workers. Unfortunately, there are no scientists available with advanced training in weed control.

DISEASES

The 77-78 wheat crop was a very expensive and painful experience for Pakistan. A severe rust epidemic occurred and yields were reduced about 20 per cent. Stripe rust was present in the northern regions and this was followed by leaf rust over most of the country. The latter was the major problem because of the larger area affected.

Official records and numerous reports document the fact that the rust susceptibility of the varieties in use has been known for several years. A stronger effort to distribute varieties with proven rust resistance could have prevented this epidemic and thereby saved Pakistan 200 to 300 million dollars in 1978–enough to finance wheat research there for about 250 years.

SEED INDUSTRY

Part of the problem which resulted in the serious yield decrease can be related directly to the absence of a

* CIMMYT assists the national program in its research and training activities through the assignment of a CIMMYT scientist. The CIMMYT involvement is financed through a contract with the Pakistan Agricultural Development Council under grants from USAID and the Ford Foundation.

seed production and distribution system. Several rust resistant varieties were available for commercial production but they were not promoted by the breeders and were not multiplied and distributed.

In Pakistan, government controlled seed corporations are responsible for the production and distribution of certified seed. They hope to handle about five per cent of the total seed used each year. The balance is handled through informal, farmer to farmer type arrangements.

Lack of an aggressive program to introduce improved varieties and replace old ones leaves the country in a very vulnerable position, even if disease resistant varieties are available. The fact that an estimated 80 per cent of the wheat under increase for distribution by the controlled seed farms and corporations was of a recently released variety, which was extremely rust susceptible, can only be accredited to the lack of a strong disease screening program in the variety development process.

A World Bank supported program is now in progress to create a functioning seed industry. Variety certification procedures and requirements are being set up. Seed cleaning and processing plants are under construction. Personnel are being trained to operate these agencies and plants. It is anticipated that the project will be operational by 1981.

HIGH YIELDING VARIETIES

It is estimated that high yield varieties (HYV) now occupy well over 4 million hectares (84 per cent) of irrigated wheat land but only on 20 per cent of the dryland areas. Past experience in Pakistan indicates that farmers will readily adopt improved varieties, if they are available. However, epidemics such as occurred in 1977-78, will undoubtedly reduce the acceptance of improved varieties.

PRINCIPAL VARIETIES

Various widely grown varieties are: Lyallpur 73, SA 75, Pothowar, Chenab 70, Barani 70, Blue Silver, Tarnab 73, Khushal 69, Mexipak 65, Nuri, Yecora, PAK 70.

Some of these varieties, including Chenab 70, PAK 70, Mexipak, Pothowar, Tarnab 73, Khushal and Mexipak 65 are all succeptible to rust. The varieties Pothowar, Khushal, Tarnab 73 were officially withdrawn from the recommended list of varieties. Because little other seed was available, a very large part of the 1978 crop may again be planted to susceptible varieties, such as Chenab 70 and Mexipak.

Realizing the critical nature of the seed reduction, the Government of Pakistan attempted to purchase as much seed of disease resistant varieties as possible. The current floor price was 37 rupees per maund and farmers were offered an 8 rupees premium for "acceptable" seed, or 45 rupees per maund. However, at that time food wheat in the open market was selling for 55 to 60 rupees per maund. Consequently government seed purchases fell far below need.

Plans were made to purchase 1,363,000 maunds of seed but only 668,000 maunds were actually obtained. Much of this was of dubious origin and quality, because the purchasing plan was put into effect late in the harvest season when the origin of the seed variety could no longer be verified.

As a result of the rust epidemic and the lack of seed of resistant varieties for planting this year, the government decided to import wheat seed. Missions were sent to India and Mexico. About 10,000 tons of Pavon were imported from Mexico and a total of 5200 tons of Sonalika, WL711 and HD2009 from India. Unfortunately some of the Sonalika seed from India had been over treated for control of weevil and the seed had a very low germination rate. Part of this seed was returned to the sellers.

The quantity of imported seeds is to be increased and the increase is to be purchased for distribution in the fall of 1979. If this occurs, a large part of the area normally sown to rust susceptible varieties can be seeded to resistant varieties. Pakistan will then be in a much less vulnerable position.

Varieties released in 76-77 were Punjab 76 and LU 26. The first named was the major variety in seed increase production in 77-78. It is estimated that this variety occupied 80 per cent of the controlled acreage under seed production. Unfortunately, it was so severely attacked by the rusts that it was withdrawn as a recommended variety. Many seed fields were nearly a total loss. LU 26 was susceptible to stripe rust, but is being continued for use in the southern regions where stripe rust is not a problem.

The only varieties released in 1977-78 were the following importations—Pavon F76, HD 2009, WL 711 and Sonalika.

PROMISING MATERIAL

The local tall varieties are C591, C271 and C273. The promising semidwarf varieties are Mexipak 65, Khushal 69, Chenab 70, Pak 70, Blue Silver, SA 42, Pothowar, Lyallpur 73, Tarnab 73, Pari 73, Sandal, Yecora 70, Nuri 70, SA 75, Punjab 76 and LU 26.

The following advanced lines are also promising— ZA 75, 141 (Tobari 66 x 8156), Ciano 'S'—LR64/Son(Amb), II—23584 x Blue Silver, Inia—Son/P4160—Son64, Blue Bird x 15-13-5/Son, NIAB—546 (derived from Nortino) and LU 25 (Blue Silver x Khushal).

AGRONOMY

There is a dire need for applied, on-farm research in agronomy. Several factors are changing which necessitate on-farm research in order to develop technology which is appropriate for the various areas and cropping regions. Some of these factors are:

(a) More and more farmers are attempting multi cropping operations e.g. a wheat—cotton rotation or rice—wheat rotation or a rice—rice—wheat system.

(b) Mechanization is accelerating with government support.
(c) Soil problems such as salinity, waterlogging and micronutrient deficiencies are becoming more evident.
(d) There is a need to recognize and delineate regions with different climatic and soil conditions or special problems, and to develop suitable technology to fit these areas.

Wheat seeding is done from early October to early January, but most seeding occurs from mid October to mid December. Weather conditions are such that the harvest begins in early April and ends in mid May. Thus the need for varieties with varying requirements for the growing season , is evident.

GRAIN END USES

Virtually all wheat is consumed as a food crop. Small amounts may be used for animal feed because the price of wheat is well below that of corn, sorghum and millets. Areas that formerly used corn as both human food and animal feed, are now turning to wheat because of the price differential.

Barley is mainly used for animal feed. The barley industry is not expanding.

Triticale which is just making its entry, has real potential both as a grain and forage crop.

Straw is an important part of the crop here. The value of the straw may equal or exceed that of the grain.

RESEARCH

There are some major areas of research which deserve high priority.

First, the effects of water logging and salinity on the uptake and utilization of fertilizer must be studied. It appears likely that yields are suppressed under these conditions and that farmers may be disappointed in the results obtained from the use of fertilizer. The salinity of water logging problems must be faced to prevent the complete deterioration of agriculture in the Indus valley, over time. Micronutrient studies must be carried out to identify problem areas and provide solutions.

Second, the problem of controlling weeds must be attacked. It is discouraging to see vast amounts of resources such as fertilizers, labor, etc., being wasted in growing weeds.

Third, the cereal disease element in variety development programs must be strengthened. Integration of plant breeders and cereal pathologists is imperative if Pakistan is to avoid a re-occurrence of the disease epidemics such as occurred in 1977-78.

INTERNATIONAL SUPPORT

Assistance given by the international centers such as CIMMYT is invaluable in respect of the development and distribution of improved germ plasm, the exchange of materials, the availability of disease screening stations such as in Kenya, and the provision of training opportunities for technical staff, visiting scientists and administrators.

PEOPLE'S REPUBLIC OF CHINA

The Chinese Academy of Agricultural Sciences at Beijing has reported the performance of CIMMYT wheats grown in an International Septoria Observation Nursery Trial, (ISEPTON).

It was planted on March 11, 1978 at Nan Jing, 32°3'N latitude, 118°47'E longitude and 67.9 m elevation. The trial received two irrigations and was harvested on June 20, 1978.

A very severe drought was experienced. Rust, scab and powdery mildew infections were lighter. Almost all varieties, including Klein Atlas and Marco Juarez INTA which originated from Argentina, and Maringa from Brazil, were infected with scab.

Many varieties were late maturing with little tolerance to high temperature in the late growing period. They were infected with leaf blight and *Septoria* resulting in somewhat shrivelled kernels. The 1,000 kernel weights were lower with many varieties having weights of only 20—30 g/1,000 kernels.

The following results were obtained with some of the lines tested in China in 1977-78:

Entry No.	Variety or Cross and pedigree	Maturity	Septoria tritici	Height (cm)	Weight of 1000 kernels
10	6664-10 K6528-Tob66 K6648	Late	S	80	38.6g
25	*5YG/RA*2F$_2$**2F Cno-Rec II44733-5M-1R-0R	Moderate	—	64	37.2g
114	Colonias 17/22/73	Late	S	86	41.5g
125	Pat$_2$	Late	S	93	37.0g
131	Marcos Juarez Inta	Moderate	S	72	18.2g
191	Gala Sr17	Early	S	62	41.2g

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Entry No.	Variety or Cross and pedigree	Maturity	Septoria tritici	Height (cm)	Weight of 1000 kernels
Five Early Maturing Varieties					
23	$*5YG/RA*2F_2**2F$ Cno-Rec I144733-3M-1R-0R	Early	–	60	33.8g
26	$*5YG/RA*2F_2**2F$ Cno-Rec I144733-5M-4R-0R	Early	S	68	33.4g
47	Cno-7C-CC X Tob66 25918-20Y-5M-4Y-0Y	Early	S	66	24.5g
173	Bman-On x Cal/Sr70 CM-16029-4Bj-OBj-0Y	Early	–	55	20.6g
191	Gala Sr17	Early	S	62	41.2g

Europe

AUSTRIA

AREA AND PRODUCTION

The following statistics relate to the 1976 crop season:

Cereal	Area (ha)	Yield (t/ha)	Production (t)
Winter Wheat	271,074	4.33	1,173,750
Spring Wheat	10,252	3.27	33,542
Durum	8,000	2.90	23,200
Winter Barley	33,630	3.75	78,663
Spring Barley	290,877	3.99	1,160,599

SEASONAL CONDITIONS

There was a good overwintering of the crop followed by low spring temperatures which resulted in good tillering. Slow development took place with the spring sown cereals, which led to an extraordinary yield in spring barley and durum wheat.

EXPORTS

There is self sufficient production, with 200,000 tonnes of winter wheat now being exported, to Poland.

FERTILIZERS

The fertilizer application rates for cereals are rather high, compared with the level of East European countries, but they do not reach the amount applied in Western Europe.

The following table shows the kg/ha rates applied since 1975:

	N	P_2O_5	K_2O
1975/76	45.2	28.4	42.8
1976/77	53.7	33.5	52.0
1977/78	53.1	36.7	55.1

There is no fertilizer shortage nor signs of nutrient deficiencies.

PRODUCTION PROBLEM

A problem is the increasing over production. Nearly 70 per cent of the crops are now cereals and in 1978 there was a surplus of more than 27 per cent over demand for small grain cereals.

Export activities are difficult due to the price differentials between Austrian and world prices, e.g.:

One tonne Austrian wheat, local rail station—3230 A.S.

One tonne Canadian hard red winter, C.I.F., Amsterdam—2044 A.S.

DISEASES AND PESTS.

In bread and durum wheats, powdery mildew and stem rust are the main problems.

Resistant varieties are Probstdorfer Karat, Extrem, Record and Erla Kolben which are grown only in the quality wheat area. In other areas, where lower baking quality wheat is grown due to lower temperatures and higher precipitation, the disease problems are *Septoria* leaf and glume blotch *(Septoria tritici, Septoria nodorum ssp.)* These high yielding varieties (up to 6.5 t/ha) are named Adam, Danubius, Granit, Kormoran, Lentia, Linerbraun, Multiweisz, Onus, Primus, St. Johanner and Wieselburger.

In durum wheats, the disease situation is not as serious but mildew and black point *(Alternaria)* are present.

In spring barley, there is a serious problem with new mildew races because only a foreign variety (Welam from Weibull—Sweden) has a high level of resistance. It appears that varieties with the so-called Esperance resistance, such as the Austrian varieties Quantum Plus and Plenum, now offer the best level of field tolerance to mildew, the main disease in barley. The yield losses range from 5-20 per cent for spring barley and 5-12 per cent for winter barleys.

There are no serious insect pest problems.

SEED INDUSTRY

In Austria, it is private. There are four big private enterprises for wheat and barley breeding (Probstdorfer Saatzucht in Lower Austria, Pflanzenzucht Neuhof—Rohrau in the country of Burgenland, O.O. Saatbaugenossenschaft in Linz/Upper Austria and Saatzucht Gleisdorf in Styria). There are also a few small local breeding stations, mainly dealing with the maintainance breeding of foreign varieties.

There is a strong seed distribution scheme, based on a plant breeding Act. Everything is controlled by the breeders association and government authorities. The system of seed production and seed distribution is equal to other systems in Central Europe. From February 1st, 1979 Austria will have plant breeders' rights for the following cereals:

Cereal	Number of Varieties
Winter wheat	21
Spring wheat	8
Durum wheat	3
Winter barley	7
Spring barley	15
Triticale	0

BREEDING PROGRAM

Two promising durum lines have been bred at the Institute for Crop Husbandry and Plant Breeding at the University for Agriculture in Vienna.

These lines were developed from crosses with CIMMYT material and they performed extremely well in 1977 and 1978 in the State trials. These two lines are:

73/145 (Cross between Adur x Rampton Rivett x CM–14566–E–500Y–12M–0Y)
73/333 (Cross Adur x D.Dwarf S–15––Crn"S")

Many other lines were developed with the CIMMYT durum material, particularly because of the short straw and the excellent grain characteristics. The main part of this breeding program is given away to the private breeders as a service from the University Institute.

PRODUCTION PRACTICES

The agronomy techniques applied in Austria are similar to those in other European countries. The sowing date for winter wheat is from mid October to mid November; durum wheats are sown as early as possible in March and not later than mid April.

RESEARCH

Investigations on yield physiology in durum wheat have revealed significant differences in the C^{14} translocation pattern from the flag leaf into the grains within all varieties tested in the International Durum Yield Trial nurseries. Attempts are being made to correlate these results with the yield performance of these varieties in order to gain more information about the physiological value of the different genotypes. This program should elucidate the background of the yield capacity of the dwarf durums in order to provide information to the breeders when crossing with these dwarf varieties.

BELGIUM

AREA AND PRODUCTION

The statistics for areas of durum wheat and barley grown in 1977 and 1978 are:

	1977 ha	1978 ha
Durum winter wheat	163,967	163,663
Durum spring wheat	12,975	14,621
Winter barley	116,603	120,762
Spring barley	35,075	32,478

The average yields in quintals/ha for these cereals from 1970–1977 were:

Season	Durum winter wheat	Durum spring wheat	Winter barley	Spring barley
1970	44.6	29.2	42.5	26.1
1971	47.5	38.2	45.1	34.6
1972	46.4	37.3	47.7	36.4
1973	52.2	41.6	49.7	39.7
1974	54.5	40.4	51.8	36.0
1975	41.7	34.1	40.2	32.4
1976	47.3	30.8	48.8	30.6
1977	42.6	33.3	48.1	32.7

VARIETIES

Varieties authorized for production are in a list issued annually by the Ministry of Agriculture. The main varieties under cultivation in 1977–78 were:

		Year Released
Durum winter wheats:	Cama	1967
	Zemon	1977
	Gamin	1975
Durum spring wheats:	Bastion	1974
	Mephiston	1975
Winter barley:	Ager	1967
	Capri	1975
	Bessy	1975
Spring barley:	Aramir	1973
	Hebe	1971
	Printa	1974

The most important of the new varieties coming from the Belgium government, private institutions or from outside, are presented every year to be inscribed in the national catalogue.

In 1978–79, these varieties represented the following figures:

	Previous trials	Cultural value First Year	Cultural value Second Year
Durum winter wheats	36	20	18
Durum spring wheats	2	2	1
Winter barley	11	5	9
Spring barley	7	7	7

YIELDS

The high yielding levels obtained in Belgium are made possible by the use of modern techniques and practices viz., choice of variety, effective control of weeds and diseases, use of proper fertilizer levels, etc.

AGRONOMIC RESEARCH

Within the administration of the agronomic research at the Belgian Ministry of Agriculture, different services or branches at the Gembloux and Gent centers conduct research in cereals. Various other research activities are conducted by programs at the Colleges of Agricultural Sciences.

Belgian agriculture profits from the cereal research work conducted in the country, especially in the field of varietal breeding and the use of chemicals.

FUTURE CONSIDERATIONS

Although the wheat and barley situations are currently satisfactory, more importance will be attached in the future to the economical aspects of production in order to avoid higher costs, especially regarding the use of chemicals.

CYPRUS

AREA AND PRODUCTION

The following table provides statistics on the 1978 crop:

	Area (ha)	Production (metric tons)
Bread wheat	10,910	9,200
Durum wheat	16,350	13,800
Barley (grain)	33,340	56,000
Barley (grazing)	6,150	–

No grain was exported, but it was necessary to import 27,000 metric tons of bread wheat and 110,000 metric tons of barley. It is not possible to expand the area sown to cereals.

Except for a moisture stress during the grain filling period, climatic conditions were favourable for cereal production.

FERTILIZERS

Nitrogenous and phosphatic fertilizers are widely used. The application per hectare for barley is 45 kg P_2O_5 and 45 kg N. The hectare rates for wheat are 45 kg P_2O_5 and 60 kg N.

There is no shortage of fertilizers. The Agricultural Bank provides credit to purchase fertilizers.

DISEASES

Wheat was free from diseases, but barley was attacked by such foliar diseases as *Helminthosporium* sp., mildew and scald.

SEED INDUSTRY

It is well organized by the government. Although the price of certified seed is higher than normal grain prices, farmers prefer to plant certified seed.

VARIETIES

The new high yielding varieties are expanding rapidly. The two principal bread wheats are Hazera 2152 and Hazera 18, both of which were released in 1973. Two releases scheduled for 1979 are Tobari 66 and Tob x 8156.

The principal durums are Kyperounda (local), Capeiti (released in 1973) and Aronas (released 1975).

POTENTIAL MATERIAL

The most promising potential varieties or lines in the program are:

Bread wheat:
- Tobari 66 and Tob x 8156

Durum wheat:
- D-Dwarf 5-15 x Cr."S"-D 33312-7Y-4M-1Y-0M
- Brant "S" x Jori "S" - D 31695 Sel A
- Anhinga "S"-Volunteer ID 31728-3L-0L-IA-0A

Barley:
- Palmella Blue

PRODUCTION PRACTICES

Sowing is conducted with the seed drill and harvesting with the combine. Chemical weed control is practiced. New rotations, methods of seedbed preparation and new seed drills (e.g. the Press-drill) are under investigation. Agronomic research is sufficient.

GRAIN END USES

Bread wheat flour is used to make bread; durum wheat flour manufactures pasta products, boulgour and bread; barley is employed for animal feeds, grazing and haymaking.

RESEARCH RESULTS

New lines from CIMMYT, ICARDA, FAO and other institutes are providing good basic material for selection and for use as parents in crosses.

ASSISTANCE FROM INTERNATIONAL CENTERS

The improvement program would benefit from more staff training, extra experimental equipment for research and from large quantities of selected lines for rapid distribution.

CZECHOSLOVAKIA

AREA AND PRODUCTION

Winter and spring wheat, spring and winter barley, winter rye, spring oats and maize are grown. Winter and spring barley are the most important cereals. *Triticum durum* and triticale are grown only on an experimental basis.

In 1978, cereals were grown on 58 per cent of the arable land. Yields and area are summarized in the table:

Crop	Area (1000 ha)	Yield (t/ha)
Winter wheat	1202	4.44
Spring wheat	73	3.61
Total wheat	1275	4.39
Spring barley	903	3.96
Winter barley	17	3.74
Total barley	920	3.96
Winter rye	187	3.35
Spring oats	151	3.02
Maize	145	4.14
Total cereals	2676	4.08

In the last 20 years, cereal yields have been doubled. The winter wheat and spring barley area has increased, whereas the area of rye and oats has decreased. The production per inhabitant reached over 0.7 tonnes in 1978. A certain amount of *Triticum durum* and maize is imported.

CLIMATE

It is an intermediate type. In some years, it is more of an atlantic type, and in other years it is more continental.

Consequently, low winter temperatures and a very dry summer season can endanger the yield.

FERTILIZERS

In Czechoslovakia 250 kg of the pure nutrients NPK in fertilizers, are applied on the average per hectare. Cereals are fertilized with even higher doses, e.g. 300–350 kg, of which 120–130 kg are nitrogen. Some soils lack calcium and several areas are deficient in magnesium.

DISEASES

Eye-spot disease and take-all of wheat are important. Of the leaf and ear diseases, powdery mildew is becoming more serious. Stem and yellow rust cause considerable damage only in some years. Leaf rust occurs regularly but it is not very harmful.

In barley, powdery mildew and leaf rust are the most important diseases. With the successful breeding for resistance to these pathogens, net blotch and *Rhynchosporium* scald are increasing.

Breeding for disease resistance as well as the application of fungicides, is a progressive trend.

SEED PRODUCTION

Seed production is organized by State and cooperative enterprises. Seed exchange covers 80 per cent of the area annually, and by the year 1980, seed exchange for the total area is proposed. Varietal testing is on a high level, being organized by the Central Agricultural Control and Varietal Testing Institute.

VARIETIES

The following cultivars of winter wheat, spring wheat, rye, winter barley and spring barley are grown:

Winter wheat: Mironovska, Iljicovka, Jubilejna, Solaris, Slavia, Lena, Grana, Jubilar, Sava and Zlatna Dolina.

Spring wheat: Jara, Rena, Mephisto and Janus.

Rye: Danae, Kustro and Dankovske nove.

Winter barley: Dura

Spring barley: Ametyst, Favorit, Hana, Rapid, Atlas, Spartan, Diabas, Korál, Safír, Topas, Dvoran and Trumf.

The most important winter wheat cultivar in the past decade was Mironovská (Mironovskaya 808–USSR), because of its broad adaptability and yield stability. To prevent lodging, CCC preparations are applied on this cultivar. New wheat cultivars from USSR possess higher yielding capacity under favourable conditions.

Yugoslavian cultivars Sava and Zlatna Dolina have played an important role in the last five years, inspite of their lower winter hardiness and yellow rust susceptibility.

In 1979, four or five new cultivars are expected to be released.

Of the spring cultivars, Jara prevails. The cultivar Rena released in 1978 represents the breeding material derived from Mexican wheats. Rena originated from the cross Nadadores 63 x Kolibri. It is grown in Czechoslovakia as well as in the German Democratic Republic. Other short strawed lines of spring wheat derived from Mexican wheats are in varietal tests.

Czechoslovak cereal breeding has been most successful in breeding spring malting barley. Most cultivars are derived from Diamant, a short strawed x-ray mutant. New cultivars are high yielding, resistant to powdery mildew and lodging, and possess very good malting quality. Some of them are also grown in USSR, Rumania, Bulgaria, Hungary and Poland.

RESEARCH

Cereal research is carried out mainly in two institutes: the Research Institute of Crop Production, Praha—Ruzyně (wheat research) and the Cereal Research and Breeding Institute, Kroměříž (barley research).

PRODUCTION PRACTICES

Czechoslovak cultivars are prevalently used as the second cereal after wheat or barley. They suffer less from take-all and eye-spot than the foreign cultivars. Of the Czechoslovak cultivars, *Slavia* released in 1976, is the most popular winter wheat.

FEDERAL REPUBLIC OF GERMANY

DURUM

In Europe, durum wheat is grown commercially only in France, Italy and Austria. The Landessaatzuchtanstalt, Universitat Hohenheim, which started yield and adaptation trials in 1968, grew CIMMYT F_2 bulks in the 1978 vegetation cycle.

These bulks flowered and matured on average one week earlier than the European material. The most noticeable character was their short straw (av. 64 cm). Resistance to mildew was good and no other diseases occurred. Thousand kernel weight ranged between 37 g and 56 g with a mean of 46 g.

TRITICALE

Triticale is not yet grown commercially in Germany, and breeding work at the Landessatzuchtanstalt, Universitat Hohenheim, started only recently. During 1978, the following materials were grown: ITSN, Good Seed Type, F_2 S x W and CB-winter.

Adverse weather conditions with excessive rain, generally low temperatures and high humidity before harvest resulted in low fertility, high ergot infection and a high percentage of sprouted kernels. In the spring material, the later maturing types-Beagle and Bronco 90 were less affected.

The winter triticales seemed to be better adapted, although they are very tall. Their fertility and grain appearance was better than that of the spring types.

Neither diseases nor insects caused any damage in triticale.

FINLAND

INTRODUCTION

Finland is north of the 60th parallel. Its agricultural production meets the nutritional demands of the total population (4.7 million). To enable this, approximately 2.6 million hectares of arable land are under cultivation, one half of it being sown with cereals.

CLIMATIC CONDITIONS

Finland is intermediate between the Atlantic climate and the more continental Russian climate. Thus the weather conditions of the growing seasons vary considerably, depending on the predominance of one or the other of the main climatic types.

The growing season is short. Even in the southern most parts of the country, the tillage period lasts only 200 days. The average temperature of the warmest month, July, is + 17°C. Night frosts can occur in every month of the growing season, and regularly as late as May and already by September.

Spring cereals are sown in mid-May. Harvesting of the earliest ripening six-rowed barleys starts, on average, during the first days of August. The growing times of the varieties are very short, partly due to the results of breeding for earliness and partly because of the favourable day-length and temperature conditions immediately after the sowing season. In southern Finland the day-length reaches 19 hours/day by the end of June. On the northern margins

The short strawed barley variety Eero (Hja 34715) at the northern experimental field (65°N) of the Hankkija Plant Breeding Institute, Finland. In the north, barley trends to grow tall and weakstrawed and the Eero type is therefore very suitable for higher latitudes.

of barley production, the maximum day-length reaches 22 hours/day.

Winter wheat is sown early in the autumn, at the beginning of September, and it is harvested during the first days of August of the following year. The growing time of winter wheat is, thus, nearly a whole year, for the main part of which the crop stands at the hardened stage through the several months-long overwintering period. The permanent snow cover lasts, on average, from November-April.

CEREAL PRODUCTION

The most common cereal crop is barley (0.6 million ha), and nearly equal to it in area is the other feed cereal, oats (0.5 mill. ha) The hectareage of barley has increased remarkably, 2.5 times over the last 20 years. The cultivation of oats has decreased slightly. Only spring varieties of barley and oats can be grown.

During 1974-78, the average area of wheat was 0.2 million ha. Of this area, 75 per cent is sown with spring wheats. Such a high proportion of spring varieties is exceptional for a European country, where winter wheats normally play a strongly dominating role. In Finland, the situation is influenced by the difficult overwintering conditions which restrict the production of winter wheat to the least snowy southwestern corner of Finland. In part, the predominance of spring wheat is due to the fact that production efforts have been directed towards producing sufficiently large quantities of spring wheat with good baking properties.

Wheat husbandry often meets with difficulties because of climatic factors. Both in 1977 and 1978, only a small fraction of wheat consumption was covered by the domestic yield. Winter wheat farmers had not managed to seed all the scheduled winter wheat and the quality of spring wheat was poor due to the cool summer weather followed by rainy harvesting seasons.

Winter rye is grown on 0.1 million ha.

USE, IMPORT AND EXPORT OF WHEAT AND BARLEY

Wheat is used for making bread of the leavened type. Qualitatively less valuable parts of wheat are used for animal feeding. Very small amounts are required by the wheat starch industry.

More than 90 per cent of the barley harvest is used for animal feeding. For brewing, specially recommended varieties are grown. Barley has only limited importance in human nutrition. A barley starch industry is just starting in Finland.

As late as the 1960's, bread wheat was being imported, but by the beginning of the 1970's Finland attained full self-sufficiency. In 1975/76 the self-sufficiency level of wheat reached 130 per cent, and wheat had to be exported which, from the point of view of the national economy is not a beneficial situation, since the costs of production of cereal crops are rather high under Finnish northern conditions.

In the crop year 1977/78, after two difficult seasons, the level of self-sufficiency fell to less than 60 per cent for bread crops. The aim of official efforts today is to bring the production to a level reasonably close to self-sufficiency and also to develop the grain storage capacity and organization for eliminating the fluctuations in production caused by the vagaries of climate extremes.

Barley production meets the demands. For export, special attention has been paid to the so-called enzyme malt barleys with a high amylolytic activity. The best known of this type is the Finnish cultivar Pirkka (Hja), which has exceptionally high diastatic power and, thus, beta-amylase activity. Another Finnish variety, Pomo (Jok), has high alpha-amylase activity. Both are six-rowed barleys.

The very early ripening Finnish six-rowed variety Olli (Hja), released in the 1920's, is still grown in Canada, from where it is continually exported to Scotland as enzyme-rich raw material for the distilleries.

AGRONOMY

The fertilizer trend has been towards increased usage, but it is likely that the upper limit of their use has now been met, partly due to the continually increasing costs of producing fertilizers.

A very efficient technical advance in plant husbandry has been the placement of fertilizers. Particularly in cereal husbandry, this fertilizing method has become a routine measure and special machines have been manufactured for it. These devices are the so-called combi-seeders, which simultaneously sow the seed and fertilizers in separate rows but close to one another. This fertilizing technique brings the nutrients close to the roots of the young seedlings, accomplishing a strong surge of growth and effective tillering which is reflected in even maturity at the ripening stage.

On the basis of experiments and practical experience, it has been estimated that placement of fertilizers brings about a 20 per cent yield increase compared with the same amount of fertilizers applied in the old-fashioned way.

The amounts of fertilizers recommended for wheat and barley, in terms of the main nutrients, are:

	N	P	K
Kg/ha	100	20	40

For humus rich soils, less nitrogen is recommended. Fertilizers are used in granulated mixtures. With increasing levels of yield, deficiencies of certain micronutrients are becoming a problem. Therefore today, fertilizer mixtures are manufactured which include the most important trace elements.

One peculiar characteristic of Finnish soils is their acidity or low pH value. This depresses both wheat and barley production. The liming of fields is a normal routine in crop husbandry, and should be carried out every five years.

VARIETIES

Despite a policy of open doors for foreign cultivars, and good cooperation with the Scandinavian and other European countries, domestic varieties completely dominate crop production.

The most important varieties cultivated in 1977 were:

	Variety	Per Cent Area	Rowed
Barley	Otra (Hja)	22	6
	Pomo (Jok)	18	6
	Karri (Hja)	12	2
	Hankkija-673 (Hja)	11	6
	Ingrid (WW)	8	2
	Pirkka (Hja)	7	6
Spring wheat	Ruso (Hja)	61	
	Tähti (Jok)	21	
	Apu (Jok)	8	
Winter wheat	Vakka (Jok)	50	
	Nisu (Jok)	21	
	Linna (Hja)	11	

Hja = Hankkija Plant Breeding Institute, SF-04300 Hyrylä, Director Dr. E.I. Kivi

Jok = Plant Breeding Dep. of the Agric. Res. Centre of Finland, SF-31600 Jokioinen, Director Prof. Dr. R. Manner.

WW = Weibulls, Sweden

WHEAT BREEDING GOALS

The permanent aim is winter hardiness in the winter program and early maturity in the spring wheat program. Straw stiffness is an important objective in all breeding programs. This character is needed because of the rainy seasons, and already remarkable achievements have been made.

Both in spring and winter wheats, special attention has been given to breeding for high baking quality. In this respect, Finnish varieties have had a long start. Even by the early 1920's, certain hard spring wheat varieties, like Marquis and Reward, had been used as crossing parents. Among modern Finnish wheat varieties, Hankkija's Ulla, from a cross (Tammi x Pissarev No 2) x (Aurore x Svenno), possesses the best baking quality.

Dwarfs and semidwarfs have been used to some extent as crossing parents for improving straw stiffness. Too drastic a reduction in straw length should not be a selection objective. The use of southern material in our breeding work invariably introduces negative characteristics, such as late maturity, higher temperature demands or short-day reactions. In wheat, this applies to mildew resistance breeding involving southern sources of resistance.

Since wheat ripens late under our conditions, breeding for resistance to sprouting in the ear is of great importance. Regarding this property, the variety Tähti (Jok) is the best achievement so far.

BARLEY BREEDING AIMS

Especially during the 1970's, new very stiff-strawed varieties of both early maturing six-rowed and two-rowed barley were released. Through their cultivation, the reliability of feed barley cultivation has been greatly advanced.

A great deal of attention has been continually paid to acidity tolerance in barley. Among the two-rowed types, Uurainen (Hja), Louhi (Hja), Helmi (Hja), Karri (Hja) and Aapo (Hja) have shown extremely good tolerance to acid conditions. The six-rowed barleys are, in general, more tolerant to soil acidity than the two-rowed ones. Among the six-rowed varieties, Pirkka (Hja) represents the peak of tolerance.

In breeding for improved feed quality, both Hiproly and Risø mutants have been used in crosses. Attempts have been made to transfer their lysine factors to the northern six-rowed feed barley type. The suppressor factor of Crypt barley is being used to eliminate the shrivelling characteristics of the Risø 1508 lysine gene.

The breeding of six-rowed enzyme barleys, rich in both alpha and beta amylases, is under intensive study.

SOURCES OF EARLINESS IN BARLEY

The Finnish barley breeding material contains a wealth of sources of earliness. Internationally, two varieties are especially worth mentioning: the barley variety Olli, already mentioned above, and a newer six-rowed variety Eero (Hja), from a cross Mari x Otra. In various connections, Eero bears the pedigree number Hja 34715 or Hja c4715 (ref. CIMMYT REPORT ON WHEAT 1976, 1.4).

The earliness of the six-rowed Eero is based on the same day-length neutrality characteristic which is found in its two-rowed parent Mari. This factor greatly influences earliness under short-day conditions, viz., in the southern crop production areas.

TRITICALE RESEARCH

The breeding of triticale types adapted for the northern marginal areas of bread grain production intrigued Finnish breeders as early as the 1940's, when triticale breeding work was started by the State Plant Breeding Institute at Jokioinen. In recent years the Department of Plant Breeding, Univ. of Helsinki (Prof. Dr. P.M.A. Tigerstedt) has been working with material received from CIMMYT.

At present, the domestic breeding material of triticale is of minor importance.

GERMAN DEMOCRATIC REPUBLIC

PRODUCTION AND AREA

Land used for farming amounts to 6.2 million ha i.e. 0.37 ha per capita. Of this area, 4.7 million ha are arable and 1.4 million ha are meadows and pastures. Large parts of the farming land, especially north of Berlin consist of sandy soils, and in part are very poor. Highly fertile soils with good conditions for wheat and malting barley, sugar beets, vegetables and forage crops are located in the middle part of the country, near the towns Magdeburg, Halle and Erfurt.

About 1500 specialized agricultural production cooperatives and state farms are concerned with plant production. Their average farming land area covers 4000–6000 ha. Their cereal area totals about 2.5 million ha, i.e. about 52 per cent of the arable land. In recent years the average cereal area has been about:

700,000 ha winter wheat
20,000 ha spring wheat
600,000 ha winter rye
10,000 ha spring rye
550,000 ha winter barley
450,000 ha spring barley
200,000 ha spring oats

YIELDS

There have been significant yield increases in average yields of these crops since 1961.

5 Year Period	t/ha
1961–1965	2.58
1966–1970	2.98
1971–1975	3.69
1978	3.85

FERTILIZERS

The average annual fertilizer applications per ha for all crops are 100 kg N, 70 kg P_2O_5, 100 kg K_2O and 200 kg CaO.

PRODUCTION PRACTICES

Farm operations are characterized by complex mechanization and extensive chemical usage.

SEED INDUSTRY

Seed production and the seed industry for agricultural and horticultural crops are organized and controlled by the public seed enterprise. Its activities are directed to the rapid introduction of the highest yielding and best adapted varieties to agricultural cooperatives and state farms.

VARIETIES

Cereal production is concentrated around the following varieties:

Crop	Variety	Origin	Year Released
winter wheat	Alcedo	GDR	1974
	Almus	GDR	1976
	Iljitschowka	USSR	1974
	Jubilejnaja	USSR	1974
	Mironowskaja 808	USSR	1969
Spring barley			
(1) malting	Trumpf	GDR	1973
	Nadja	GDR	1975
(2) feeding	Mirena	GDR	1974

BREEDING PROGRAMS

They are concerned with winter wheat, winter rye, winter and spring barley, and spring oats. At present, triticale is not important in breeding and production.

The following goals for winter wheat and spring barley breeding reflect the current and future problems of the cereal production:

Winter Wheat

1. High yield potential under intensive production conditions (more than 100 kg/ha N, irrigation,) and/or cultivation on sandy soils.
2. High yield stability:
   —good field resistance or tolerance against *Erysiphe graminis* D.C.f.sp. *tritici* Marchal, *Puccinia recondita* Rob.et Desm.f.sp. *tritici, Cercosporella herpotrichoides* Fron., *Ophiobolus graminis* Sacc., *Septoria nodorum* Berk., *Fusarium culmorum* Link.
   —good winterhardiness;
   —good sprouting resistance;
   —good lodging resistance;
   —good ecological adaptibility;
   —different ripening times.
3. Quality: More than 60 per cent of the total harvested wheat crop is used as a feed source for animals. Therefore improving the protein content and quality is, besides good milling and baking quality, a very important breeding goal.

Spring Barley

1. High yield potential: Cultivation of malting barley predominantly on good soils in the middle and southern part of the country, and of feed barley also on sandy soils, possessing drought stress.
2. High yield stability:
   —good field resistance or tolerance against *Erysiphe graminis* D.C.f.sp.*hordei* Marchal, *Puccinia striiformis* West.f.sp.*hordei, Puccinia hordei* Otth., *Helminthosporium gramineum* Rbh,
   —earliness;
   —good lodging resistance;
   —no ear or kernel losses before harvest;
   —good ecological adaptability.
3. Quality: Good complex malting and brewing characters for malting barley; improved protein content and/or quality for feed barley. Hull-less types are under observation and breeding.

INTERNATIONAL COOPERATION

In connection with the above mentioned breeding goals, the cereal breeders are interested in CIMMYT's International Nurseries for different characters and in helping CIMMYT to obtain useful information about reponses of its material under the environmental conditions in the German Democratic Republic.

GREECE

INTRODUCTION

Wheat is the most widely cultivated and most important crop in Greece. The goal is to increase production and to decrease the area on which it is grown.

There was a wheat deficit until 1956 and about 500,000 metric tonnes were annually imported. Since then, there have been significant increases in production. Wheat is no longer imported, and up to 400,000 t of flour are now exported.

CEREAL PRODUCTION

The following statistics indicate the area, yield and production for wheat and barley from 1961–1978:

	ANNUAL AREA (1000 ha)		ANNUAL YIELD (kg/ha)		ANNUAL PRODUCTION (1000 t)	
Seasons	Wheat	Barley	Wheat	Barley	Wheat	Barley
1961–1965	1085	194	1632	1446	1781	284
INCREASES	–10	76	14	34	2	34
1966–1970	980	342	1854	1932	1809	664
INCREASES	–7	18	17	12	10	33
1971–1975	913	405	2172	2172	1988	880
INCREASES	+2	–5	10	4	13	2
1976–1978	933	383	2400	2250	2238	862

Since 1970, durum has been grown only on about 20 per cent of the wheat area. The main reason for the limited cultivation of durum is the development of the new bread wheat varieties with high yield potential and wide adaptation. The yield of bread wheat has been 20–30 per cent higher than durum wheat, since 1965.

CEREAL AREAS

Most winter cereals are grown mainly in areas with a classic Mediterranean–type climate with a hot dry spring and summer. The growing season varies from 6–8 months depending on the latitude and rainfall, which can average from 350–1200 mm per annum. Rainfall decreases from west to east. Most cereals are grown in lower rainfall areas and with little or no spring and summer rains. Because of the generally arid climate of Greece, relatively small areas are irrigated. Such areas are preferred for crops of greater economic return such as cotton, corn, rice, sugar beets. Wheat on irrigated areas is quite rare, only for rotation purposes. Most winter cereal crops are therefore grown under dryland conditions and are rainfed.

The soils of cereal areas which have developed from limestone or highly calcareous parent material are generally neutral to alkaline in reaction. Most of them are typical red Mediterranean–type soils. Wheat is a favoured crop on the heavier soils, while barley predominates on the lighter, particularly on the light sandy loams which stretch along the coast and islands of the Aegean Sea. In the more northernly cereal areas, particularly in West Macedonia, some soils for wheat are heavier.

CLIMATE

Rainfall is erratic and may be inadequate for cereal growth in the spring, or in some years at any time during the growing season. High evapo–transpiration, because of high temperatures from spring onward, can be a major factor in limiting crop yields. The distribution of rainfall, particularly in the spring, and also spring temperatures, are very important factors in crop performance. Crop growth may be restricted by low winter temperatures. In some areas of northern Greece, frost damage can cause reduction in yield. In the southern parts of the country, frost damage at anthesis can cause a yield reduction through damage to the developing heads of some varieties. Later, close to harvest time, shrivelling of grain due to the hot wind "Livas", is also a possibility for late maturing varieties of late sown crops. At harvest, grain loss through shattering due to winds is also a possibility in many areas.

In general, cereal crops in Greece are exposed to all climatic hazards and a variability from year to year that can range from seasons of severe moisture deficit to those of above average rainfall, thereby causing soil nitrogen losses by excessive leaching, or crop damage by lodging.

Edaphic variation between localities, together with seasonal variation at any locality in Greece, poses problems in the stability of crop production and to the plant breeders, seeking to increase yield by using the appropriate selection procedures.

BREEDING OBJECTIVES AND METHODS

The major objective of the wheat program is to develop varieties that have consistent high yield potential and wide adaptation. Greek cereal breeders try to combine the following four characteristics:

High yield potential under wide range of environments.
Semidwarf characteristics.
Broad resistance to disease, especially rusts.
Frost resistance.

The approaches used to produce varieties with wide adaptability and disease resistance are selection in segregating generation material and advanced lines at 10–30 locations in the whole country, two generations a year of a number of crosses in Thessaloniki, artificial inoculation with different races of rusts and very early, normal and very late sowing dates for segregating materials.

The two generations of segregating material are grown and selected for agronomic type and disease resistance at one location. One generation of fall sowing is grown during the winter and spring with artificial inoculation of rusts, and the second summer sowing is grown under irrigation. During its growth, severe epidemics of stem rust occur every year. A third location at an elevation of 1500 m is used for the evaluation of frost resistance in advanced lines. Also, to select varieties with wide adaptation, different techniques for measuring adaptation or genotype environment interaction are used (Finlay and Wilkinson (1963), Eberhart and Russell (1966), Miller et al. (1959 etc.)

Crosses are made in the field during the spring. The main selection procedure has been the F_2 progeny method (Skorda 1973). The higher yielding plants are selected at a range of sites. This selection system concentrates on the yield of F_2 plant progenies over several generations. Progenies with poor straw strength, late maturity and rust susceptibility are discarded, but yield is taken to be of greater importance than other plant characters. With this procedure, the initial unit of selection is more the cross than the progeny. This enables crosses with the best yielding potential to be isolated, so that selection can be concentrated in the most profitable area—a necessity when a wide range of genetic material is under study.

Although two way crosses between adapted and exotic varieties were common in the early stages of the program, later it was found more useful to backcross such an initial cross of the same or another adapted parent. Intercrossing between our own selections is also important. Some interspecific and intergeneric crosses between indigenous grasses as *T. boeticum, Aegilops spp.* are being conducted to incorporate genes of resistance to frost, drought and diseases.

In the quality field, the Cereal Institute has the equipment to carry out extensive quality testing of flour and semolina. Sedimentation test, protein content and quality, and bread quality for bread wheat and also pigmentation, cooking quality, extrusion suitability, protein and so forth for durum wheat are now added to the selection pressure available. These will complement the visual quality assessment of seed size, test weight and grain appearence.

All wheat breeding work in Greece is based at the Small Grain Department of the Cereal Institute, Thessaloniki.

EVOLUTION OF BREEDING PROGRAMS

Wheat breeding programs started in Greece in 1925 with locally adapted genetic sources consisting of 230 local variable varieties which were known by different local names. They were mixtures of 2–5 botanical types, tall, very late maturing and rust susceptible.

The study of all these local materials gave very useful informations for the orientation of the breeding program in Greece (Papadakis 1929. Talellis 1963).

At the same time, thousands of individual selections were made from which the varieties Xylokastron, Eretria and Mykine were released.

These selections from local population lines, with earlier flowering habit than the existing populations, marked the beginning of wheat improvement in Greece. The new lines or varieties ripened earlier than the existing ones and were thus better able to withstand the moisture stresses of late spring, the hot dry spring wind from Africa ("Livas") and tha late expansion of stem rust epiphytotics. They produced relatively good yields of well filled grains.

These new varieties and also Mentana and Canberra were accepted by some farmers and they provided tha main basis for the Greek crop until the release of new varieties from hybridization, towards the end of the 1940's.

The second step in the Greek breeding program was the introduction of many exotic varieties, both durum and bread, and the testing for their suitability for Greek conditions or as parental material. The Cereal Institute collection now contains about 1000 entries. During the early stage of varietial assessment, it was found that several introductions from Australia, and especially from Italy, were well adapted to Greek conditions, and in crosses they gave very good varieties.

Crosses involving the Italian variety Rieti, with the Australian variety, Quality, have segregated many high yielding lines with excellent field characters. The best of these lines were the variety G–38290, which was the leading variety of Greece for more than 20 years, and G–46025 for cool regions, because of its resistance to frost, where it was the leading variety for more than 15 years.

Crosses with Greek and other varieties were made later and gave very excellent varieties, which were released and grown for several years in large areas as G–54327, G–58383, G–59132, G–61450, Pella, Amyntas, Olymbia, Methoni, Electra etc.

Since 1954, Greek breeders have made crosses with Norin x Brevor 10 derivatives from Vogel's material, with Greek or other varieties to develop shorter varieties to withstand high quantities of fertilizers. From these crosses, new varieties with two dwarf genes were developed as well as very promising material for further selection. Unfortunately in 1964, a new race of *P. striiformis,* the 20A, appeared suddenly, to which all these varieties and the breeding material from Norin derivative crosses were susceptible.

Greek breeders then started a new breeding program, which gave very interesting varieties. Two Italian varieties with dwarf genes and resistance to the 20A race of yellow rust were used in crosses with Greek and other varieties. By growing two generations a year and by artificial inoculation of yellow rust and other rusts in the greenhouse and field, three new short varieties resistant to yellow rust race 20A were developed. They were released to farmers to replace the yellow rust susceptible varieties.

Two of these varieties G–84865 and G–84909 are grown in many regions; G–85458 is cultivated in northern Greece because of its resistance to frost. G–84865 is the variety with the widest adaptation of all cultivated varieties. It gave the highest mean yield over five years of testing at 18 sites each year.

In the same period, all CIMMYT varieties and segregating material were tested. From these materials, the varieties Niki and G–0893 were released in 1965 and 1970 respectively, which were grown in limited areas for some years. Also the varieties Siete Cerros, Yecora and Jupateco were selected and are grown in the most fertile and moist soils.

Wheat has also been used as a model crop in mutation research. The induced mutations have been utilized in the breeding program. From this program of artificial mutations, the variety G–07783 has been selected. It was derived from G–38290 after irradiation with thermal neutrons. It is resistant to the three rusts, is short in height and gives consistent high yields. Other new promising varieties are being tested in trials and very soon will be released to farmers.

Studies on the genetics and cytogenetics of induced wheat mutations and structural changes have yielded some good tools and valuable information for further breeding. Fundamental studies are also being conducted at the Cereal Institute on the origin of wheat, monosomic analysis, inheritance in general, of resistance to several wheat diseases, and the physiology of the wheat plant etc.

The improved Greek varieties have a high tillering capacity to achieve adequate crop density. Under dryland conditions a dry winter can restrict tillering but, if followed by a wet spring, it stimulates late tillers, in these varieties to give good yields. These conditions prevailed in 1975–1976, when production was estimated in April 1976 to be 1,000,000 tonnes, but the actual harvest reached 1,700,000 tonnes after some rains in late April and early May.

WHEAT DISEASES

They are a major limiting factor to the Greek crop, Varieties resistant to two or three rusts help to stabilize production. Yellow rust *(Puccinia striiformis)* is wide spread, and in severe infections can cause crop damage. Yellow rust has limited the varieties which were grown in large areas. Most of the advanced lines were susceptible to race 20A when it suddenly appeared and wheat breeders at the Cereal Institute had to start the breeding programs from the beginning, and much very productive material was lost. Fortunately several sources of resistance have been located in many varieties. Resistant genes are being transferred to Greek varieties and rapid tests for resistance have been carried out to aid selection. Grown varieties are resistant to this rust.

Leaf rust *(P. recondita)* is present almost every year and causes severe losses to susceptible varieties. Most of grown varieties are resistant to this rust. Stem rust *(P. graminis)* is a problem in some years. Losses are significant for susceptible varieties, but grown varieties escape severe infection because of their early maturity.

A research project investigating crop loss assessment, pathogenic variability, race identification, sources of resistance and mechanisms of resistance is being conducted at the Cereal Institute.

The wheat breeders at the Cereal Institute have developed special machines for field plot work. These developments are aimed at improving the efficiency of operations and reducing the labour requirement of the programs.

CONCLUSIONS

In Greece, bread wheat varieties have been developed with wide adaptation. This has allowed their distribution to many regions of the country. This width of adaption has not been achieved among the varieties of durum wheat.

If production gains are to be maintained, the first priority is the protection of present genetic potentials for yield from degradations of weather and diseases. Improvements in cultural practices will have a large stabilizing effect and will allow the varieties to express their genetic potentials for yield. On the other hand, the danger of losses from diseases with cropping intensity is greater because it produces a more favorable microclimate within fields for pathogens. An example is mildew, which has become a problem in wheat in the last three years.

Concerning the diseases, no variety has or will be developed with resistance to all diseases, or races of one disease such as stem rust, because barberry bushes, *Berberis cretica,* are scattered everywhere on which new races are developed every year. Also, winds bring new races from neighbouring countries.

Wheat breeders in Greece must increase yield stability through resistance to weather, diseases and insect hazards, broaden the genetic basis and increase knowledge on the structure and physiology of the wheat plant as the basis for increasing yield potential.

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HUNGARY

From left to right: Dr. Bent Skovmand (CIMMYT), Dr. Janus Matuz, Dr. Arpad Kiss, Dr. Zoltane Barabas and Dr. Zoltane Kerterz visit wheat and triticale plots at the Cereal Research Station, Szeged, Hungary.

WHEAT AREA AND PRODUCTION

In the 1977-78 growing year, wheat was sown on 1.3 million hectares. The growing area has not changed significantly over the last ten years and there is no further opportunity for increasing it.

There was a record average yield of 4.28 t/ha in 1978. Thus it is possible to export a significant portion of the total 5.5 million tonnes yield. Home consumption is about 3 million tonnes.

VARIETIES

Registered foreign and native varieties grown on a large scale are as follows, in the rank of their importance:

Jubilejnaja 50 Libellula	Native varieties: at Martonvásár	Improved varieties at Szeged
Bezostaya 1	MV 4	GK 3
Sava	MV 1	GK 2

Rana 1, 2, 3	MV 2	GK Tiszatáj
Aurora	MV 3	GK Szeged
Kavkaz		

CLIMATE

It is favorable for growing winter cereals; spring wheat is not grown at all. The autumn is cool and rainy, so generally well developed plants go into the winter. The winter temperature falls to –15/–20°C with breaks. Most of the sowing area is covered by snow with breaks in the winter.

The warm, rainy spring is favorable for the development of wheat as well as for the reproduction of fungi. The spring season is followed by a dry summer, with harvest in July.

DISEASES

The most important fungal diseases are leaf rust *(P. recondita)*, and powdery mildew *(E. graminis)*. In some years stem rust and *Fusarium* infections are also very powerful. Other fungal diseases are dangerous too, e.g. *Septoria nodorum, Septoria tritici, Cercosporella*, etc.

AGRONOMY

Winter wheat is generally grown in dense sowings, with 500–600 seeds/m^2 with a row spacing of 12–13 cm and a standard seed grain amount of 200–250 kg/ha. The amount of fertilizer used is high viz., 300–400 kg effective substance in a 1:1:1 ratio of N:P:K.

The seed grain supply is centrally organized by the state. The state farms and better cooperatives use seed grain of the 1st, 2nd and 3rd class and 95 per cent of the total sowing area is in their possession.

Winter rye is sown first, in the beginning of September, followed by winter barley in the first half of October and winter wheat in the middle of October. Triticale is sown in mid–October. Rye has the highest survival potential followed in decreasing order, by frost hard winter wheat, the less resistant fodder wheat, hexaploid triticale and winter barley.

Winter barley is very particular about the optimal sowing time. Summer in Hungary is usually warm and dry. Only the early ripening cereals can escape the risks of drought. Winter barley is the first to ripen at the end of June and the beginning of July. Rye is harvested in the first week of July, wheat in the first two weeks of July. Late wheat and triticale are ripe by mid–July. For this reason, the production of late wheat varieties and triticale No 64 is rather unsafe in Hungary. Early cereals are given preference over the late ones. In the latest semidwarf and semi–tall triticale types, maturity must be advanced to the level of that of the intermediate wheat varieties to excape damage by drought and hot weather.

Over the last 15 years the average wheat yield per hectare has increased consistently. Now it is about twice as high as it was in 1963. The most important limiting factors are the diseases.

BREEDING RESEARCH

In Hungary there are two wheat breeding centers viz., the Cereal Research Institute (CRI) in Southern Hungary and the Agricultural Research Institute of the Hungarian Academy of Sciences in Martonvásár, in central Hungary.

The breeding goal is the improvement of intensive type, semidwarf, disease resistant varieties with good winter–hardiness and baking quality. In the CRI about 500 combinations are produced per year.

The F_1 and F_2 generations are grown in spaced plantings–10 cm within the rows and 50 cm between the rows. From the F_2 generation, an individual selection is made on the basis of agronomic traits, phenotype, disease resistance and protein content. Research work on improving the efficiency of selection based on qualitative traits and yield is also in progress.

The grain weight per ear, the number of grains per ear and the harvest index seem to be promising for the prediction of the yield potential of the lines. (Fischer–Kertesz, 1976). This is followed by a yield test in a dense sowing with the special Seedmatic rod row technique in the F_3–F_4 generations. The yield potential of about 5000–10,000 lines is screened each year. Further yield tests are conducted on F_4–F_5 on 5–10 m^2 large plots in four replications. Generally F_5–F_6 materials are tested at several locations for adaptability.

The selection for disease resistance is conducted in pathological nurseries with artificial infection. The CRI methods for testing horizontal resistance against fungi, primary tolerance and field resistance, give the best possibility for a breeder to study these questions (Center Pivot Method, Matuz–Mesterhazy–Barabas, 1979).

The Cereal Research Institute also conducting a limited hybrid wheat breeding program. A blending technique has been developed for making the separation of the two parents possible after harvesting because of the transfer of the purple gene into the pericarp of the Rf lines. Using restorer lines with a purple pericarp, the mixed sowing, better pollination, and separation of parents with an electrical colour separator is realizable. The production of seed grain is economical (Barabas–Kertesz, 1979).

CULTIVAR REGISTRATION

Seven new GK winter wheat lines were presented for state registration in the autumn of 1978. In the National Cultivar Trials on over 14 stations, GK Csongor, GK Danko and GK Hajnal wheat cultivar candidates surpassed the grain yield of the standard MV 4. There was more resistance to lodging and less susceptibility to disease. In the early Winter Wheat Group, GK Csongor was the best of all 22 cultivars.

BREEDING AIDS

Accelerated vernalization

With 100 ppm kinetin, a 20 day cold treatment was as effective as a 40 day cold treatment without kinetin. (Barabas–Csepely, 1978).

DURUM PROGRAM

In 1977, two candidates were sent to the National Cultivar Trials. One of them, named GK Minaret (originated from the CIMMYT program of Turkey) had an average yield of 5.13 t/ha in 1978. It compares fairly well with the best *Triticum aestivum* control variety MV 4, that produced 6.3 t/ha.

TRITICALE

Introduction

The first primary hexaploid triticale was developed in Hungary by crossing *T. turgidum buccale x S. cereale* with the aim to supply farms with a constant wheat–rye hybrid of good productivity, and relatively rich in protein and lysine for animal feeding. It appeared later that 20–30 per cent triticale flour mixed with 70–80 per cent wheat flour gave an excellent, savoury bread of wheat quality. The secondary hexaploid triticale No.64 was given out to farmers in 1964 and was preliminary released after State trials in 1968.

Area and Production

Production has, however, gradually decreased since 1977. At first, farmers were rather keen to grow triticale as new things usually excite interest. The area under triticale covered 25,000 ha in 1972 with a 17.1 t/ha mean yield. Today production comprises only 2200 ha. It replaced rye only on sandy soils of better quality, but rye maintained dominance on poor sandy soils. Some short wheat varieties with proper cultural methods and nutrient supply also proved to be superior to the tall triticale No 64 which has a strong tendency to lodging.

Triticale Types

The first dwarf, semidwarf and semi–tall hexaploid triticale types were developed in 1965. Dwarf triticales 40–60 cm high are very susceptible to diseases, have poor fertility and very shrivelled, shrunken seeds. Some 15–20 years of breeding may be needed to turn then into economically valuable cereals. In the semidwarf types 70–90 cm high, Bokoló A_2 and Kedvelt A_2 promise well in nursery trials. The former still needs improvement in plant habit as it is of prostrate tillering with a lot of shoots; no close stand can be formed in dense sowing. The semidwarf Kedvelt A_2 is an erect type but its winter and frost hardiness is rather poor. Seed quality and 1000 kernel weight must be improved in both.

At present, the highest fertility is found in the semidwarf hexaploid triticales 100–120 cm high, including the early and late strains of KT–77 and KM–79. In the latter, firmer seed type, higher thousand kernel weight and the erect tillering habit of the Mexican triticales have been fixed. All three strains have stronger culms and higher productivity than No 64. If State trials confirm the nursery results, the strains can well compete with the very fertile fodder wheat varieties Libelulla, Száva and GK Szeged on soils of poorer quality.

Yields

At the Vegetable Crops Research Institute Kecskemet, triticale No 64 has produced the following yields on brown sand and sandy soils:

Year	Area (ha)	Yield (t/ha)
1975	107	3.35
1976	187	3.64
1977	179	3.90
1978	171	4.39

Fertilizers

In large scale production, yields of 4–5 t/ha are sought. Depending on precultures and soil analysis results, 80–100 kg N, 80–100 kg P_2O_5 and 80–100 kg K_2O active agent are supplied in the ratio of 1:1:1. Nitrogen is given in three doses: before sowing, at the end of winter, and before shooting. The third dose should be given at the time of stem elongation, but on small areas, application involves too much damage caused by traffic.

On large cereal farms, nitrogen is distributed by aeroplane with very good results. In trial plots, Volldünger foliar spray is applied after heading with triticale. Foliar sprays are regularly used on large wheat farms with 100–200 kg/ha surplus yield attributed to their beneficial effect.

Seed Production

On seed propagation fields of the semi tall triticale 5–6 t/ha are envisaged. In 1978, 5.6 t/ha grain yield were obtained. On better sandy soils, the results could be maintained and even surpassed by using proper cultural methods and chemicals to strengthen the culm. With this prospect before them, farmers would be more willing to grow shorter triticale on large areas. Poultry, sheep and pig farms still prefer the constant wheat–rye hybrid for feeding.

Diseases and Pests

In Hungary, intensive wheat production implies higher risks of fungus diseases because of the inevitable wheat–maize rotation. Triticale No 64 and the latest strains are resistant and tolerant, respectively, against powdery mildew and the three rust species. In some years, infection of *Fusarium, Septoria, Cercosporella* and *Rhynchosporium* cause problems.

In a dry autumn and with early sowing, cereal flies cause damage; in dry summers aphids are found. The latter are not very important. In Hungary, ears of rye and triticale are heavily infected by ergot *(Claviceps purpurea)* in some years. The standfast, fertile triticales are rather free of it, but ears on sides shoots of No 64 are very susceptible when lodged..

Seed Distribution

Triticale seeds of first and second degree are marketed by the State Seed Company. It distributes quality seeds among State and cooperative farms and small growers. Seed change is proposed in every third year. Triticale is in demand for animal feeding. Growers are, however, disappointed by the low fertility and easy lodging of No 64. They want types of higher productivity, earlier ripening and stronger culms.

Fodder Trials

In green fodder trials, mixtures of triticale and hairy vetch performed satisfactorily. Similar good results were obtained by mixed sowings of triticale and hairy vetch for vetch grain production. Triticale does not oppress vetch, so good grain yields can be obtained. Rye being less particular and more quick in developing, always oppresses vetch. The fodder is of poor quality as it contains less vetch which is rich in proteins. For the same reason, grain yields of vetch are also low.

International Cooperation

Connections were established with CIMMYT in 1970. Initially, ITYN trials were conducted, followed later by F_2 selection and the ITSN autumn x spring trials. From the Vegetable Crops Research Institute the special Bókoló and some other types were sent for crossing purposes. An indebtedness is felt to CIMMYT for breeding for earliness and good seed type. It was especially interesting to test the day length indifferent CIMMYT strains in Hungary.

Similar good relations are maintained with Poland, the German Democratic Republic, the German Federal Republic, and the Soviet Union, where Hungarian semidwarf winterhard triticales are selected.

Unfortunately the development of new triticale types and the gradual improvement of semidwarf types still require long years. International mutual help is of great advantage. In 1978 considerable progress was reported from the Soviet Union. The growing area of the semi tall, winter hard, hexaploid triticale Harkov AD 206 reached 400,000 ha (Solundin, 1978 personal communication).

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ITALY

INTRODUCTION

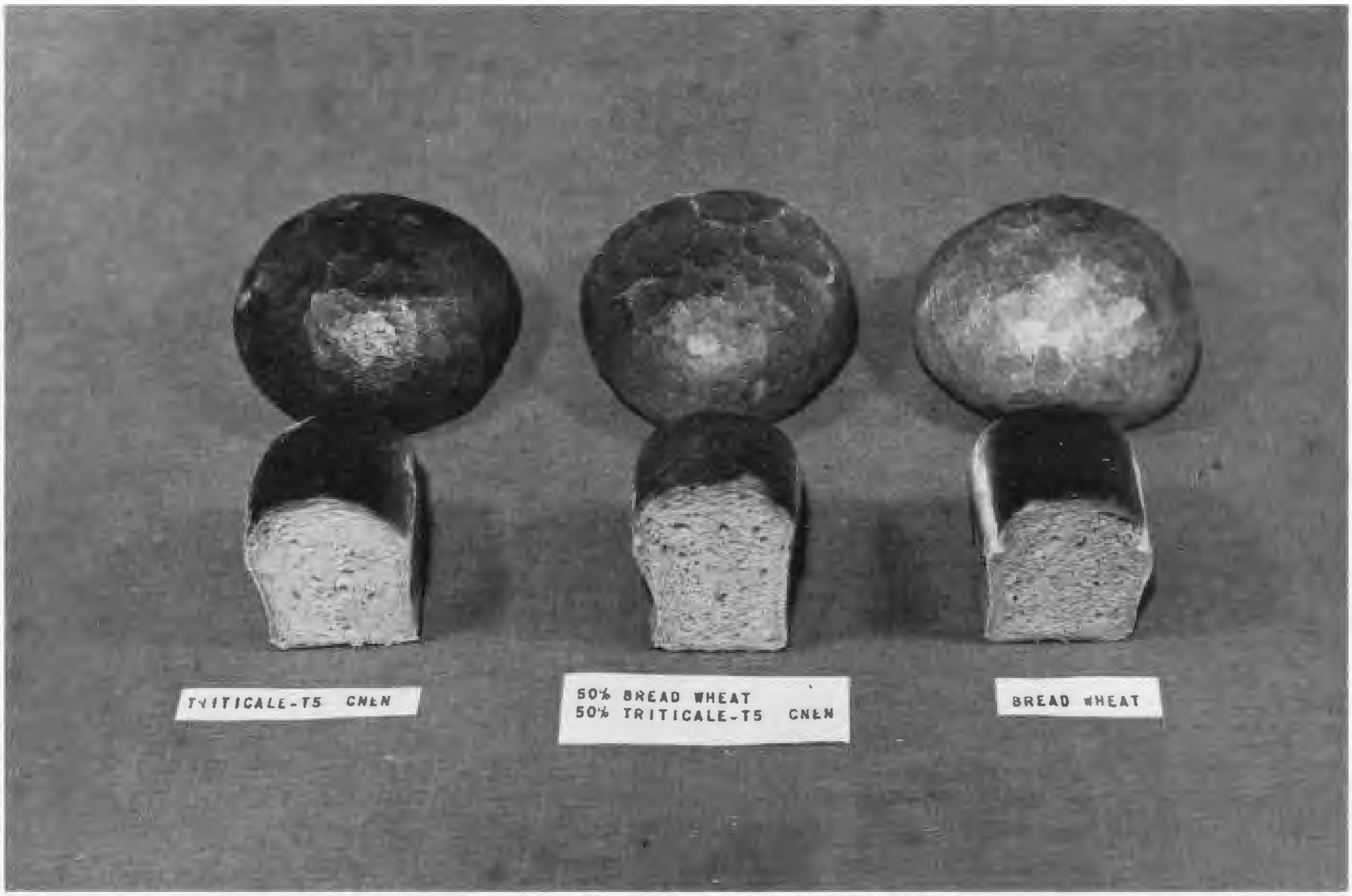
Italy grows 3.8 million hectares of bread wheat, durum wheat and barley. Altogether, their production is approximately 9.6 million tonnes. The area distribution among these cereal species is bread wheat 48.2 per cent, durum wheat 44 per cent and barley 7.8 per cent. Imports of wheat and other cereals in 1000 tonne units from 1975-78 were:

Crops	1975	1976	1977	1978
wheat (bread +durum)	1,246	1,785	1,315	2,700
barley (+rye +oat)	849	850	971	1,253

BREAD WHEAT

The production, areas and yields are listed below:

Bread wheat	1973	1974	1975	1976	1977	1978
Production (1000 t)	6,275	6,812	6,150	6,298	4,313	5,564
Area (1000 ha)	2,065	2,150	1,993	1,873	1,527	1,825
Yield	3,040	3,170	3,080	3,360	2,830	3,050



Bread produced in Rome, Italy from the following flours—left, triticale 100 per cent; centre, 50 per cent triticale; right, 100 per cent bread wheat.

The biggest share of this production is used for bread making (about 6 million t); 0.4 million t are utilized as seed for normal sowing; a small quantity for feed and a little for export. The daily consumption of bread per capita is 230 grams, which is about half the amount consumed by a person in 1946.

The price is established by the EEC Authority and is kept at a relatively high level to assure a reasonable income to the European farmers. Compared with other cereals (maize and barley) the price of wheat, kept higher until a few years ago, is now leveling off. As far as milling and baking quality is concerned, there is an increasing demand for a better quality and a corresponding attitude of the millers to pay more for wheats of better quality. Usually, to meet the quality requirements, conspicuous amounts of wheats of a very good quality are imported from Canada, USA and Argentina.

Although the area has been continuously decreasing over the last twenty years, total wheat production remained constant till 1968, due to the increased yield per ha (50 per cent higher in the last 15 years). The low production obtained in 1977 was mainly caused by continuous rain during the sowing period as well by other unfavorable situations during the growing season. In 1978 the area sown again reached the normal level of the previous year. The climatic season was good and consequently the total production has been satisfactory.

Bread wheat is mainly grown in North and Central Italy. The crop is normally sown in the three, months period October–November–December. Sometimes sowing is delayed until January, especially in the South, because of unsuitable weather conditions. In regions where cold winters occur, winter varieties are preferred, otherwise spring types are used, which are sown in the autumn. Harvest takes place at the end of June and early July.

Agronomic techniques are advanced and have been applied by almost all the farmers since the first decades of the century when the first short straw and lodging resistant varieties were developed in Italy and put in cultivation.

Chemical fertilizers are commonly used in sufficient quantities and 80–200 kg/ha N are usually applied two or three times.

Herbicide treatments are also a common practice. The chemical control of aphids and powdery mildew is a new practice which is spreading over the country. Such treatments depend upon the severity of the attacks and the agronomic and technological skill of the farmers. The most widespread diseases are mildew and leaf and stem rusts. Stripe rust occurs very rarely; however serious outbreaks of this disease occurred in 1977 and 1978. Other diseases such as *Septoria spp., Fusarium spp., Ophiobolus graminis and Cercosporella* are also present in some patches, and they vary from year to year.

Pests such as *Oulema melanopus, Oulema cyanella, Contarinia tritici,* etc., can be responsible for limited damage in some areas.

Varieties

The list of the cultivars available and included in the National Register of Varieties comprises 92 entries of which seven are of foreign origin. The varietal situation is in continuous evolution. Most of them (64 per cent) have been released after 1972. Some old varieties such as San Pastore, Mara, Marimp 3, Fiorello, Campodoro, Funo, Gallini, Argelato, Conte Marzotto, Libellula, De Carolis, are still being cultivated but they are slowly decreasing; others like Mec, Orso, Adria, Aquileia, Saliente, Morandi, Flavio, Flaminio, Sanya, Valledoro etc., seem very promising and their hectareage is rapidly increasing.

Only a small proportion (one fifth) of the bread wheat area is occupied by varieties or populations not included in the National Register of Varieties. In these cases, the yield is rather low.

Though the great majority of the farmers use improved varieties, the amount of certified seed is only 43 per cent of the total.

The improvement of Italian wheat varieties commenced with the pioneer plant breeder Nazareno Strampelli. His work led in 1920 to the release of a semi-dwarf wheat which was early maturing. It was named Ardito. It was derived from a cross between a tall hybrid, which came from Rieti x Wilhemina Tarwe, and the early Japanese semidwarf variety Akagomughi. For the first time, the yield ceiling of five t/ha was reached, and Italy became self sufficient within a few years.

Strampelli also developed high yielding varieties such as Villa Glori, Mentana, Damiano Chiesa and San Pastore. The latter was released in 1930 and is still being cultivated on 300,000 ha in northern Italy. Strampelli also carried out interspecific and intergeneric hybridization with wheat and *Secale and Heynaldia villosa.*

DURUM WHEAT

Italy is the biggest consumer and exporter of pasta in the world and is one of the most important importers of durum wheat. The following figures show the production, area and yield of durum in Italy:

Durum wheat	1966-67-68	1975	1976	1977	1978
Total Production (1000 t)	2,105	3,460	3,218	2,016	3,200
Area (1000 ha)	1,362	1,552	1,671	1,261	1,662
Yield (kg/ha)	1,545	2,230	1,930	1,600	1,930

Durum is used to manufacture pasta products e.g. spaghetti, macaroni, noodles, etc). The consumption of these products is very high but it is decreasing slowly viz., from 32–29 kg/capita/annum, over the last 15 years.

Durum wheat is grown mainly in South and Central Italy. The development of new high yielding varieties has moved the limit of the crop northward into fertile soils and in some areas of the PO Valley, which was previously occupied by bread wheat.

In spite of the high yield obtained in these limited areas, the national average yield remains relatively low. In fact, the large typical durum areas have received little benefit from the introduction of the high yielding durum. In these areas the most cultivated varieties are Capeiti, Patrizio, Appulo and Trinakria (the last one is the best for protein and technological quality). They are all rather tall, early flowering and ripening, and are susceptible to lodging.

HYV DURUMS

The most important high yielding varieties are Creso, Valsacco, Valnova, Valgerardo, Valfiora, Valnera, Valselva, Tito. Compared with Capeiti they are late flowering and late ripening; some of them show remarkable resistance to stem rust, leaf rust and mildew. They are recommended for fertile soils with good availability of water and N fertilizers. In such conditions, their yielding ability is competitive with bread wheats.

In the following table, the grain yields and hectoliter weights of bread wheats and durums (Capeiti, Creso and Tito) are compared in more than 80 trials in Central Italy.

	Bread Wheats (Irnerio or Flaminio)	Durum Wheats Capeiti	Creso	Tito
Mean Yield. (100 kg/ha)	54.01	40.56	58.83	58.43
Mean hectoliter weight. (kg/hl)	77.65	81.29	81.95	77.37

All the high yielding varieties, except Tito, are semi-dwarf types with Norin 10 genes. Tito is the only variety which is competitive with semidwarf types in yielding ability and lodging resistance. It was selected at the Casaccia–CNEN from a cross between Lakota and Castelporziano, which is a short straw mutant from Cappelli. Under very good agroclimatic conditions, Tito represents a valid alternative to the monoculture of Norin 10 types. It is a semi winter type and cold resistant.

Among the new varieties, Creso is the most important agronomically and economically. It was released in 1974; more than 300,000 ha were cultivated in Italy in the season 1977-78. With Capeiti, Patrizio and Appulo it is the most cultivated durum in Italy.

The technological quality, mainly expressed by spaghetti making properties, is considered in Italy a very important character, which must be safeguarded whenever new varieties are developed and new areas are occupied by durums.

At the moment 53 varieties are included in the National Register of Varieties; only three of them come from abroad. Most of the 70 per cent of the present varieties have been released after 1972, confirming the significance of the breeding work in this crop.

Only 10 per cent of the national durum area is cultivated with varieties not included in the Register, while 80 per cent of the whole durum area is still cultivated with non certified seed. It means that a lot of seed is multiplied on the farms or is coming from farmer's exchanges.

BARLEY

It is used mainly for feed, both as grain and as silage, and for the production of malt for the beer industry. Sometimes, especially in South Italy, it is sown in the beginning of autumn, mixed with some beans to be used as fodder.

Total production, area and yield statistics are:

Barley	1965-66	1975	1976	1977	1978
Total Production (1000 t)	254	647	755	677	790
Area (1000 ha)	179	249	274	290	294
Yield (kg/ha)	1,420	2,600	2,760	2,330	2,690

The total production meets only 30 per cent of the Italian needs, and a relevant amount is imported. From 1966–1976, the sown area increased by 50 per cent and production by 200 per cent. The higher yield per hectare is due to improved varieties, extension of this cereal onto more fertile soils and improved agronomic techniques. Winter habit and spring varieties are sown from October to the beginning of December; spring sowing is carried out from January to mid March.

Seeding rates are 120–150 kg/ha for two row varieties and 100–130 kg/ha for six row barley. In this way, a density of 350 seeds/m^2 can be assured; for spring sowing, densities of 400–420 seeds/m^2 are recommended.

The rates of nitrogen fertilizers are generally within the range of 50–90 kg/ha N.

Seed is treated with chemicals against pathogens.

The most common diseases are powdery mildew, *Rhynchosporium*, *Helminthosporium*, leaf rust, etc.

Varieties

For sometime, Italian plant breeders have neglected barley. Due to a big shortage of feedstuffs, there has been a recent emphasis placed on barley improvement. The cultivars included in the National Register of Varieties now number 53, of which 45 have come from abroad, especially from Central and Northern Europe. Some 85 per cent of the cultivars in production have been released after 1972.

Lodging and disease susceptibility are the main problems in barley in Italy.

TRITICALE

It is becoming an agronomic reality in Italy both in some experimental stations and in farming. Research activity and triticale breeding are carried out at the Casaccia Center. Primary triticales, obtained from crosses of new durum varieties (Creso and Tito) with semidwarf autofertile ryes, have been produced, selected and crossed with secondary triticales. A lot of segregating material and numerous secondary triticales received from CIMMYT, are grown and selected for breeding purposes. About 1,000 new lines are tested every year in the preliminary trials.

Selection is differentiated according to the types of areas in which triticale may be introduced, and according to its specific utilization. In the dry areas of South Italy (Sicily and similar Mediterranean Regions) some triticale lines outyield wheat and barley. Their test weight is relatively good (74–76 kg/hl). However, it is rather unlikely that triticale can compete, in these areas with durum wheat being priced much higher than other cereals.

In some fertile soils of the Mediterranean region, triticale can express its high yielding potential because of the very good climatic conditions during the filling and ripening periods. In such areas the best triticales outyielded the best wheats and barley; test weights were 75–76 kg/hl, extraction rates ranged from 59.7–66.7 per cent, protein content from 12.1–14.4 in the grains, and from 10.4–12.3 in the flour, and DBC values significantly higher than in wheats. Different lines show promising technological data and genetic variability for farinograms, alveograms and extensograms.

Bread has been produced either in the laboratory or at typical Italian bakers, without adding any conditioners or emulsifiers: the triticale bread is good for bread, texture, crumb color, flavor and taste. However, in the present Italian bakery situation, the use of triticale for bread making is not foreseeable, at least in the very near future.

At the moment, one line is used both for silage (higher production but less palatability compared with barley) and for feed.

Other interesting areas of selection are the mountain regions and foot hills of the Alpes, where winter habit and cold resistant types are necessary. In these areas, triticale competes successfully with feeding barley.

NETHERLANDS

AREA AND PRODUCTION

In 1955 the total area of arable crops was 922,576 ha. By 1975 it had gradually diminished to 683,315 ha (a reduction of 25 per cent) mainly as a result of expansion in industrial and residential land. The wheat crop now occupies about 125,000 ha (18.3 per cent) of which approximately 100,000 ha are grown with winter wheat. The remainder is planted with spring wheat. These ratios differ somewhat from year to year depending on the fall weather conditions.

The current statistics on yield, area and production for winter and springs wheats are:

Crop	Yield (1000 kg/ha)	Area (ha)	Production (1000 kg)
Winter	5.550	98,375	545,981.25
Spring	4.525	27,900	126,247.50

The long term yield increase is 1.5 per cent. The values in 1000 kg/ha were the yield averages over the period 1973-76. The moisture content was 16 per cent.

EXPORTS AND IMPORTS

Only a small part (± 5 per cent) of the total wheat production is used for breadmaking, because of the poor dough and baking characteristics (10-11 per cent protein). Some 250,000 metric tons are used for animal feed. The remainder (± 400,000 metric tons) is exported. The annual import of quality wheat from the North American continent and France amounts to about 1,850,000 metric tons.

CLIMATE AND PRODUCTION

The winters are generally mild and the summers are cool. Rain may fall throughout the year. Annual average rainfall amounts to 765 mm with 216 days receiving more than 0.1 mm. The hours of sunshine/year are 1572. The mean temperature in January is 1.7°C and in July, it is 17.0°C.

The winter crop is planted in the fall, from mid October to mid November. Flowering is around June 10th. The crop is harvested in mid August.

The spring crop is planted from March onwards, preferably as early as possible. Spring wheat flowers some two weeks after the winter crop and the harvest is also two weeks later.

Cool summers generally lead to high yields and low protein percentage, while higher temperatures generally inverse this picture.

FERTILIZERS

On the average, 95 kg N fertilizer are applied to winter wheat. The quantity is dependent on the amount of N in the soil after the winter. There is a regional advisory service, which gives fertilizer N advice to the farmers, based on soil N determinations. The total amount of N which has to be available for a good yielding crop, should be between 150-200 kg/ha.

Small quantities of K and P (about 40 and 20 kg/ha respectively) are applied because a considerable amount may still be present after the previous crop is removed. This is mostly potatoes, but also sugar beets.

DISEASES

The most devastating wheat disease is stripe rust *(Puccinia striiformis)*, which can become epidemic around the stages F_9-F_{10}. It does not occur every year, but when it attacks, the yield losses may be as high as 40 per cent. It is difficult to predict when this rust will be a problem. It may be as often as once in every 5-6 years.

The next most important disease is leaf rust *(Puccinia recondita f.sp. tritici)*. It is not as severe as stripe (yellow) rust, but occurs more frequently and causes an estimated yield loss of 20 per cent. *Septoria nodorum* is a very severe problem in some years (e.g. 1972). It can cause yield losses of up to 40 per cent, but normally about 6 per cent. These figures have to be interpreted carefully, since diseases almost never occur alone.

There are some tendencies which indicate that the disease situation is more severe at present than 10-20 years ago. The high N applications and the uniformity of modern varieties may be debited for this. Fungicidal treatments of the crop are common practice. Farmers are advised when to spray.

SEED INDUSTRY

The industry is private and seed production is well organized. The Department of Plant Breeding of the Agricultural University apart from teaching, is involved in basic problem oriented research. A public funded government institute (SVP) conducts crop oriented, more applied research in problem areas. It supplies private breeders with promising breeding material.

VARIETIES

Farmers can choose their varieties from the descriptions in the national field crops variety list. Some 10 or more varieties of winter wheat are generally described therein with recommendations how to grow them. For spring wheat, a smaller number of varieties is present.

The adoption of new varieties by the farmers is very rapid, since they know that only good varieties are admitted to the market. A thorough study of all the characteristics of a variety and its performance is carried out by a government institute (RIVRO).

The principal varieties now in production are Arminda, Caribo, Okapi, Donata and Durin. Donata and Durin were first grown this year, Arminda since 1976, Okapi since 1975 and Caribo is slightly older (1968). The height of these varieties varies between 80-100 cm.

IPO

This organization viz., Institute Voor Plantenziektenkundig Onderzoek (Research Institute for Plant Protection) is located at Wageningen.

It organized the European Wheat Rusts Nursery (EWRN) which was sent to 200 places in 43 countries. The EWRN comprised the most important European Wheat cultivars.

In Italy races 40E8 and 41E136 seriously attacked the highly susceptible varieties and in Spain and Portugal the introduced 'Mexican' wheats were heavily infected by races 38E16 and 41E136 being new in both countries. In East Europe the variety Sava highly susceptible to almost all races of yellow rust was again seriously attacked.

Results in Wageningen showed the presence of races 41E136, 106E139, 169E137 and 233E137 in Belgium, 104E41, 104E137, 105E137 and 168E137 in West Germany, 41E136, 106E139, 169E136 and 232E137 in France, 32E0, 32E64, 40E8 and 169E136 in Switzerland, 41E136, 104E137, 106E139 and 108E141 in Yugoslavia, 104E41 in Poland, 33E128 and 104E137 in Czechoslovakia, 104E137, 106E139 and 108E141 in Hungary, 6E16 in Greece and 38E146 in Finland.

In separate fields (race nurseries) additional data were obtained on the specific and non-specific resistance of the EWRN wheat cultivars by inoculating them with races 41E168, 104E41 and 169E136 and by inoculating them in the seedling stage with 29 European and non-European races.

The varieties Benno, Persues, Prestige, Sadovo, Saladin, Weique, Winnetou and Zorba, deriving their resistance from rye as Clement, showed resistance to the Clement race 232E137 as well as to the new race 169E136 attacking Clement too. The new race 41E168, rendering ineffective the resistance of Anouska, was also virulent to Caribo' and Okapi.

In four field experiments, triadimefon (Bayleton, 125 g a.i./ha) proved to be much better than tridemorf (Calixin 560 g a.i./ha) + benadonil (Calirus, 500 g a.i./ha) for the control of yellow rust in highly susceptible varieties. Yellow rust in moderate susceptible varieties was also controlled effectively with tridemorf (Calixin 560 g a.i./ha). The fungicides were combined with maneb (1600 g a.i./ha). The results further indicate that the time of application should be made dependent on the disease development.

In Europe there was little or no yellow rust in barley *(Puccinia striiformis* f.sp. *hordei).* Results of comparative tests indicated that the race attacking barley in South America is identical to that prevailing in Europe. In a race nursery inoculated with race 24 *'Mazurka–Varunda'*, almost all varieties of CIMMYT's international barley nursery were severely infected.

DEVELOPING COUNTRIES

Virulence of yellow rust in wheat was surveyed by the Regional Disease Trap Nursery (RDTN) set up by CIMMYT in the wheat growing areas of Asia and Africa, and by the Ensayo Latino Americano de las Royas (ELAR) in South America. Rust samples from both nurseries were sent to Wageningen for virulence analysis which was made by inoculating the most important varieties of both nurseries with spores multiplied from each sample. Yellow rust severely attacked the wheat in northern Pakistan, but not the adjacent wheat in northern India. In the latter country, the susceptible varieties were in time replaced by resistant ones.

CIMMYT's nurseries comprising 1134 varieties of bread and durum wheats, triticales and multilines were tested in the field on their resistance to a mixture of races 32E96, 34E139 and 232E137. The majority of the wheat material showed an adequate level of resistance.

IPO and CIMMYT jointly organized a Regional Workshop on Wheat Rusts Methodology in Turkey and Kenya. These workshops financed by the Directorate for International Technical Aid have the objective to train personnel of national wheat breeding stations in the use of techniques and equipment developed for handling the rust diseases in the field as well in the laboratory. The workshops, the first of which was held in India in 1976, also comprise the provision of equipment to the stations.

BARLEY AREA AND PRODUCTION

In the five year period 1974-1978, barley averaged about 71,000 ha (10.4 per cent) of the total area sown to arable crops (686,160 ha). For the period, the averaged statistics for yield, area and production are:

Crop	Yield (t/ha)	Area (ha)	Production (t)
Winter barley	4.92	9,260	45,943
Spring barley	4.3	62,000	265,239

Approximately 87,000 t (±30 per cent) of the spring barley is used for malting, of which 27,000 t (±30 per cent) is exported to Belgium, France and the Federal Republic of Germany. The remainder of the spring barley and the winter barley are used for feed.

BARLEY GROWING SEASON

Winter barley is sown earlier than winter wheat, namely the end of September. It is normally harvested in mid July. Spring barley is sown at the same time as spring wheat. It is harvested in mid August.

FERTILIZER

The average application to spring barley is 50 kg N/ha. The amount depends on the quantity remaining in the soil after winter. The previous crop is mainly sugar beet so only small amounts of K and P are applied.

BARLEY DISEASES

Erysiphe graminis was the most damaging disease in spring barley in earlier years. Nowadays *Rhynchosporium secalis* can cause some yield loss in winter barley. Fungicidal applications are commonly practiced to reduce crop damage.

BARLEY VARIETIES

The principal spring varieties are Pirouette, Aramir, Trumpf and Mazurka. The last named is the oldest, having been grown since 1970. The main winter barley variety is Banteng.

The seed production industry is the same as for wheat.

NORWAY

Harvesting spring wheat breeding material in Norway. Wheat production meets only 20 per cent of home consumption at present. It is planned to increase production by 50 per cent by 1990.

AREA AND YIELDS

The total small grain area is approximately 300,000 ha. In 1978, barley was planted on 185,000 ha and there were 97,000 ha with oats and 20,000 ha with wheat. The goal is to increase the total area to 360,000 ha by 1990. The average yields in 1978 in t/ha were 3.61, 3.77 and 3.89 for barley, oats and wheat respectively. During the last 25 years the yields have increased from 2.0 t/ha to the 1978 level.

Barley and oats are mainly used for feed, and a total of 500,000 tonnes of feed grain are imported annually.

Wheat production covers only 20 per cent of the consumption. It is aimed to increase this figure by 50 per cent by 1990.

FERTILIZERS

Norway exports fertilizer and the domestic prices are relatively low. Normal nitrogen applications on small grains range from 100–150 kg/ha.

PRODUCTION PRACTICES

Small grain production is concentrated in the south eastern part of the country between 59°–62° N latitude, and in a smaller area in Tröndelag between 63°–65° N latitude. Planting starts in late April in the earliest districts, and continues through May. A small area of 3000–5000 ha are planted to winter wheat in September. All small grains are harvested in August–September.

CLIMATE

The average April–September temperatures range from 10°C–14°C and rainfall varies from 300 mm–400mm during the summer months. In south east Norway, there is normally a drought period in June, and approximately 20 per cent of the small grain area is sprinkler irrigated.

DISEASES

Powdery mildew, *Septoria* and take-all are the most important diseases of wheat. The barley diseases are mildew, *Rhyncosporium* and *Drechslera.*

SEED INDUSTRY

This industry is operated privately, but the State Seed Testing Station is reponsible for seed certification.

BREEDING PROGRAMS

Small grain breeding programs were initiated in the early nineteen twenties. The Agricultural University and the State Experiment stations are responsible for both breeding and variety testing.

Of spring wheats, only Norwegian varieties are grown. Runar was released in 1972 and Reno in 1975. They are both short statured, early maturing varieties with the *German M 1* resistance to powdery mildew. Both are high yielding and Reno especially is resistant to sprouting. The winter wheat varieties Kjaldar and Rida were selected for winter–hardiness, resistance to snow molds and earliness.

Since the late nineteen sixties, CIMMYT nurseries have been grown at the Agricultural University. The CIMMYT germ plasm has been extensively used in the wheat breeding program. Many of the Mexican varieties are heading earlier than the locally adapted varieties, but they are later at maturity.

Because earliness is the main limiting factor, it is not expected that there will be varieties in the CIMMYT nurseries for direct use under Norwegian condition. In 1979, however, Nacozari 'S' and Mapache are being tested in larger plots.

Primarily the CIMMYT nurseries are used as parent sources in the Norwegian breeding programs. It is hoped that the results from the high latitudes regions will help CIMMYT produce varieties with even greater adaptability.

TRITICALE

Varieties tested often grow late tillers. To date, a triticale has not been found that is early enough for the Norwegian climate.

BARLEY

The area sown is split mainly between the Norwegian 6–row varieties Lise and Yrjar and the 2–row varieties Gunilla (Swedish) and Moyjar (Norwegian). About 8–10 other varieties are grown on limited areas.

POLAND

INTRODUCTION

Wheat breeding in Poland has a long tradition reaching back 120 years. The oldest breeding station, which continues its work uninterruptedly to the present day, will celebrate its centenary in 1980. It is the Plant Breeding Station in Dańków in the northern part of the Radom District in Central Poland.

Cereal seeds are bred mainly by two state institutions: The Institute of Plant Breeding and Acclimatisation, and the Union for Agricultural and Horticultural Seed Production. Testing of new and cultivated varieties is done by the Centre for Testing Varieties of Crop Plants in Slupia Wielka, and also by several score of experimental stations throughout Poland. The results of these trials which usually last 2–3 years, are decisive for qualifying new varieties for release and for the removal of older ones.

AREA AND PRODUCTION

The statistics for 1977 are:

Crop	Area (1000 ha)	Yield (1000 t)
winter wheat	1,561.8	4,572
spring wheat	272.1	736
winter barley	71.5	229
spring barley	1,163.9	3,167
winter rye	3,115.7	6,250
spring oats	1,096.6	2,255

This production, although increasing continuously does not satisfy market requirements because of the high demand for grain as fodder.

A new winter wheat variety, Pszenica Ozima, [(Weique x D. Biata) x Luna] x Grana, being tested in national trials in Poland.

IMPORTS AND EXPORTS

The importation of cereal grains for consumption and fodder in 1977 for each of wheat and barley was 2,599 thousand tonnes and 1,268 thousand tonnes respectively.

Rye exports exceeded the tonnage of wheat, oats and barley imported.

CLIMATE

Poland lies on the borders of two climatic zones: oceanic and continental, which results in a high variability of climatic conditions over the years. Therefore in various years, crop yields are influenced by various climatic and pathological factors. In contrast to the year 1977 when diseases were the main factor reducing the yields, a mild winter in 1978, a favourable distribution of precipitation and a prolonged growing period in most regions, have favored a very good harvest. Only the north–western region suffered a prolonged drought. On the other hand, incessant rain made the harvest very difficult, and caused losses in the crop.

FERTILIZERS

The mean use of the fertilizers NPK is 189 kg/ha, (consisting of 63.9 kg/ha N, 49.2 kg/ha P_2O_5 and 75.9 kg/ha K_2O) plus 125.4 kg/ha CaO. In general, the supply of fertilizers is sufficient. In intensive wheat cultivation, doses up to 300–400 kg/ha NPK are applied. In some regions, magnesium is deficient and it is supplied in the form of magnesium lime.

PRODUCTION PROBLEMS

Cultivation of winter cereal crops prevails in Poland over that of spring varieties for climatic reasons. Because Central Europe spring droughts are relatively common, the winter cereal varieties better utilize the moisture stored in the soil during winter. In some years, the protracted winter causes a delay in spring seeding and this unfavourably affects the yields of spring cereal varieties.

Owing to the prevalence of light and partly acidic soils, the proportion of rye culture is high. Poland is second after the U.S.S.R. as regards the area sown with this plant and in relation to other cereals, rye production in Poland is of paramount importance. In the six–year period 1973–1978, rye yields have doubled as compared with the analogous period 1950–1955. This can be attributed jointly to the influence of fertilization and to the introduction of new varieties.

These factors have increased production although the area sown with rye has diminished from 5 to 3 million ha. In the same period, wheat yields have increased from 1.3 to 3.0 t/ha.

Because of the variable climate of Central Europe, various factors are decisive for the crop in different years. In view of frequent and violent storms and downpours in summer, one of the most important factors deciding yield, is lodging. In the last decade, great progress has been made in breeding from this point of view.

In some years, an important unfavorable factor restricting winter wheat and winter barley crops is winter killing of the young plants, owing to insufficient snow cover.

DISEASES

With a long lying snow cover, the winter cereals, particularly rye and barley, suffer from infection with fungi of the genus *Fusarium,* mainly *Fusarium nivale.*

The most frequent infection affecting wheat and barley is mildew, *Erysiphe graminis,* which lowers yields by about 20 per cent, as demonstrated by some experiments. Less frequent and occurring intensively once in a few years is wheat septoriosis, mainly *Septoria nodorum* on the leaves and heads, and also brown rust, *Puccinia recondita.* The losses due to a high incidence of these diseases may reach as much as 40 per cent.

Black rust, *Puccinia graminis,* is frequent in south–eastern Poland. A high, disastrous incidence was noted in the whole country in the years 1932 and 1972, causing losses in wheat reaching more than 50 per cent in some regions.

Yellow rust, *Puccinia glumarum,* occurs sometimes on wheat, particularly in the western and southern regions. Its spread, however, seems to be restricted by low winter temperatures. Therefore the losses caused by this disease are relatively low.

Besides *Fusarium nivale,* another species viz., *Fusarium culmorum* infects the heads in some years, particularly in rye and wheat. The losses in rye, measured by the depressed 1000 grain weight in some cases reached 30 per cent in 1977. Root diseases *Cercosporella herpotrichoides and Ophiobolus graminis* may be important on heavier and lighter soils respectively.

SEED INDUSTRY

Seeds are produced by the State Union for Agricultural and Horticultural Seed Production. Its legal basis is the Law on Seed Production, which obliges farmers to renew the seeding material every three or four years. On the other hand, the state farms use qualified seeding material for the whole of their plantations. This warrants a relatively rapid introduction of new varieties.

Annual production of basic seed and super elites of cultivated cereal varieties is achieved by maintenance breeding by the breeders. The latter also produce basic seed and super elites of newly bred cereal varieties in quantities sufficient for their inscription into the Catalogue of Registered Varieties. Regarding very promising new varieties, reproduction is started earlier, on the basis of provisional seed certification, so that at the moment of introduction of such a variety for commercial use, the breeder disposes of material of the second or third successive degree of approbation, that is super elite, elite and sometimes original seed.

HYV

High yielding varieties are commonly used. They are rapidly released, owing to their intensive multiplication and to the interest they arouse among farmers. As an example, the winter wheat Grana, released in 1970 was expected then to contribute 11 per cent. Three years later its contribution was as high as 30 per cent and in 1976 it reached 40 per cent. The resulting demand for seed was fully satisfied.

The most important varieties in production are:

Cereal		Year Released
Winter wheat	Grana	1970
	Jana	1975
Spring wheat	Kolibri (W.Germany)	1972
	Alfa	1974
Winter barley	Vogelsänger Gold (W. Germany)	1976
	Xenia (E.Germany)	1969
Spring barley	Aramir(Netherlands)	1974
	Trumpf(E.Germany)	1975
Winter rye	Dańkowskie Złote	1968
	Dańkowskie Nowe	1976
Spring oats	Leanda (Netherlands)	1974
	Diadem(Czechoslovakia)	1972

Among the new varieties which are tested in state trials or have already gone through the experimental cycle, the following seem very promising:

Winter wheat	Modra, released in 1978
	188_{72}
	P 5796_{73}
Spring wheat	N 952
	N 962
Winter barley	Bekas, released 1977
	5138_{69}
Oats	Markus, released 1979

PROMISING MATERIALS

In 1978, four new Polish varieties of winter wheat were released for production. They included the high yielding and lodging resistant Modra and the very lodging resistant Begra of high milling and baking value. For state trials, a number of new varieties have been released, among them several promising winter wheats.

TRITICALE

The first six Polish winter triticale varieties are being tested in official trials; three were bred at the Plant Breeding Station, Dańków–Laski, of the Union for Agricultural and Horticultural Seed Production; two in the Institute of Plant Breeding and Acclimatisation, and one in the Agricultural University of Lublin.

The best yielding of these varieties, LT 176_{73}, produced 0.6 t/ha more in six trials than the winter wheat Grana. The former is relatively resistant to lodging and it produces well developed grain.

Triticale in years when wheat and rye are highly infected, is much higher than the other two cereals, whereas in years when the disease distributions are less intensive, the yields are similar. In 1978 which was particularly favourable to cereal growth, the record yield of one of the triticale strains in experiments in Choryń on relatively light soil (rye soil), was over 9 t/ha.

Thus, the introduction of this new plant for cultivation preceded by a series of varietal and cultivation experiments may contribute to the stabilization of cereal yields in Poland, particularly in regions where infection with diseases plays a major role, and also on soils of a transitional character. The propagation of triticale for commercial production requires much circumspection. The varieties presently submitted for trials still have some shortcomings; their winter hardiness and resistance to lodging are still mostly unsatisfactory.

However, it is hoped that, after further trials, at least one new variety will be tentatively released. The tempo of progress in breeding seems to indicate that in a few years time, new and much improved varieties will appear. An International Meeting of the Cereal Section of Eucarpia devoted to the breeding of triticale, will take place in Poland in 1979.

In view of the perspectives for introducing triticale for production, problems have to be solved connected with the cultivation methods of varieties in various environmental conditions in this country and with methods of seed production, such as the necessary frequency of seed renewal, isolation of plantations, methods of seed harvesting, drying and seed dressing.

Pertinent investigations are partly under way.

PRODUCTION PRACTICES

Cereals in Poland are not irrigated. Depending on the region, the seeding date for winter cereals is from the 10th September to the 20th October and in the western provinces, sometimes to the end of October. Spring varieties are usually sown between the 1st of March and 15th of April, depending on the year and region. The earlier dates of winter seeding concern the eastern regions, and those of spring varieties, the western regions.

Winter cereals are harvested from August 1–31, depending on the season.

CROP UTILIZATION

A large part of the grain of bread wheat and rye is used as fodder.

QUALITY

Most of the winter wheat cultivars are of medium or poor baking quality as also is the major part of the spring varieties. A serious problem in the use of rye grain as fodder is its relatively low protein content and the presence of substances inhibiting growth in young animals.

At present, intensive investigations are under way in Poland on the biochemical nature of these substances, since this role ascribed to alkylresorcinols, arouses serious doubts. The problem can be solved technologically by treatment with high temperature. The eventual genetic—breeding solution will take much longer, because it will have to take into account, the results of the above mentioned biochemical studies. This is one of the reasons why the breeding of hexaploid winter triticale, the grain of which has a much higher nutrient value than rye, arouses great interest in Poland as fodder.

INTERNATIONAL COLLABORATION

Collaboration with CIMMYT relates mainly to wheat and triticale. CIMMYT wheat lines in general cannot compete under central European conditions in yield with the varieties bred in Europe. On the other hand, they are a valuable source of resistance to disease, to lodging and earliness in the Polish programs of both winter and spring wheat breeding crosses between winter and spring varieties.

Two promising new spring varieties, N 952 and N 962 which originated from crosses with the variety Kalyansona and some Polish semidwarf lines and which give good prospects for the future, include Mexican varieties in their pedigree.

The main interest of Polish breeding, however, is centred on collaboration concerning triticale. The ITYN conducted for several years in Laski, qualified some spring CIMMYT varieties with markedly higher yields under local conditions viz., Mapache and Setter. The same is true for the ITSN. Of particular value to Poland however, is the collaboration in the program of spring triticale crosses with winter ones, towards the winter forms. Hence there is much interest in F_2 populations and in crossing block nurseries.

A valued feature of the collaboration with CIMMYT is the opportunity for Poland to take part in the program not only by the evaluation of the material and the supply of information, but also by supplying triticale, rye and wheat strains which are included in the crosses and the triticale material which is also accepted for the international crossing block. Poland is keen to continue collaboration particularly because of the possibility of including Polish high yielding rye varieties and strains into the international program.

PORTUGAL

AREA AND PRODUCTION

Provisional figures issued by the National Institute of Statistics for the 1977-78 wheat crop show that 351,500 ha were sown, which produced a harvest of 252,200 tonnes at an average yield of 718 kg/ha.

Compared with the figures for the 10 year period before 1978, there has been a drastic overall deterioration. The wheat averages for 1968-77 were 464,000 ha, 571,000 tonnes and 1,210 kg/ha yield.

The same trend has occurred with barley. The averages for the 1968-77 period and also the 1978 averages, shown in brackets, were 94,000 (72,000) ha, 72,000 (39,000) tonnes and 740 (544) kg/ha, respectively.

As a consequence of a decline in all of the wheat area, production and yield, the need to import has been severely increasing. Wheat production in 1978 was not enough to feed the Portuguese people for four months. Normally, wheat products are among the cheapest foods.

CLIMATE

To a large extent, the success or failure of small grain production in Portugal is influenced by rainfall fluctuations; in the period December—March too much rain is decisively a negative factor, meanwhile in April—May drought is another important cause of yield losses.

The climatic conditions, in 1977-78, were not favourable for high productions of cereal crops due to heavy rains throughout the wet period, particularly in December and February. Wheat and barley were most affected compared to oats, which showed better tolerance to waterlogged soils.

BREAD WHEAT AND DURUM PRODUCTION

Wheat can be grown every where in Portugal. It is only grown under dry farming conditions and occupies about 50 per cent of the area under winter cereals.

The most important wheat growing area is concentrated in Alentejo, which is in southern Portugal comprising Beja, Evora and Elvas regions. Here, bread wheat is the dominant crop; durum wheat is well adapted to deep and clay soils of Alentejo, but at present, its growing area is very reduced partly due to the low potential of the varieties and partly due to the poor prices paid to the farmer. Under these conditions, durum wheat amounts to less than 3 per cent of the national production.

In Alentejo, wheat is sown by broadcasting, usually from the end of October to mid December. The seed rate ranges from 160—180 kg/ha. Seed drills are only used by a few farmers. Because the winters are not severe, almost all varieties are spring types. Bread wheat is harvested in June and durum wheat from mid June—end of July.

Cereal breeding and agricultural research are more advanced in the south. Consequently the farmers of Alentejo have easier access to certified seed of high yielding varieties and they also receive proper fertilizer use advice.

The uplands of the north east are a secondary wheat growing area. There, wheat is of great importance to local agriculture and is grown in two different environmental conditions. In the high plateaux of Bragança and Miranda, the winters are long and very severe. Therefore winter and semi-late types are grown. Barbela which is the most widespread variety, is a native variety well adapted to the hard environmental conditions of the uplands, but it is tall, susceptible to lodging and not high yielding.

There is an urgent need to develop high yielding varieties adapted to the highland plateaux.

The normal season for sowing in the high plateaux is the end of September and beginning of October. Harvesting takes place in July and sometimes August.

In the north east region there are some low altitude valleys where the ecological conditions are very similar to the Mediterranean areas. Tua Valley is the most representative and there, bread wheat can be cultivated with the same varieties as in the southern region.

TRITICALE

Both in the highlands (terra fria) and low-altitude valleys (terra quente), the soils have a high degree of acidity with a pH below 5.5, making liming necessary. Triticale will probably be an important crop in the future. Field experiments including some CIMMYT triticale lines have shown positive results only in the valleys well protected against the cold winds. Beagle is the triticale variety which has performed better under those conditions.

Regarding the uplands, i.e. the so-called "terra fria", a few triticales lines selected in the Plant Breeding Station of Clermont-Ferrand (France) have performed satisfactorily. Otherwise triticale breeding research is being conducted by the Department of Genetics of the Institute of Vila Real.

Field and laboratory experiments have produced some interesting results in some lines, viz., Maya—Armadillo "S", Arabian, Bacum, Beagle, Mapache, Navojoa, Rahum and Yoreme. Now some efforts are underway in the seed production of a selected line of Maya II—Armadillo "S". Certified seeds of Arabian, Mapache and Beagle are being obtained.

BARLEY PRODUCTION

Like wheat, barley is grown only under dry farming conditions and it occupies about 10 per cent of the area under winter cereals. It is cultivated mainly South of the Tagus River, chiefly in the Districts of Beja, Evora, Santarém and Portalegre.

Barley is grown mainly for animal feed, malting and brewing, and to a lesser extent as a forage crop.

Barley has been cultivated for animal feed for a long time in Portugal, but only recently for malting purposes. The system for malting barley production is far better organized. This is a logical result of many cooperative efforts developed in recent years by the brewing industry and the Ministry of Agriculture. Some financial and technical incentives, improved commercial organization, systems for proper use of fertilizers (mainly nitrogen) and the use of herbicides has made it more attractive for farmers to grow malting barley.

The system for producing feed barley is, on the contrary, quite unprotected. For an average yield of 880 kg/ha in the period 1971-75, malting barley registered an average of 1,380 kg/ha, and that grown for animal feed only 680 kg/ha.

The majority of the feed barley is produced in the more marginal areas with poor soil conditions and low technology while in the richer more advanced agricultural areas, farmers favour wheat or malting barley production. Under these conditions the yields of feeding barley are dramatically low.

Some introduced varieties have performed well under the Portuguese conditions, but qualified seed is not available on the market. So exists a dramatic gap in this point between the agricultural research and the feed barley growers.

On the other hand, it is needed to increase substantially the national production to compensate for the huge imports of grain cereals to supply the grain feed industry. Recent economical studies enhance the need to increase ten times the actual barley production which it means to produce, i.e. 433,000 m. tons.

Regarding malting barleys, only three varieties were included in the Official List of Malting Barley Varieties in 1977-78. They were:

Variety	Origin	Row Type	Sown area Per cent	First year in the list
Beka	France	2	74	1959
Union	W.Germany	2	18	1967
Delisa	Holland	2	8	1971

Variety Beka dominates the area sown because of its good adaptation and high malting quality. At present, it is considered unreasonable for it to occupy such a large area.

In the 1978-79 season, Delisa will be discarded and Carina will replace it. Simultaneously, some efforts are being made to multiply seed of the new two-rowed variety Ribeka, which was bred at the Elvas Plant Breeding Station. It comes from the cross Rika x Beka and will probably be released to farmers in 1980-81.

It is believed that there are potentialities for Portugal to become not only self-sufficient, but also a malt exporter.

Due to the mild winter in southern Portugal, practically only spring barley varieties are used. The crop is sown in the late autumn/early winter. Harvesting takes place at the end of May and during June.

DISEASES

Apart from adverse climatic conditions, diseases are also responsible for low yields. The cool and wet spring season resulted in stripe rust developing into seriously epidemic proportions particularly in the south of the country.

The severity of the attacks of yellow rust on susceptible varieties like Siete Cerros, Campodoro and Mexicano 1481 substantially reduced the yields of these varieties. Anza showed extremely good resistance to this disease. *Septoria tritici* was also of major importance especially from the tillering to the flowering stage.

Rhynchosporium secalis was the major disease in the barley crop. Root diseases were also observed on cereal crops. Mildew was of minor importance, although humidity was present in abundance throughout the crop season.

SEED INDUSTRY

There has been an efficient wheat seed production system in operation for a long time. Breeder's seed and Foundation seed are carefully produced at the Plant Breeding Station; Registered seed is produced at selected Government Farms; Certified seed is grown by wheat seed growers on contract. Every step of the system is under the supervision of the Seed Testing Station. On the other hand, the total commercialization of seed and wheat grain is made exclusively by the public enterprise, Empresa Publica de Abastecimiento de Cereales, (EPAC).

A considerable proportion of the wheat area is sown with certified seed—approximately 50 per cent in 1977-78.

VARIETIES

The bread wheat varieties most frequently grown in Portugal are:

Variety	Origin	Per cent	First official listing
Siete Cerros	CIMMYT-México	27	1969
Impeto	Italy	20	1955
Campodoro	Italy	10	1958
Mexicano 1481	CIMMYT/Portugal	9	1970
Mara	Italy	7	1958
Chaimite	Portugal	6	1967
Etoile de Choisy	France	6	1968
N.Strampelli	Italy	5	1970
Anza	CIMMYT/Sudan	4	1977
Mucaba	Portugal	2	1964
Others	—	1	—

The most widely grown durum wheat is Capieti, of Italian origin and which was first officially listed in 1966.

Some defects in the official List of Wheat Varieties have been argued as including too many varieties, some varieties remaining in the list for too many years, and the selection and seed production system taking too long.

INTERNATIONAL COOPERATION

The Plant Breeding Station at Elvas has been developed with close cooperation from the Swedish Seed Association, Svalöf (Sweden). Materials, methods and research philosophy of that institution have been assimilated and translated into Portugal's particular environmental conditions and aims. Svalöf has also given valuable training for breeders and geneticists at the Plant Breeding Station.

At the present time, the closest cooperation in the areas of bread wheat, durum wheat, triticale and barley research, is with CIMMYT and ICARDA.

Since 1961 an appreciable amount of genetic material from Mexico has been tested at Elvas. The bread wheat variety Mexicano 1481 is a reselection made at Elvas on segregating material from the cross Nor $10B_1$ x P14. That variety is high-yielding and performs very well in a wide range of environmental conditions. It shows acceptable resistance to stem rust, medium resistance to lodging and it is a good agronomic type. Siete Cerros, a direct introduction from CIMMYT, was the widest grown wheat variety in 1977-78. Anza, another direct introduction, is presently the highest yielding and best adapted bread variety grown in Portugal. Both Siete Cerros and Mexicano 1481 for the first time, showed high susceptibility to *Puccinia striiformis* in the 1978 cropping season.

Every growing season many of the CIMMYT and ICARDA varieties or lines of bread wheat, durum wheat, barley and triticale are hybridized with Portuguese and Italian lines with good results.

Some CIMMYT barley lines which have shown resistance to *Rhynchosporium secalis* in field conditions are being used as resistant parents in the planned crosses of the barley breeding program. Some CIMMYT triticale genotypes are being systematically hybridized to induce improved genetic combinations of secondary triticales.

Every cropping season, some lines of different crops are isolated from the International Nurseries and included in routine breeding works.

The following lines have shown an extremely good response in advanced yield trials conducted in different sites spread throughout Portugal.

Crop	Line	Origin
Bread Wheat	Anza	CIMMYT
Bread Wheat	(21931/Ch53-An x Gb 56) An 64	Israel
Bread Wheat	Marimp 8-Mexicano 1481	Portugal

con't

Crop	Line	Origin
Bread Wheat	Xevora	Portugal
Durum Wheat	Mexicali 75	CIMMYT
Durum Wheat	Cocorit 71	CIMMYT
Durum Wheat	Grulla	CIMMYT
Durum Wheat	Maioral 1	Portugal
Triticale	Maya II-Arm "S"	CIMMYT
Triticale	Beagle	CIMMYT
Triticale	Inia-Arm "S"	CIMMYT
Triticale	Mapache	CIMMYT

The facilities given by CIMMYT in training young cereal breeders of Portugal represent a very valuable contribution to the advancement of plant breeding.

Since 1977, Portugal has been included in the FAO-European Research Network on Durum Wheat. In 1977-78 a cooperative yield trial was carried out at Elvas. Durum wheat varieties from France (2), Greece (2), Italy (3), Portugal (2) and USA (1) were observed and tested under different climatic and edaphic conditions. A good response was shown overall by the Portuguese durum wheat varieties, Alforge and Faisca. They are semi-dwarf types carrying a one dwarf gene from Oviachic; highly responsive to nitrogen; good fertility; modern agronomic type; their quality for macaroni is acceptable.

Periodic meetings sponsored by FAO take place between research scientists involved in the FAO-European Research Network on Durum Wheat.

The advancement of the malting barley crop has been materially assisted by international cooperation on a European basis, from the Barley Committee of the European Brewery Convention.

RUMANIA

AREA AND PRODUCTION

In 1978 wheat was grown on 2.3 million hectares, practically all of which was planted to bread wheat. The wheat crop ranks second to maize, which is the most important crop.

Barley has been increasingly sown since 1965. As yet, triticale is not grown on a commercial scale.

The following table shows the area and production figures for wheat and barley since 1956.

Year	Wheat		Barley	
	Area (million ha)	Yield (100 kg/ha)	Area (million ha)	Yield (100 kg/ha)
1956–1960	3.06	11.2	0.29	12.9
1961–1965	3.05	14.5	0.23	17.5
1966–1970	2.82	16.8	0.27	19.1
1971–1975	2.46	22.1	0.36	23.3
1976–1977	2.36	28.0	0.50	30.8
1978	2.32	27.1	0.72	31.7

Almost all wheat and most barley are winter crops, planted in September–October and harvested in July, having to survive winter temperatures going frequently as low as –20° or –25°C, mostly with snow cover. The weather in 1978 was very unfavourable to wheat due to a dry autumn in the south and east areas.

DISEASES

The disease development was moderate, except for a limited area in the west, where heavy attacks of stripe rust were noted on susceptible varieties (Novosadska Rana 2, Zlatna Dolina).

FERTILIZERS

Fertilizer availability continued to improve. A total amount of 1.480 million metric tons, in terms of the chemical elements, was delivered to the farms. This, along with other improvements in crop management, resulted in a wheat yield of 2712 kg/ha, which was only 108 kg/ha less than the record yield of 1977. The barley yield of 3170 kg/ha, was about the same as in 1977, despite unfavourable weather.

VARIETIES

Almost all the wheat area in recent years has been sown with modern, short and medium height varieties. The most widely grown wheat varieties in 1978 were:

Dacia, Rumanian variety, selected from the cross Bucuresti 1/Skorospelka 3 b, released in 1970, on about 35 per cent of the area.

Bezostaia 1, Russian variety, introduced in 1961, on about 15 per cent of the area.

Iulia, Rumanian variety, selected from the cross Belotzerkovskaia 198/Bezostaia 1, released in 1973, on about 12 per cent of the area.

Libellula, Italian variety, introduced in 1971, on about 9.5 per cent of the area.

Ceres, Rumanian variety, selected from the cross Mitchurinka/Bezostaia 1, released in 1973, on about 4.5 per cent of the area.

Ileana, Rumanian variety, selected from the cross Orofen/Skorospelka 3 b, released in 1974, on about 4 per cent of the area.

The new Rumanian varieties Turda 195 (released in 1971), Silvana (released in 1975), Potaissa (released in 1976) and Montana (released in 1976), were grown on a smaller but increasing area.

First quantities of commercial seed were produced for the new bread wheat varieties released in 1977: Doina (from the cross Etoile de Choisy/Monon) and Lovrin 24 (from the cross Lovrin 10/Lovrin 62) and also for the first Rumanian semidwarf winter durum variety Topaz released in 1977.

It is hoped that Topaz, selected from a cross between a Mexican spring semidwarf material and a local population of winter durum, will provide a new start to durum wheat in Rumania.

Almost all the barley area was sown with the Rumanian short, high yielding variety Miraj, released in 1974. A new Rumanian malting barley variety Victoria, with short stem and high yields, released in 1977, is under multiplication.

Although spring wheat cannot compete with winter wheat in Rumania, and therefore CIMMYT wheats are not usable as such in wheat production, CIMMYT activity has been most useful in the development of wheat breeding.

Both bread wheat and durum wheats originated by CIMMYT and its predecessor organization were extensively used in crosses, with remarkable results. The winter durum variety Topaz and most of the advanced durum lines possess dwarfing genes derived from Mexican germ plasm. Many lines of bread wheat, from crosses including Mexican varieties (Nadadores 63, Yecora 70, etc.) are in final testing and are considered promising.

SPAIN

AREA AND PRODUCTION

The area and production statistics for bread wheat, durum wheat, barley and triticale are shown in the following table:

Season 1977-78	Area (1000 ha)	Production (1000 t)
Bread wheat	2,800	4,500
Durum wheat	85	180
Barley	3,300	7,900
Triticale	1	1.5

IMPORTS AND EXPORTS

Imports amounted to 200,000 t of durum wheat and 500 t of barley. Exports were 35,000 t of bread wheat and 3,000 t of barley.

CLIMATIC CONDITIONS

Generally, the 1977-78 season was good and normal for winter cereals. There were, however, excessive winter rains in the Extremadura region, where low winter temperatures continued for longer than normal. All this adversely affected cereal production in the region and favored the occurrence of root rots and several other diseases. With this exception, the weather was normal in all other cereal producing regions in Spain.

FERTILIZERS

The supply of nitrogen and complex fertilizers was normal, with some slight problems in the supply of superphosphate. However, cereal production was not limited. The rates used vary widely according to weather conditions and soil fertility in the different regions.

There are some indications of minor element deficiencies in some regions, but they are not yet important limiting factors to production.

FACTORS LIMITING EXPANSION OF CEREALS

The fundamental problem is that of weeds especially wild oats *(Avena fatua* and *A. sterilis)* and Vallico *(Agropyron* sp). These weeds proliferate greatly when cereal monoculture is practiced without crop rotations.

DISEASES AND PESTS

Two diseases which economically affect cereal production in Spain, with varying intensity in the different regions are yellow rust and *Septoria.* In regard to insects, two genera *Aelia* and *Eurigaster* severely damaged cereals in the Duero region and in Andalusia. Good control measures do not exist.

SEED INDUSTRY

The seed industry in Spain is basically private, but its development and capability for research. processing and distribution of varieties, is variable.

There is a co-existence of multinational enterprises, which possess a high capacity and technology, and other organizations of modest means and distribution capability.

SENPA (the National Service of Agrarian Agricultural Products) is an organization for government intervention in the market. It can provide farmers with a special type of seed, defined in the legislation as habilitated seed.

This fact and the limited capability of the organizations in charge of research and development of new high yielding well adapted varieties, has resulted in many varieties staying in production for a longer time than their useful life. Nowadays there is a new thrust in research, both by government and private organizations.

In both the medium and long term future, this thrust is expected to see new germ plasm become more readily available, better distributed and increasingly grown by farmers.

VARIETIES

Nowadays high yielding bread wheat varieties are making an important contribution to production. Efforts are being made to enlarge the cycle of these varieties, which is now quite short for the Central Plateau—the main cereal production area in Spain.

The main varieties under production are of Spanish origin, plus some varieties of Italian, French and Mexican origin, in that order. These varieties have a varying useful life of 10-25 years for the older ones, and 8-15 years for the most recent varieties.

High yielding durum varieties are not very important and will not be important if the same problem is not solved.

Barley varieties are mainly of European origin, but have been improved and adapted to Spanish conditions. Their life is 5-15 years.

PRODUCTION PRACTICES

Most of the crop is planted in the fall (November-December), although it all depends on climatological conditions. The remainder is planted from mid January—late March, i.e., winter-spring plantings.

The crop is harvested from late May for the early barleys in the South, to the end of August for late barleys and wheats in the Northern sub plateau.

GRAIN END USES

Bread wheats are used for bread making, cookies and cakes. Durum wheat is used for semolina and pasta. Triticale, which is an imported crop so far, is also used for forage.

Barley is used as a feedstuff; about 10 per cent of barley production goes for malting purposes. The industrial use of rye is mainly for integral bread making; a high proportion is used as forage.

SWEDEN

AREA

The areas sown to winter wheat, summer wheat, barley and triticale are 250,000 hectares, 50,000 hectares, 60,000 hectares and nil respectively.

IMPORTS AND EXPORTS

The wheat figures are 10,000 tonnes imported and 800,000 tonnes exported. Barley exports range from 50-100,000 tonnes.

CLIMATE

Sweden is situated in the nordic temperate zone. Hence, the climatic conditions are variable. The planting times are August—September for winter wheats and March—April for spring wheats.

Wheat heads around July 1 and barley around June 20.

Maturation is from the end of August to the beginning of September.

The number of sun hours during the season (March—Sept) is 1900, the average annual rainfall is 400 mm and the average temperature is 10°C.

Limiting climatic factors are the uneven distribution of temperature and rainfall, while the main disorders are temporary droughts and excess precipitation during harvest.

FERTILIZERS

The units used are N, P, K and are 90, 22 and 40 respectively, per hectare.

The production of varieties with more efficient nutrient uptakes, is currently under discussion. Economical and environmental factors may impose limitations on fertilizer usage.

DISEASES

The important wheat diseases are mildew, *Septoria,* take—all and *Fusarium spp.* Barley is attacked by mildew and nematodes.

SEED INDUSTRY

It is very advanced and fully operational.

PRINCIPAL VARIETIES

The following winter wheats are now in production: Hildur, Holme, Solid, Starke II and Walde. The summer wheat varieties being grown are Amy, Drabant and Pompe.

The barley variety list consists of Akka, Alva, Eva, Gunilla, Ingrid, Mona, Prisca, Rupal, Yalka, Yalve, Simba Yärla, Tellus and Welam.

PRODUCTION PRACTICES

The Swedish Agricultural University is involved in agronomic studies on programmed production with the application of fertilizers and chemicals.

CROP UTILIZATION

One third of the wheat crop is used for human consumption. The remainder is exported or occasionally utilized as fodder. About 95 per cent of barley is consumed as fodder, and the balance goes to beer production.

RESEARCH

Recognized potential fields for researching are nutrient uptake, physiological response to the environment, drought resistance and disease resistance.

INTERNATIONAL SUPPORT

The distribution of CIMMYT germ plasm is considered to be essential; likewise the exchange of ideas or scientific results from appropriate international centers.

SWITZERLAND

In spite of its relatively small surface (41,000 km^2), Switzerland has a great climatic heterogeneity, due to the mountainous topography. Annual rainfall varies from 500-2000mm, according to the region. The annual range of temperature varies considerably just as the period of snow cover. Twenty five per cent of the national territory (10^6 ha, not taking into consideration 600,000 ha of pastures in the mountains) is used for agricultural purposes.

The main production is herbage crops for dairy cattle. Arable land includes only 260,000 ha of which 180,000 ha are planted to bread cereals (wheat, rye and spelt wheat) and forage cereals (oats, barley and maize). Actually, the production of bread cereals is considered to be sufficient; on the other hand, forage cereals cover only 20 per cent of the country's needs.

PLANT BREEDING

Wheat breeding is orientated towards greater yield stability and better baking quality. Maize breeding is also carried out to improve its adaptation to the climate. The national agricultural plan provides for a decrease in herbage production and for an increase in grain forage cereals.

TRITICALE

The aims of the triticale breeding program are for high yields, good protein quality and wide adaptation to the particular climatic conditions of the herbage crop area, i.e. sprouting and lodging resistance in humid regions and adaptation to cold and snow cover areas.

Octoploid triticale

The triticale program started in the fifties with the creation of primary octoploid triticale. The first aim was to improve the fertility, which was achieved for the greatest part by the use of a Japanese line, Kyoto 17. In the sixties, yields of 30 q/ha were obtained in agronomical trials, but the plants were very tall.

Lodging resistance was improved by hybridization and mutagenic programs, without a significant increase in yield. Actually, a collection of 180 octoploid triticale lines is being kept. Their fertility is good, but must be maintained by severe plant selection. Chromosomal instability is very well-marked and is at the origin of the loss of fertility during seed multiplication. The octoploid triticales at the Federal Agricultural Research Station, Changins are used only as cross parents in the selection program of hexaploid triticale.

Hexaploid triticale

The breeding program, which started five years ago, is orientated only towards winter triticale. Agronomical trials with the most advanced European lines have shown that the yields come close to those of wheat and rye, but the yield potential can be fully expressed only in dry areas. Under humid conditions, early lodging, sprouting and grain shrivelling cause important yield decreases. Furthermore, some lines lack winter hardiness. The aim of the selection of hexaploid triticale is therefore to improve the possibility of adaptation to the marginal conditions existing in Switzerland.

Each year 200-300 new combinations of the types Tc 6x. Tc 6x, Tc 8x. Tc 6x and Tc 6x. soft wheat, are realized. The capacity to adapt to Swiss climatic conditions can be reached by combining hexaploid triticale with soft wheat, octoploid triticale of the research station's collection, and European hexaploid triticale.

Another important source of genetic material, especially for disease resistance genes and dwarfing genes, is the material received each year from CIMMYT (Crossing Block and F_2 Bulk Winter Triticale).

The means to conduct triticale research in Switzerland are very limited. Selection is carried out only in one institute.

Fixed lines only are tested under other conditions viz., in the rusts and *Septoria* nurseries of Zurich, at a station at 1100 m above sea-level for resistance to snow cover, and also in growth chambers for testing cold resistance.

Agronomical trials are carried out at different locations in the country. Protein composition is analysed for the most advanced lines. Because hexaploid triticale research in Switzerland started only five years ago, it is too early to consider the actual results as being final. It is interesting to note that the best lines have already reached the yield level of wheat.

Green forage triticale

Besides being used as forage cereal, which is the actual selection aim in Switzerland, it seems that triticale can be very useful as green forage. Intercropping with a mixture of rye and vetch is a common practice during winter. Agronomical trials have shown that triticale could advantageously replace rye in the mixture. Triticale grows more rapidly in spring, its dry matter yield is more important and the nutritive quality of the forage is superior. Should the 1979 trials confirm the former results, farmers could be recommended to use triticale as green forage crop.

YUGOSLAVIA

Dr. Slavco Borojevic (left) and Dr. Glenn Anderson (right) CIMMYT, discussing improved material in an increase field near Novi Sad, Yugoslavia.

AREA

Winter wheat is grown annually on about 1,800,000 hectares. Spring wheat is grown on less than 50,000 hectares, while durum wheat is grown only on a few thousand hectares in southern Yugoslavia (Macedonia).

Barley is grown as winter crop for feeding (6–rowed) and as spring crop for beer making (2–rowed). The total area is about 300,000 hectares.

Triticale is not grown in large scale production, but some CIMMYT varieties which gave good yields in small plot trials, are being tested in large plot trials on the state farms.

EXPORTS

By increasing the average yield three times during the past 20 years (in 1957 it was 1.1 t/ha, and in 1977 3.5 t/ha), Yugoslavia has become self sufficient in wheat production and in some years it may have some for export.

The following table shows wheat production statistics and principal varieties for the period 1930–1977.

Year	Area in 000 hectares (ha)	Grain yield (t/ha)	Principal Varieties and country of origin
1930-1939	2.140	1.1	Maks. Prolifik (Yug.)
1947-1951	1.802	1.2	Korićeva–U–1 "
1952-1957	1.900	1.2	Bankuti–1205 (Hun.)
1958	1.990	1.2	
1959	2.130	1.9	San Pastore (Ital.)
1960	2.060	1.7	Abbondanza "
1961	1.960	1.6	Leonardo "
1962	2.130	1.7	Etoile de choisy (Fran.)
1963	2.140	1.9	
1964	2.100	1.8	
1965	1.680	2.1	Bezostaia–1 (USSR)
1966	1.830	2.5	Kavkaz "
1967	1.880	2.6	Aurora "
1968	2.010	2.2	
1969	2.019	2.4	
1970	1.831	2.1	Libellula (Ital.)
1971	1.929	2.9	
1972	1.924	2.5	
1973	1.697	2.8	
1974	1.842	3.4	Sava (Yug.)
1975	1.615	2.7	Zlatna Dolina (Yug.)
1976	1.723	3.5	Novosadske rane "
1977	1.609	3.5	Partizanka "

CLIMATE

Climatic conditions for growing small grains in general, are favorable. Total rainfall per year in wheat growing regions is 600–800 mm, or 400–600 mm during the wheat vegetation period.

FERTILIZERS

Their use has been increased many fold compared with 20–30 years ago. Average dose used on the state farms is 120 kg/ha N, 90 kg/ha P_2O_5 and 60 kg/ha K_2O. Many private farms (small holdings) apply 60–100 kg/ha N.

PRODUCTION PLANS

Since high yields are already achieved on a national level, the plan is to decrease the area under wheat and to increase the average yield still further so as to produce at least 6 million tonnes per year. Industrial crops, such as sunflower, sugar beet, vegetables, etc. are taking hectares from wheat and other small grains.

DISEASES

By increasing the density to 600 spikes/m^2 and more, the disease situation has become more serious, particularly in regard to attacks by powdery mildew and *Fusarium spp.* In 1975 and 1978, grain yield was reduced due to the attack of *Fusarium* on spike, by 20–30 per cent. No sources of resistance to *Fusarium* have been found.

Insect problems are rare.

SEED INDUSTRY

Seed production is well organized. The breeder seed (elite seed) is produced by institutions which develop varieties, while original seed and certified seed (first reproduction) is produced at state farms which specialize as seed growers. The seed is distributed to farmers through the seed enterprises.

All is done under contract among the organizations involved and each one shares in the profits. Due to such organization, a prospective variety may become a leading variety (up to 60 per cent) during four years, after its registration by the Federal Commission for Variety Approval.

HYV

High-yielding varieties of wheat have been grown since 1958. In 1970, low yielding varieties were completely removed from production and since 1975, high yielding varieties developed by Yugoslav research institutes have completely replaced Italian and Russian varieties.

PRINCIPAL VARIETIES

Principal varieties in production in 1977/78 were Sava, Novosadska rana 1, Novosadska rana 2, Drina, Biserka, Partizanka, all developed by the Institute for Field and Vegetable Crops, Faculty of Agriculture, University of Novi Sad, and varieties Zlatna dolina and Sanja developed by the Institute for Crop Production and Plant Breeding, Faculty of Agriculture, Zagreb.

There are several promising new lines which surpass Sava and Zlatna dolina in yield and quality.

PRODUCTION PRACTICES

As a result of growing new high yielding varieties and good agricultural practices on many farms, record yields are obtained up to 9 t/ha. On large estate farms, Sava has yielded as much as 9600 kg/ha while on small private farms, NS–rana 2 has given the highest yield, viz 9300 kg/ha.

Sowing is done in October and harvest in July. Last year, agricultural practices were improved in seed preparation, and increasing the rate and better distribution of nitrogen as a top dressing.

CROP USES

Wheat is used primarily for bread and other products for human consumption. When wheat prices are lower than for maize, some wheat is used for feeding. Straw is used as a litter for animals or is burned.

RESEARCH

Investigations have shown that semidwarf varieties (60–80 cm culm length) have the best ratio between the source and sink capacity. When optimal or near optimal canopy is obtained for each variety, differentiation among varieties comes through the number of kernels per spike and not through any green area parameters. To make further progress it is essential to increase the sink capacity, first by increasing the number of kernels per spikelet.

INTERNATIONAL SUPPORT

Cooperation with CIMMYT has been very fruitful, encouraging and has brought new ideas for national breeding programs.

Middle East

IRAQ

AREA AND PRODUCTION

In 1977-78, wheat was planted on 1,590,250 hectares of which 1,495,650 ha were harvested to produce 909,800 tonnes at an average yield of 608.4 kg/ha. These statistics indicate an eight per cent area increase and a 31 per cent yield increase, over the previous year.

Barley was planted on 775,450 ha from which 714,325 ha were harvested which yielded 617,200 tonnes at an average yield of 864 kg/ha. The sown barley area decreased 3.3 per cent and the production declined by 35 per cent, relative to the 1976-77 season.

IMPORTS

Nearly half a million tonnes of wheat and barley were imported.

CLIMATE

The climatic conditions were somewhat dry. Below normal rains were received both in the rainfed and irrigated areas.

FERTILIZERS

About 100,000 hectares of wheat were fertilized with nitrogenous and phosphatic fertilizers using some 10,000 metric tons of N and 6,000 tons of P_2O_5. This area was located in the irrigated and high rainfall areas. Barley is normally not fertilized because of lodging. With the development of semidwarf varieties, the situation may change.

MAJOR PROBLEM

Salinity is the major problem in the Middle and South of Iraq where the main irrigated area is situated. Several government projects are under way for the reclamation of these areas. The situation will improve once these areas are reclaimed. Simultaneously, efforts are being made to find salt tolerant varieties for such conditions.

In the relatively good irrigated lands, the improved wheat and barley varieties occupy the major area. In the rainfed areas of the North, the uncertainty of the rainfall amount and distribution is posing a problem to the expansion of new varieties. Here efforts are being concentrated on the development of drought resistant varieties of both crops.

DISEASES AND PESTS

Due to low humidity in the irrigated areas of the middle and southern regions as well as the low rainfall areas of the north, there were no serious diseases. However, in the high rainfall area of the north, rusts (leaf and yellow) and smuts (both covered and loose smut) caused some damage to the two crops. In the wheat and barley breeding program, emphasis is being placed on the development of resistant varieties to these diseases.

Green aphids are becoming a problem on both wheat and barley in irrigated and well fertilized conditions. Control of the aphids through suitable insecticides is now very essential in order to get good yields.

SEED INDUSTRY

The seed industry is conducted by the government and is developing gradually. Every year about 20 per cent of the wheat and five per cent of the barley area is renewed with improved seeds of the two crops. Last year about 25,000 tonnes of certified seeds were produced.

HYV

The high yielding varieties of wheat and barley occupy the major area in the irrigated (92 per cent) and high rainfall (70 per cent) regions. In the case of barley, the high yielding varieties are grown over one third of the total barley area in Iraq.

VARIETIES

The principal varieties are:

Bread wheat: Mexipak, Inia 66 and Abu–Ghraib 1.
Durum: Jori C69 and Cocorit C71

Because of the dry weather conditions in the irrigated areas of the middle and south Iraq, there was only a slight attack of leaf rust on Mexipak and therefore it is still giving good results.

Barley: Six row—Numar, CM 67 and Arivat
Two row—Clipper, Weah and Prior

PROMISING MATERIALS

The following lines/varieties are of special interest:

Bread wheat: Abu Ghraib 3, Araz, Abu Ghraib 4, Nuri 70 and SA 42.

Durum: Gerardo 574 and Stork 'S'
Barley: Six row—Giza 121, Minn 126 and M67-U-Sask
Two row—Several lines are being tested.

AGRONOMIC RESEARCH

Experiments being conducted by the Cereals Division were the effect of N fertilizer application at different timings on yield and quality of Mexipak; the effect of different doses of N P K fertilizer on yield and quality of Mexipak; the effect of different doses of N and P on yield and quality of Mexipak (rainfed area); the effect of different doses of N P K fertilizers on yield and quality of the wheat variety Nuri 70 (rainfed area); the effect of urea (soil and foliar application) on yield and quality of Nuri 70 (low rainfall area); wheat rotations; the effect of different doses of N and P fertilizer on yield and quality of barley varieties, Giza 121 and Arrivat; the effect of different doses of N and P fertilizers on yield and quality of barley variety Clipper and the effect of cutting on the forage and grain yield of barley.

PRODUCTION PRACTICES

The wheat crop is sown from mid October—mid December and harvested from mid April to the end of June, in different areas in the country.

CEREAL USAGE

Bread wheat grain is used for bread, biscuits and cookies. Durum goes into macaroni, spaghetti, pudding, bulger and many breakfast foods.

Barley enters the food, feed and beer industries. To date special varieties have not been developed for fodder purposes.

NURSERY EXPERIMENTS

A huge amount of breeding material is being handled annually. The following international nursery experiments were conducted during the year:

International Winter x Spring Wheat Screening Nursery
1st Elite Barley Yield Trial.
11th International Bread Wheat Screening Nursery.
8th International Disease Screening Nursery.
Crossing Block—Bread Wheat.
8th Regional Barley Yield Trial (2 sets).
7th Preliminary Barley Observation Nursery.
9th Regional Wheat Yield Trial.
7th Preliminary Observation Nursery—Durum Wheat (2 sets).
6th Regional Wheat Yield Trial.

INTERNATIONAL SUPPORT

The cereal improvement programs would benefit from staff training in breeding, agronomy, pathology and laboratory operations. In addition, samples of already tested machinery for planting, weeding and harvesting would be invaluable to receive and to use.

ISRAEL

AREA

In 1977-78, the total area sown to wheat was 64,000 hectares, which was 13.7 per cent less than the previous year. The decline in the north was 25 per cent. As a result, wheat in the south occupied 72 per cent of the total area as compared with 66 per cent in 1976-77.

PRODUCTION

The 1977-78 winter was very dry in the Negev and in part of the Lakhish area, resulting in a total or partial loss of about 25,000 ha. Damage was estimated at 65,000,000 Israeli pounds of which less than half was covered by indemnifications. In the north, very high yields were harvested in many fields. The national average yield was 2,250 kg/ha. Total production reached 160,000 tonnes which represented 31 per cent of the 1978 wheat consumption (510,000 tonnes).

VARIETIES

As in 1976-77, the most important varieties were Lakhish, Miriam and Cee-on. The sown area percentages were:

	1976-77	1977-78
Lakhish	36	44
Miriam	34	33
Cee-on	23	11

The newly released variety Hazera 895 occupied more than 6 per cent as against less than half a per cent in 1976-77. It is a few days earlier than Miriam, and about 10 cm shorter. It has very high yield potential. Almost 9 t/ha have been harvested at one of the Hazera farms. It is susceptible to yellow rust. Its yield and test weight were unfavourably affected in yellow rust infested fields. However, even under those conditions, in several cases it still outyielded all other commercial varieties.

The new variety Barkay, released by the Agricultural Research Organization (ARO), also performed well. It is a few days earlier than Hazera 895, but seems to be slower ripening. It has shorter straw than Hazera 895, and therefore does not compete well with weeds. Both new varieties have good baking quality.

VARIETY LISTS

The two official variety lists viz., List of Varieties Admitted for Sale and the List of Recommended Varieties, have been united into the Israel List of Varieties. Eligible for inclusion in this list are all agronomically acceptable, protected or non-protected, locally bred or introduced varieties or any crop, of which seeds are to be produced and/or sold in Israel for home use or export.

There is no change in procedures for acquisition or recognition of breeder's rights.

Measures are being taken to adjust seed production and to control schemes to the rules prescribed by international organizations (UPOV, Assinsel, OECD).

PLANT BREEDING

In the bread wheat breeding programs, emphasis is on early maturity, medium (semidwarf) height, resistance to stripe and leaf rusts and to *Septoria* leaf blotch, and good baking quality. The *Septoria* research program at Tel-Aviv University provides breeders with sources for resistance and/or tolerance. In the last few years, *Septoria* has posed less problems than previously, probably because most of the wheat area is being planted to varieties having some tolerance.

Several of the most advanced lines in the ARO program have H-574 as the *Septoria* resistance source. Recently, varieties combining *Septoria* resistance with resistance to rusts are forthcoming from the Tel-Aviv program for inclusion in C.B.'s.

Among the highest yielding varieties in Hazera's preliminary and advanced yield trials were Blue Jay types and selections from Blue Jay derived crosses. A disadvantage is their relative lateness. From Hazera crosses, several considerably earlier heading lines with promising yield potentials, have been selected.

WHEAT PRICES

A three-year contract between the Field Crops Growers Association and the Ministry of Commerce and Industry signed in the spring 1978, guarantees a minimum price approximating 140 U.S. dollars per ton for locally produced bread wheat for 1978-1980. The price is based on average cost of import of U.S. No.2 HRW. Only good quality varieties are going to be accepted.

At the present yearly inflation rate of about 40 per cent and devaluation of the Israeli pound to the U.S. dollar of less than 10 per cent, net return of wheat production is declining, which makes an agreement on income stabilization necessary.

PROTEIN

In preparation for the eventual payment of premiums for high protein content, every wheat load delivered in 1978 was sampled. The survey showed great fluctuations within varieties and between localities. The only correlation detected between protein content and growing conditions, was a negative effect of irrigation.

Generally, protein contents were high, with a few peaks reaching about 17 per cent. There seems to be no justification for premiums to be paid and there is apparently no direct and urgent need for breeding for higher protein content. However potentialities for the incorporation of high protein materials, both from local origin *(Triticum dicoccoides* at the Weizmann Institute and at ARO) as well as from introductions (Nebraska) in current breeding programs, exist.

DURUM

It is being bought from producers directly by consumers, i.e. the macaroni industry. Its economic possibilities depend on yield and quality. ARO has released a new variety, Inbar, the quality of which has been accepted by industry.

It heads 7-10 days later than Miriam. Hazera started multiplication of the new durum variety Hazera 870. It is almost as early as Hazera 895 and its yield potential is high (a yield of more than 8,000 kg/ha has been harvested). However, it has unacceptable industrial quality. It may be attractive to Arab farmers (pitah).

FEED GRAINS

Israel's yearly imports of feed grains (barley, maize and sorghum) are about 1.2 million tons, which represent 95 per cent of its needs. Home production of feed grains is limited to a few thousand hectares of barley and sorghum.

Barley breeding programs are being conducted at ARO, and at the Weizmann Institute. Their scope is very limited in accordance with the present economic importance of the crop. The Weizmann Institute released Ruth, a 2-rowed early maturing, net blotch and mildew resistant variety, designed for marginal rainfall areas in the south, where it outyields considerably the variety DVIR, a selection from local 2-rowed barley.

Feedgrain production may become important again in the south as an alternative to bread wheat when suitable varieties of barley or triticale could be produced. The Weizmann Institute has several promising barley lines in yield trials. It has started a program to incorporate leaf rust resistance.

TRITICALE

The triticale materials in the ARO and Hazera breeding programs are all of CIMMYT origin. High yielding selections have been identified, as well as very early heading types, but even those are not maturing early enough.

PRODUCTION TRENDS

Agricultural production is being intensified in field and other economic crops.

In most of Israel, farmers have expanded irrigated cotton production because of its high net return. Wheat grain/cotton double cropping is not possible with the present commercial wheat and cotton varieties, although current wheat varieties are considerably earlier maturing than former ones.

There is some experimentation with wheat/cotton intercropping as well as the search for still much earlier wheat varieties. There are suggestions for a three-crop rotation, including Acala-type cotton, Pima-type cotton (earlier ripening than Acala) and wheat to be planted about one month earlier than usual.

There is also a shift in winter fodder production from green fodder to silage. As a result, the area of wheat planted for silage is steadily growing, at the expense of wheat grain production.

With rising costs of irrigation water, wheat production with supplemental irrigation is decreasing.

PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

Wheat was hervested by hand in the early period of the wheat improvement project in the People's Democratic Republic of Yemen.

WHEAT AREA AND PRODUCTION

The following statistics show the data from 1976 and provide projections to 1984:

	1976-77	1977-78	1978-79	1983-84*
Area (ha)	6520	6359	6670	8125
Production (tonnes)	9114	8143	9710	19012

* Projected at the end of 5-Year Plan

Bread wheat is the most common winter cereal grown. Barley is grown on a small area and its importance is decreasing.

The area under wheat has remained almost constant during the past three years with a slight trend towards better production in 1978-79. At the end of the 5-Year Plan (1979-84), the wheat area is projected to increase by nearly 23 per cent and production by nearly 96 per cent over the 1978-79 level. It is anticipated that there will be a better organization of state and cooperative farms and better application of new technology. Wheat is mainly used for making bakery bread.

IMPORTS AND EXPORTS

It is estimated that the present annual wheat consumption is about 84,000 tonnes. The domestic production of wheat in 1978-79 constituted 12 per cent of total requirement. However, in the 5-Year Plan (1979-84) the objective is both horizontal and vertical expansion. At the end of this period, in 1983-84, annual production is anticipated to reach 19,012 tonnes which is nearly 23 per cent of the present wheat demand. In 1978 78,000 tonnes of wheat were imported.

CLIMATE

The nation is located between latitudes of 12°—20°N and longitudes of 42°—53°E, in the south west corner of the Arabian Peninsula. The climate is predominantly arid and tropical to sub-tropical, with hot summers and mild winters. The average rainfall in most

Operations are now mechanized, including the use of combines in harvesting the trial plots.

areas is about 60 mm per annum, except in highland areas, where the average annual rainfall is about 250–300 mm.

Wheat and barley are grown in areas ranging from 500–2000 m elevation. The average winter temperatures in most areas range from 17°C–22°C. The average minimum seldom drops below 10°C, except in highland areas where it may reach 4–6°C.

PRODUCTION PRACTICES

The soils are generally calcareous with sandy loam to silt loam textures. In most wheat and barley areas, the pH ranges from 7.0–8.5.

In the main belt, both wheat and barley are grown under groundwater irrigation from deep tubewells or shallow wells. The number of irrigations varies from 6–9. The crop water requirement is estimated at 3500–4000 cubic m/ha.

Planting is done in late October–November and harvesting starts from the beginning of February. The crop maturity period ranges from 95–105 days. In the highland regions (with very limited area), wheat and barley are grown throughout the year as rainfed and/or groundwater irrigated crops.

The most common rotation followed is:

Wheat (November–February); sorghum/sesamum (March–May); millet/sorghum (July–December); fallow (January–October); wheat (November–February).

Higher temperatures at planting time, mild winter seasons and a short maturity are important climatic factors which limit crop yields.

The seed bed preparation is fully mechanized while planting, weeding and harvesting are mainly carried out manually in the cooperative farms. On state farms, attempt are being made to mechanize these operations including the use of combines.

PRODUCTION PROBLEMS

The following constraints operate against an extension of the area under wheat and increased production:

(a) Limited irrigation water: Being an arid country, the availability and quality of groundwater is the chief limiting factor in the extension of the area under wheat. Further, heavy investments are involved in sinking tubewells. Therefore the expansion of area under crops is slow.

(b) Weeds: They are a serious problem in wheat fields. Most of the weeds are annual broad leafed species. So far, weed control is done manually. Work on herbicides is yet to be undertaken.

(c) Soil and water salinity: About 15 per cent of the wheat area has water and/or water salinity problems. The salinity in irrigation water generally ranges from 5–15 mm hos/cm and affects yields adversely. The investigations carried out show that with water having a salinity of 9.5 mmhos/cm, yield reduction may range from nearly 42 per cent in local cultivars to 76 per cent in high-yielding varieties. Therefore, it is planned to continue cultivation of local cultivars in such areas.

Work on the development of better fertilizer and irrigation practices and to improve local cultivars will be undertaken in future years.

(d) Cost of inputs and pricing system: The optimum fertilizer recommendation is 110 kg N/ha in the form of urea and 56 kg P_2O_5/ha, as triple superphosphate. The total farm-gate price for the recommended dose is about 50 dollars U.S. which is fairly high. Consequently, often the full package is not applied, with resulting losses in production. A fertilizer subsidy along with price incentives for wheat grain could greatly help to improve the situation. At present, there is no subsidy.

Fertilizers are not manufactured, and therefore all types are imported. Usually a sufficient quantity is available in the country.

Micro-nutrient deficiencies have not been noticed.

Sufficient quantities of insecticides are available. However, labour and motorized spraying equipment shortages are often the main bottleneck.

(e) Labour Shortage: Due to a small population and a large labour demand caused by the spur in developmental activities, there is presently an acute shortage of labour in the country. Consequently, quality and timing of agricultural operations, particularly those of labour intensive operations such as sowing, weeding and harvesting, are adversely affected. Work is in progress to mechanize wheat production.

LOCAL CULTIVARS

Most local wheat cultivars belong to *T. aestivum* species. In solitary pockets, a mixture of *T. aestivum* and *T. durum* types is noticed. Local cultivars are tall, non–synchronous in earing and they are susceptible to rusts and lodging. The grains are generally reddish and small. The average 1000 grain weight is about 25 gm.

In barley, local cultivars are a mixture of 2 and 6 row types, with heavy stem breakage at maturity and a high degree of susceptibility to stripe rust.

HYV

In 1973, 13 tonnes of seed of two high-yielding varieties, Kalyansona and Sonalika, were imported from India. Simultaneous trials at the experiment stations and farmers' fields (mainly at state farms) were conducted. A seed multiplication program was also started. The performance of HYVs as compared with local cultivars is given below. Data indicate that the HYVs gave yield increases ranging from 20 to nearly 100 per cent over different local varieties, besides showing superiority in kernel weight and resistance to lodging and rusts.

Comparative performance of Kalyansona, Sonalika and Local Wheat Varieties, Seiyun, 1975/76

Character	Kalyansona	Sonalika	Local Varieties (Range)
Grain yield (t/ha)	3.37	3.86	1.71–2.86
1000 grain weight (gm)	37	56	17–41
Plant height (cm)	81	87	86–104
Days to maturity	89	81	80–107
Lodging per cent	0	0	20–100

In order to accelerate the adoption pace of new varieties and related production techniques, a special programme called the national Crop Production Programme was initiated. This involved the selection of suitable areas for high-yielding varieties, provision of credit inputs, and providing guidance in production practices by research staff throughout the crop season. It led to a rapid increase in sown areas and fairly high yields e.g. 4.0 t/ha.

In 1975–76 and 1976–77, large scale surveys were carried out to determine the yields obtained by farmers with HYVs grown commercially under varied ecological conditions. For Sonalika the grain yield ranged from 2.59–2.61 tonnes/ha and for Kalyansona from 2.04–2.13 tonnes/ha. These are nearly 50–70 per cent higher yields than those obtained with local varieties. Kalyansona and Sonalika are recommended for different regions and the proportion of area under them, is 70 per cent for Kalyansona and 30 per cent for Sonalika.

From a commencement in 1973–74, nearly 37 per cent of the total wheat areas was occupied by HYVs within the first three years. During the next two years, due to a sudden and acute shortage of labour, a lag in the seed multiplication program and steep rises in the cost of production, the spread of HYVs was very much slowed down. It is hoped that with the introduction of increased levels of mechanization, and other corrective measures being undertaken, it will be possible to achieve a target of 5416 hectares, representing nearly 67 per cent of the total wheat area, in 1983–84.

The productivity of HYVs is expected to reach 2.70 tonnes of grain/ha, raising the overall wheat productivity in the country to 2.34 tonnes/ha as compared with the existing level of 1.46 t/ha.

PROMISING MATERIALS

From the materials received from CIMMYT, ICARDA and FAO, three new strains were selected which are now in the final stages of evaluation in farmers' fields. These are, S311 x Norteño-Jit-43-2L; CNO Bb x Cd I/7C/Lib64-Inia x Inia Bb, and LR64-Son 64 x Cc/Ska CM 34093. These have out-yielded Kalyansona and Sonalika by significant margins for the last three years.

The performance of these new strains with Kalyansona and Sonalika is compared, as follows:

Varieties	Grain Yield (t/ha)		Days to maturity		Plant Height (cm)	
	(N)	(E)	(N)	(E)	(N)	(E)
S311 x Norteño Jit–43–2L	3.37	5.69	105	115	79	92
CNO Bb x Cd I/7C/ Lib64–Inia x Inia Bb	3.25	5.92	93	117	65	82
LR64–Son 64 x Cc/ Ska CM 34093	3.25	4.39	91	–	59	78
Kalyansona	2.75	3.91	82	96	65	74
Sonalika	2.50	3.38	89	90	61	76
LSD_{05}	0.34	0.41				

(N) Normal sown 1976-77 (November 15)
(E) Early sown in 1977-78 (October 27)

It will be noticed that under both normal and early plantings, new strains were significantly superior, giving yield increases ranging from 12–15 per cent. Better adaptation of new strains to higher temperatures is a very valuable character in yield stabilization at a high level.

AGRONOMIC RESEARCH

(a) Time of planting and seed rate: From the experiments conducted during the past four years, it has clearly been established that planting in the first three weeks of November, and a seed rate of 156 kg/ha for Kalyansona and 204 kg/ha for Sonalika, are the optima. This high seed rate is required due to the warmer weather in early stages, which depresses tillering, and to the short crop growth period of nearly 95 days.

Experiments have shown that in late sowings, two weeks after normal planting, yield decreased sharply (50 per cent of normal sowing). Even with an increased seed rate and a higher fertilizer dose, no substantial improvement was noticed.

(b) Fertilizer Response: Responses of Kalyansona and Sonalika and the local variety Baftaim to both nitrogen and phosphorus have been measured. A maximum response was found to the combined application of nitrogen and phosphate. In Kalyansona and Sonalika, highest yields of 3.34 and 4.02 t/ha respectively were obtained with a treatment of 165 kg N plus 54 kg P_2O_5. In the local variety, the maximum yield was 2.59 t/ha with a treatment of 110 kg N plus 36 kg P_2O_5.

Based on further experimentation, the present recommended dose is 110 kg N/ha plus 56 kg P_2O_5/ha.

(c) Irrigation requirements: The effect of different amounts of water applied at various levels of soil moisture depletion was studied to identify the practices approaching theoretical evapo-transpiration which would produce a normal yield on a sandy loam soil. The different water quantities applied are given below. It was concluded from these results that wheat may require 3500–4000 m^3 of water/ha, with an additional amount to be given depending upon soil and water salinity.

Effect of irrigation on grain and straw yields

	A	B	C	D
Grains (t/F)	3.86	4.00	3.84	3.48
Stalk (t/F)	10.03	10.51	9.24	9.67
Amount of water applied (m^3)	3760	3990	3340	5300

The treatment differences are non significant.

(d) Mechanization: Mechanization of wheat production is being emphasized. The seed fertilizer drill and combine harvesting were introduced. Initial attempts are encouraging. However, modifications in existing cultural practices will be needed before these machines can be used more efficiently.

DISEASES AND PESTS

Leaf rust is the most important disease which causes severe damage once in every three or four years. HYVs, Kalyansona and Sonalika when planted in November (timely) usually escaped the damage and exhibited a certain amount of resistance. However, in the late plantings, infection reached moderate intensity particularly in plantations close to or inside date groves where the temperature is lower than other areas and humidity is high. Now, Kalyansona and Sonalika isogenic resistant lines received from IARI in India, are under test.

Aphids, termites and seedling weevil (which cuts the growing shoot) are the main pests on wheat. Aphids are the most serious and the extent of their damage depends on the temperature during the wheat growing season and the time of planting. Higher temperatures during crop growth and early or late plantings lead to heavy infestations. This pest attacks local as well as introduced varieties. It was successfully controlled with Dimethoate (Roger 40) insecticide.

Termites and seedling weevil occur in isolated areas, and in individual fields damage may be high. They are controlled with Dieldrin-50 at the first irrigation.

Shootfly also attacks wheat in the first 4–6 weeks causing damage to the crop. The distribution of this pest is restricted. It is more severe in late sown crops (December). It has been found to be effectively controlled by a seed treatment with Furadan.

SEED INDUSTRY

In the initial stages, seed multiplication of high-yielding varieties was carried out by the Research Centre. In 1978, an FAO Project viz., the Establishment of a Seed Development Programme in PDR Yemen, was started to undertake production, processing and marketing of certified seeds of cereal and other crops. In 1977 and 1978, 270 tonnes of seed of Kalyansona and Sonalika were imported from India. It is hoped that starting 1979, the country will be able to meet its own demand for seeds of high-yielding varieties of wheat, which presently ranges from 600–700 t/year and is estimated at nearly 1000 t in 1983–84.

INTERNATIONAL COOPERATION

The present system of distributing international nurseries serves a very useful purpose. PDR Yemen would like access to the diverse and wide germ plasm being generated by CIMMYT. Visits by national program leaders during the growing season to international centers like CIMMYT and ICRISAT, would be beneficial.

It is proposed that herbicide trials with important HYV's be cooperatively conducted in different regions, where appropriate facilities exist.

An annual publication reporting various fields of wheat research would help national programs.

SAUDI ARABIA

INTRODUCTION

Work on wheat variety testing started in 1965 at various research stations and high yielding varieties were selected. The availability of new high yielding varieties and the application of advanced wheat production technology made it possible for the Ministry of Agriculture and Water to initiate wheat improvement programs in 1971/72.

These programs continued with adaptive research on introduced wheat varieties. Demonstrations started on farmers' fields with the adapted high yielding variety

Super X, plus all the required recent production methods from preparation of land until harvest. The average yield of the demonstration fields is about 4 t/ha.

Inspection for off-types in these fields is carried out. Thus the grain produced can be used as high quality seed.

AREA AND PRODUCTION

Wheat is the second most important cereal crop after sorghum in Saudi Arabia. The annual area is about 74,000 hectares and grain production is about 93,000 tonnes.

The average grain yield of local varieties is about 1.5 t/ha.

IMPORTS

Saudi Arabia annually imports about 320,000 tonnes of wheat grain and flour.

FERTILIZERS

There is a fertilizer supply for the important provinces that grow wheat. The doses applied to wheat are 120 kg N and 80 kg P_2O_5 per hectare.

Indirect subsidies are offered on fertilizer, seed and farm machinery. Direct subsidy was also paid on the grain produced.

PROBLEMS

Water resources are a major factor precluding wheat expansion. A relatively low yield of wheat may be due to:

(a) A large portion of the wheat area is cultivated with local low yielding and disease susceptible varieties.
(b) About 20 per cent of the area depends on a rainfall that fluctuates considerably from one season to another.
(c) Shortage of high yielding and drought resistant cultivars in rainfed areas.

DISEASES AND PESTS

Rusts seem to be serious diseases in the cold and high humidity regions. Aphids represent a slight problem in some season.

SEED INDUSTRY

A seed multiplication program started in 1975/76, and about 270 tonnes of certified seed were produced. For 1977/78, the certified seed production reached 700 tonnes which were distributed to farmers through the wheat passed from one farmer to another.

A seed cleaning plant was established by the Ministry of Agriculture and Water to promote the seed industry. This project aims at cleaning wheat and other cereal seeds. It also applies chemical dressings for the control of diseases or insects.

HYV

High yielding varieties recently developed by the wheat project represent a rather significant percentage of the current production. Their area is expanding gradually. It is expected to produce 1500 tonnes of certified seed in the 1978/79 season.

VARIETIES

The principal varieties of bread wheat grown in farmers' fields are Super X (released in 1971/72) and Arz–MY 54E–LR x H 490 ILR 64 (released in 1976/77). The most promising varieties/ lines of bread wheat are S 331 x Norteño, Jit 43–2L and 7C–On x Inia B. Man 128428–8Y–1Y–0M.

PROMISING MATERIALS

Promising varieties of durum wheat are Jori 69 (released in 1975/76), Stork "S"/CM 470–1M–2Y-0M and Plc 'S'–Cr'S'/Mca'S' x Pg'S'–Cr'S' MCA'S' x Pg'S' Para 66/270. CM–1800–1B–3M–7Y.

PRODUCTION PRACTICES

The optimum sowing period ranges from mid November to mid December. A seed rate of 120 kg/ha is considered optimum. The harvesting period commences in early April.

Agronomic and irrigation research are being conducted in various stations in order to increase yield. This includes water requirements, rates of fertilizer and time of application, date of sowing and the chemical control of weeds in wheat fields.

The production of wheat is limited in Saudi Arabia by important environmental factors which cannot be entirely controlled by agricultural methods. These factors include high temperature and drought. It is important to develop high yielding varieties under these climatic conditions.

WHEAT CROP USAGE

Both bread and durum wheat are used for human consumption.

BARLEY

A barley program was started in 1974/75 to increase overall production. Efforts are now underway to strengthen the present program to reach this target by identifying suitable disease resistant/high yielding varieties for both irrigated and rainfed areas. In addition, the proper agronomic practices for optimizing grain production economically are being investigated.

Barley occupies only about 10,000 hectares annually, which produce about 12,000 tonnes. There is a high consumption of barley by dairy farms which require about 20,000 tonnes to be imported annually.

Fertilizer is applied at 100 kg N and 60 kg P_2O_5/ha.

Important barley diseases are rusts, *Helminthosporium sp.* and covered smut.

Beecher and Giza 121 varieties were included in the national Seed Multiplication Program.

Barley is grown for green forage or for grain for feed purposes. In the irrigated areas it is sown from November–mid December at 120 kg/ha. Harvest is from March–April. In the rainfed areas, seeding at about 150 kg/ha takes place from October–December. Harvest is during March–April.

Because of the greater profitability arising from the application of irrigation water to vegetables and alfalfa, the only potential area increase for barley production is in rainfed regions.

TRITICALE

The main objective of research work is to compare the new triticale varieties with commercial wheat varieties. International Triticale Nurseries planted in some research stations indicated that the variety/line x 2802–38N–2M–6N–1M–0Y–4B–0Y with an average yield 5.7 tonnes/ha, out yielded the local check wheat variety.

INTERNATIONAL SUPPORT

Saudi Arabia could be further assisted by being supplied with wheat varieties suitable for arid and semi arid environments.

YEMEN ARAB REPUBLIC

AREA AND PRODUCTION

Wheat production was approximately 52,000 tonnes raised on about 50,000 hectares, of which 99 per cent was bread wheat and one per cent was durum.

Barley was grown on 68,000 ha and it yielded nearly 75,000 t. Triticale is under test, but it is not yet being grown commercially.

IMPORTS

Accurate figures are not available. It is estimated that local consumption is about 200,000 tonnes per annum. It is increasing rapidly. There is no macaroni industry in the country and consequently imports are from 150-200 tonnes per annum.

CLIMATE

For the 1978 season, climatic conditions generally favored production and farmers obtained a good harvest.

FERTILIZERS

They have been recently introduced and they are becoming widespread in the provinces where agricultural research work has been conducted with successful results. The benefits are being conveyed to farmers by demonstration plots and field days conducted by the extension service.

The recommendations for HYV under irrigation or high rainfall are 100 kg N/ha and 80 kg P_2O_5/ha. In low rainfall areas, the rates drop to 70 per cent of these recommendations. For barley, 60 kg N/ha for high rainfall areas and 40 kg N/ha are the rates advocated. Triticale responds to the same rates as recommended for wheat.

Fertilizers are not in short supply and they are not subsidized.

PRODUCTION PROBLEMS

There are several problems which are restricting an expansion of cereal areas and yields. They include:

1. Poor genetic potential of indigenous material. This will eventually be overcome by the distribution of the right genotype of HYV's and by improving local material, which will take time.
2. An unpredictable environment consisting of multi micro climatic zones, exists which needs well buffered genotype(s) that are able to maintain productivity at high levels, despite environmental fluctuations.
3. The wheat price policy is affecting expansion of the sown area.
4. Inadequate cultural practices. Weeds are removed by hand. Farmers are not using herbicides.
5. Nearly all indigenous wheat varieties are susceptible to lodging, which reduces yield by at least 10 per cent.
6. There is a lack of agricultural laborers and trained mechanics to operate and maintain machinery.
7. Susceptibility to rusts occurs in the southern uplands, the main durum wheat production area.

DISEASES AND PESTS

The 1978 rainfed summer season was characterized by a low incidence of rusts. Normally yellow rust and stem rust are limiting factors to yield. Powdery mildew was severe. There were no insect problems.

SEED INDUSTRY

A seed production industry which commenced in January 1978 and produced between 100-200 tonnes of certified bread wheat, is a small government unit lacking finance, facilities and staff. Another project to produce certified barley seed has started.

HYV

The area sown to these varieties is expanding rapidly in respect of bread wheat, but only slowly with barley.

The principal variety in cultivation is Sonalika, which was released in 1976. It seems that it may persist for a longer period.

PROMISING MATERIALS

Potential varieties/lines of bread wheat, barley and triticale are:

Bread Wheat:

Dhumran (name given by farmers) = Alondra 'S'; D 6301-Nai x Weiqui-RM-Cno^2 -chr; CM 11683-A-17-1M-3Y-0M-0Z; Sakha 61 Inia-RL 4220 x 7c/Yr 'S'; Brochis 'S'-CH 5872-B-8Y-1M-2Y-4M-0Y-0Z; We-Cmn 'S'-No 66/zbz CM 8953-E-3m-2Y-1n-1Y-0z; Pavon 'S'; Sakha 7; Inia 66 and Tob-Cno 'S' x Tob-8156/Cal x Bb-Cno.

Barley:

Giza 121; Arivat x LD8; Beecher; Cr 366/13/12 and 2762 x Beecher.

Triticale:

Drira; Beagle; Bacum and Maya-Arm 'S'.

GRAIN END USES

Wheat is used for bread and other home dishes. There is a good standard biscuit industry using special imported wheat flour. Barley is used for animal feed mostly; a small portion is used in bread either in a mixture with wheat flour or straight, by only using the naked barley variety Habib.

TRITICALE

There is hope that triticale may have a future due to its high grain yielding ability (4–5 t/ha under rainfed conditions), plus a good straw harvest. Straw is very important to Yemeni farmers and it provides a valuable economic return.

Most of the varieties/lines tested todate are resistant to the dominant rusts. Farmers are closely watching seed shrivelling and late maturity which is another problem. Bacum, Beagle and some other promising lines are receiving consideration for multiplication in the near future.

AGRONOMY

Applied agronomy technology is based on an adaptive research program, which is examining factors limiting production.

There are two main growing seasons. In the winter season (under irrigation), crops are sown in November-December and harvested in March-April. The second season which is rainfed, is the main season. Sowing is during October-November. Wheat and barley crops can be grown all the year, depending on the locality.

The progress of agronomic research on a sufficiently wide scale is limited by facilities and personnel.

Pacific

AUSTRALIA

Australian wheat farmers produced a record yield in the 1978/79 season. It is estimated to be at least 17.5 million tonnes, 18 per cent higher than the 1968/69 record, and 38 per cent more than any other single harvest. The area sown is estimated at 10.2 million hectares, second only to the 1968/69 planting. The average yield is forecast to be a record 1.72 tonnes per hectare. Many individual yields exceeded 6 t/ha.

The bumper crop followed sustained good growing conditions in most areas. Although many farmers were forced to plant late, adequate rainfall and mild temperatures enabled crops to fill well.

VARIETIES

Varieties with Norin 10 dwarfing genes, such as Condor, Songlen, Egret, Kite and Oxley, which now occupy about half the area in the eastern wheat belt, were mostly able to capitalize on the good growing conditions. They contributed significantly to the production record, mainly through higher inherent yield, but reduced lodging was also significant in some areas.

DISEASES

Diseases were widespread, but although serious in some localized areas, overall losses were not particularly high. Those causing problems included take-all, cereal cyst nematode, and *Septoria* leaf blotch, particularly in the southern areas. Good progress is being made at several centers in breeding for resistance to the two latter diseases, with sources of resistance well identified and breeding programs at an advanced stage.

Surprisingly for such a wet season, stem and leaf rust did not become well established. One reason in the case of stem rust is the widespread cultivation of resistant varieties in northern areas. However, a large proportion of the Australian crop remains at risk through susceptibility to rust. Furthermore, genetic vulnerability poses a threat with stem rust, through heavy reliance on *Sr Tt1* for protection in several major varieties.

Another disease present in the northern areas was leaf yellow spot *(Pyrenophora tritici-repentis)*, causing pink grain discolouration as well as leaf damage. This disease is increasing in prominence as the retention of stubble on the soil surface becomes a more popular agronomic practice in areas prone to soil erosion.

OTHER PROBLEMS

These included large losses from inadequate weed control, and the downgrading of quality in some areas from rain damage prior to harvest. Regarding the latter, it is interesting to note that the variety Kite again stood out as having very good resistance to weathering for a white grain wheat.

DURUM WHEAT

This wheat is a small, but expanding industry in the northeastern Australian wheat belt. Production last year is estimated at 18,000 tonnes and it is expected to increase rapidly in the near future. A major factor in this expansion is the new variety Durati, a high yielding, early maturing semidwarf with good quality and low susceptibility to black point. This already occupies over half the durum area and it is expected to eclipse all other varieties next season.

TRITICALE

Interest in triticale increased greatly last year, and the first official release of varieties from one or more of the three active centers in Australia is expected in the near future. The interest in this crop has been further stimulated by a court decision upholding the monopoly control of wheat by the Australian Wheat Board. Some farmers are now viewing triticale as an alternative feed grain for free market trading. A small area of an older type triticale, from a private farmer's release, is being already grown, but this will quickly be superseded when the new varieties go into production.

The advanced lines under test are from CIMMYT introductions, with selection for high yield combined with a good balance of other agronomic characters. Late maturity and some difficulty in threshing are two problems encountered and largely overcome, but susceptibility to drought remains a question mark in the Australian environment.

NEW ZEALAND

Cereal crops have been grown in New Zealand since European colonization of the country in the mid 19th century. The principal cereals grown are bread wheat and barley for which the production goal is national self-sufficiency. Durum wheat and triticale are being grown only on an experimental basis at this stage. Climatic conditions are favourable to high grain yields, though low grain protein content in bread wheat in some seasons, leads to problems in commercial bread production.

FERTILIZERS

Wheat is commonly grown as a cash crop in a pastoral rotation which allows productive crops to be grown with relatively low fertilizer inputs, particularly with respect to applied nitrogen. Fertilizer supplies are imported, either already compounded (as in the case of nitrogen), or as raw materials imported for treatment in the country (as for phosphate).

DISEASES

Although some cereal crop diseases are found in the country, disease is rarely a major limitation to production. Barley yellow dwarf virus is probably the principal disease factor in yield reduction.

SEED CERTIFICATION

New Zealand has a highly sophisticated system of seed certification, which ensures that farmers have access to reliable seed. New cultivars are rapidly made available and they soon become prevalent. New spring wheats are based on semidwarf stocks of Mexican origin while autumn sown wheat and spring barley cultivars are produced by local breeding programs in which European material has made a significant contribution. Durum wheat and triticale stocks of CIMMYT origin are being commercially evaluated at present.

PLANT BREEDING

In New Zealand it is mainly the responsibility of government research divisions and is backed by effective agricultural and biological research. Recent developments have led to the establishment of a number of collaborative plant breeding projects with institutes in Europe and North America, which have proved to be mutually beneficial. Co-operation with CIMMYT has proved to be of considerable value for the introduction of new germ plasm and it is hoped that the relationship can be maintained on its present basis.

Glossary

ACI	Average Coefficient of Rust Infection
ACSAD	Arab Arid Zone and Dryland Research Center
ACWYT	African Cooperative Wheat Yield Trial
a.i.	active ingredient
ALAD	Arid Lands Agricultural Development
BADC	Bangladesh Agricultural Development Corporation
BV	Biological Value
BV77	El Batan Verano (Summer), México, 1977
BWYT	Bread Wheat Yield Trial
BYDV	Barley Yellow Dwarf Virus
CB	Crossing Block
cc	cubic centimeter
CCGC	Coopérative Centrale des Grandes Cultures
CCSPS	Coopérative Centrale de Semences et Plants Séléctionnés
Cd	Ciudad (e.g. Cd. Obregón = City of Obregon)
CI	Coefficient of Infection (Rust)
CIAB	Centro de Investigaciones Agrícolas del Bajío (México)
CIANO	Centro de Investigaciones Agrícolas del Noroeste (Cd. Obregón, México)
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center)
CIP	International Potato Center
cm	centimeter
CNPT	National Wheat Research Center (Brazil)
COCEBLE	Coopérative Centrale de Blé
COSEM	Coopérative Centrale de Semences
CRI	Coefficient of Rust Infection
CRL	Cereal Rust Laboratory, USDA, St. Paul, Minnesota
CV	Coefficient of Variation
DAP	Diammonium Phosphate
DBC	Dye Binding Capacity
DM	Dry Matter
DYT	District Yield Trial (Zambia)
donum	Equals 0.227 acres = 919 sq. meters
EACA	Epsilon Amino N Caproic Acid
EBYT	International Barley Yield Trial
EDYT	Elite Durum Yield Trial
ELAR	Ensayo Latino Americano de las Royas
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agency for Agricultural Research)
EPAC	Empresa Pública de Abastecimiento de Cereais (Portugal)
ESYT	Elite Selection Yield Trial
EUCARPIA	European Association for Research in Plant Breeding
FAO	Food and Agriculture Organization of the United Nations
feddan	Equals 0.42 ha = 1.038 acres
g	gram
ha	hectare
hl	hectoliter

HYV's	High Yielding Varieties
IBON	International Barley Observation Nursery
IBWIN	International Bread Wheat Increasing Nursery
IBWYN	International Bread Wheat Yield Nursery
IBWSN	International Bread Wheat Screening Nursery
IC	Index of Quality
ICARDA	International Center for Agricultural Research in the Dry Areas
IDGC	Institut de Developpement des Grandes Cultures (Field Crops Institute)
IDRC	International Development Research Center (Ottawa, Canada)
IDSN	International Durum Screening Nursery
IDYN	International Durum Yield Nursery
INAT	Institut National Agricole Tunisienne
INCAP	Instituto de Nutrición de Centroamérica y Panamá (The Institute of Nutrition for Central America and Panama)
INIA	Instituto Nacional de Investigaciones Agrícolas (The Mexican National Institute of Agricultural Research)
INIAP	Instituto Nacional de Investigaciones Agropecuarias (Ecuador)
INIP	Instituto Nacional de Investigaciones Pecuarias
INRAT	Institut National de la Recherche Agronomique
INTA	Instituto Nacional de Technología Agropecuaria (Argentina)
IPO	Institut Voor Plantenziektenkundig Onderzoek (Research Institute for Plant Protection, Netherlands)
ISA	Instituto Superior de Agricultura (San Cristobal, Dominican Republic)
ISEPTON	International Septoria Observation Nursery
ISWRN	International Spring Wheat Rust Nursery
ISWYN	International Spring Wheat Yield Nursery
ITSN	International Triticale Screening Nursery
ITYN	International Triticale Yield Nursery
IWSWSN	International Winter x Spring Wheat Screening Nursery
K_2O	Oxide of Potassium
kg	kilogram
kg/ha	kilogram per hectare
kg/hl	kilogram per hectoliter
LADISN	Latin American Disease and Insect Screening Nursery
LDC	Less Developed Countries
LR	Leaf Rust
LSD	Least Significant Difference
maund	Equals 82 pounds (=37.25 kg)
m	meter
m^2	square meter
MLN	Multiline Nursery
MV77	Toluca Verano (Summer), México, 1977
N	Nitrogen
NCIC	National Crop Improvement Committee
NIRS	National Irrigation Research Station (Zambia)
NPBS	National Plant Breeding Station (Njoro, Kenya)
NPU	Net Protein Utilization
PC	Small plot multiplication for pure seed
PER	Protein Efficiency Ratio
Pgt	Puccinia graminis tritici
PMC	Small increase plot
PMI	International Multiplication Plots
PON	Preliminary Observation Nursery
ppm	parts per million
ppt	parts per thousand
PRONASE	Productora Nacional de Semillas (The Mexican National Seed Production Agency)
Ps	Puccinia striiformis
P_2O_5	Oxide of Phosphorus
PYT	Preliminary Yield Trial (Zambia)
PzV77	Patzcuaro Verano (Summer), México, 1977

q	quintal (= 100 kg)
q/ha	quintal/hectare
Rad	Ramified durum wheat
Rah	Ramified bread wheat
Rai	Equals 1600 sq. m
RCB	Regional Crossing Block
RDISN	Regional Disease and Insect Screening Nursery
RDTN	Regional Disease Trap Nursery
RfWYT	Rainfed Wheat Yield Trial
RTN	Regional Trap Nursery
RV	Roque Verano (Summer), Celaya, México
RWYT	Regional Wheat Yield Trial
SAG	Secretaría de Agricultura y Ganadería, México
SARWEIN	South African Regional Wheat Evaluation and Improvement Nursery
SCU	Sulphur Coated Urea
SNACWYT	Screening Nursery for the African Cooperative Wheat Yield Trial
SR	Stripe Rust
t	tonne (= 1000 kg)
tarea	Equals 628 sq. cm
TCCA	Thana Central Cooperative Association
TD	True Digestibility
TDRN	Triticale Disease Resistance Nursery
t/ha	tonnes/hectare
TL	Turkish Lira
tonne	metric ton (= 1000 kg)
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VEOLA	Vivero de Enfermedades y Observación de Latino América
YR	Yellow Rust
Y77-78	Yaqui, México, 1977-78
Y78-79	Yaqui, México, 1978-79

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