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BIOFERTILIZER-AN OVERVIEW

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Introduction

Biofertilizer is a term that can be interpreted in different ways (El-Ghamry *et al.*, 2018; Mącik *et al.* 2020). It is also called microbial inoculants, are organic products containing specific microorganisms, which are derived from plant roots and root zones. According to Kawalekar (2013), biofertilizer improves the growth and yield of the plant by 10-40%. A substance which contains living microorganisms when applied to the soil, a seed or plant surface colonizes the rhizosphere and promotes growth by increasing the supply or availability of nutrients to the host plant is called biofertilizer (Vessey, 2003). Biofertilizer is most commonly referred to as selected strains of beneficial soil microorganisms cultured in the laboratory and packed in suitable carriers (Hari and Perumal, 2010). The term biofertilizer may be used to include all organic resources for plant growth which are rendered in available form for plant absorption through microorganisms or plant associations or interactions (Khosro and Yousef, 2012). Biofertlizer started with culture of small scale compost production that has evidently proved the ability of biofertilizer (Khosro and Yousef, 2012). It is recognized when the culture accelerates the decomposition of organic residues and agricultural by products through different processes and gives healthy harvest of crops. The history of biofertilizer began with the start of "Nitragin" by Nobbe and Hilther in 1895.

Advantage of biofertilizers

- Application of biofertilizer increases crop yield by 20-30%, replaces chemical N and P by 25% and also stimulates plant growth. Therefore, it is supplementary to chemical fertilizers.
- It is cost effective relative to chemical fertilizers and low manufacturing costs especially N and P use.
- Organic fertilizers have been known to improve biodiversity (soil life) and long term productivity of soil, and may prove a large depository for excess carbon dioxide.
- It increases the abundance of soil organisms such as fungal mycorrhiza, which help plants in absorbing nutrients.
- It improves soil structure (porosity), water holding capacity and secrete certain growth promoting substances.
- It enhances seed germination.
- It improves soil fertility and fertilizer use efficiency and ultimately the yield of crops.

- Continuous use of biofertilizers for 3–4 years, there is no need for their application, as parental inocula are sufficient for growth and multiplication (Bumandalai and Tserennadmid, 2019)

Limitation of biofertilizers

- Non availability of appropriate and efficient strains of bacteria.
- Lack of suitable carrier, due to which self life is short.
- Marketing of biofertilizer is not easy as the product contains living organisms.
- Shortage and viability of *Vesicular Arbuscular Mycorrhiza* (VAM) inoculum
- Transportation is the major problem during storage of biofertilizers.
- Lack of awareness of farmers.
- Poor and inexperienced staffs.

Different types of biofertilizers

Biofertilizers are grouped into different types based on their mode of action and functions. Microorganisms used as biofertilizer include- Nitrogen fixers e.g. *Azotobacter chroococcum, Cyanobacteria, Rhizobium* sp. and potassium solubilizers e.g. *Bacillus mucilaginous*, phosphorus solubilizers e.g. *Aspergillus fumigatus, Bacillus megaterium,* Plant Growth Promoting *Rhizobacteria* (PGPR), *Vesicular Arbuscular Mycorrhiza* (VAM) e.g., *Glomus mosseae* and sulfur oxidizers (S-oxidizers). In one gram of fertile soil, up to 10^{10} bacteria can be present, with a live weight of 2000 kg ha^{-1} (Raynaud and Nunan, 2014). Soil bacteria could be *cocci* (sphere, 0.5 µm), *bacilli* (rod, 0.5–0.3 µm), or spiral shaped (1–100 µm). The presence of bacteria in the soil mainly depends upon the physical, chemical properties of the soil, organic matter and phosphorus contents, as well as cultural activities. Although, nutrient fixation and plant growth enhancement by bacteria are key mechanisms for achieving sustainable agriculture goals in the future. Different types of biofertilizers based on the type of microbe used and mode of action along with suitable examples are presented briefly in Table-1.

Table 1. Different types of biofertilizers, mechanisms and their groups with examples

Biofertilizers	Mechanism of different biofertilizers	Groups and their examples	Citations
Nitrogen (N) fixing	Increase soil N content by fixing atmospheric N and make it available to the plants	a. Free-living (e.g. *Azotobacter, Anabaena*, *Clostridium, Aulosira, Bejerinkia, Nostoc, Klebsiella, Stigonema, Desulfovibrio, Rhodospirillum* and *Rhodopseudomonas*) b. Symbiotic (e.g. *Anabaena azollae, Frankia, Rhizobium* and *Trichodesmium*) c. Associative symbiotic (e.g. *Azospirillum* spp., *Alcaligenes, Azoarcus* sp. *Acetobacter diazotrophicus, Enterobacter, Herbaspirillum* sp.)	Choudhury and Kennedy, 2004

Biofertilizers	Mechanism of different biofertilizers	Groups and their examples	Citations
Phosphorus (P) solubilizing	Solubilize the insoluble forms of P in the soil into soluble forms by secreting organic acids and lowering soil pH to dissolve bound phosphates	a. Bacteria (e.g. *Agrobacterium, Aereobacter, Bacillus circulans, B. subtilis, B. polymyxa, Flavobacterium, Microccocus, Pseudomonas striata and Penicillium* sp.) b. Fungi (e.g. *Penicillum* sp., *Aspergillus awamori* and *Trichoderm*a)	Board, 2004
P mobilizing	Transfer P from the soil to the root cortex which are broad spectrum biofertilizers. Some fungi increase the uptake of soluble phosphates.	a. Mycorrhiza (e.g. *Arbuscular mycorrhiza, Acaulospora* spp., *Gigaspora* sp., *Glomus* sp., *Scutellospora* sp. and *Sclerocystis* sp.)	Chang, 2009
Potassium (K) solubilizing	Solubilization of K by producing organic acids that decompose silicates and help in the removal of metal ions and make it available to plants.	**a. Bacteria** (e.g. *Bacillus mucilaginosus*, *B. circulanscan, B. edaphicus* and *Arthrobacter* sp.) **b. Fungi** (e.g. *Aspergillus niger*)	Etesami *et al.*, 2017
K mobilizing	They mobilize the inaccessible forms of K in the soil.	a. Bacteria (e.g. *Bacillus* sp.) b. Fungi (e.g. *Aspergillus niger*)	Jha, 2017
Micronutrient	Oxidizing sulfur (S) to sulfates which are usable by plants.	a. S oxidizing (e.g. *Thiobacillus* sp.)	Itelima *et al.,* 2018
	Solubilize the zinc (Zn) by chelated ligands, proton, acidification and by oxidoreductive systems.	a. Zn solubilizing (e.g. *Bacillus* sp., *Mycorhiza, Pseudomonas* sp.)	Kamran *et al.,* 2017
Plant growth Promoting (PGP)	A variety of bacteria can develop hormone that promote root growth, increases nutrient availability and help in improvement of crop yield.	PGP rhizobacteria (e.g. *Agrobacterium, Arthrobacter, Bacillus, Enterobacter, Erwinia, Pseudomonas* sp., *Pseudomonas fluorescens, Rhizobium, Streptomyces* and *Xanthomonas*)	Backer *et al.,* 2018

Application of biofertilizers

- Biofertilizers can be applied on seedlings, seeds and directly to the soil.
- Seed treatment is the most common practice of applying biofertilizers due to its simplicity and small amount of product required for inoculation (Asif *et al.,* 2018).

- Inoculants can be applied to the seeds in different ways *i.e.* dusting, slurry and seed coating (Malusa and Ciesielska, 2012).
- Through dusting method, dry seeds are mixed directly with the inoculants. This method may result in weak adherence of microorganisms to the seeds, hence is thought to be least effective.
- With slurry, bio inoculant is mixed with wetted seeds or directly with water and then with seeds. Alternatively, the seeds may be left in the slurry for night (Malusa and Ciesielska, 2012).
- Seed must be coated with the appropriate number of microorganisms adhesives such as gum arabic, carboxy methyl cellulose, sucrose solutions, vegetable oils and non-toxic commercial products are used (Bashan *et al.,* 2014).
- In seed coating method, seeds are mixed with the slurry prepared from the inoculants and then are coated with finely ground inorganic inert materials such as lime, clay, rock phosphate, charcoal, dolomite, calcium carbonate or talc.
- As a result, microorganisms are protected from adverse environmental conditions and from the harmful impact of chemical fertilizers and pesticides (Malusa and Ciesielska, 2012).
- Seed treatment may be conducted with bacteria belonging to the following genus: *Azotobacter, Azospirillum*, phosphorus solubilizing microorganisms (PSM), *Rhizobium* and also with the consortium of microorganisms. Seeds are firstly coated with *Azotobacter* sp. or *Azospirillum* sp. and *Rhizobium* and then, PSM inoculant is added as the outer layer thus the higher number of feasible microbial cells can be maintained (Brahmaprakash *et al.,* 2017).
- Soil treatment facilitates control of the location and the application rate of the inoculants, protects inoculants from the harmful impact of pesticides and fungicides and also avoids damage to the seed coats.
- The soil inoculation increases chance of contacting seeds with the higher concentration of biofertilizer in comparison with seed treatment.
- Generally, soil inoculation with granules has been implemented in developed countries, where advanced machinery and accessories for fertilization are used (Bashan *et al.,* 2014).

Precaution for the use of biofertilizers

- Biofertilizers should also be stored at appropriate temperature, no below 0 °C and over 35 °C.
- Avoid direct exposure to sunlight.
- Away from direct sun or hot wind and store the packets of biofertilizers in cold place.
- Treat the seeds (seed coating) or seedling (dipping) under shade only.
- Avoid direct contact of chemical fertilizers and pesticides.
- Good quality biofertilizer is identified with the moisture content of 30-40%,
- In case of soil application, mix recommended dose of biofertilizer with 50 kg pulverized soil or FYM and broadcast.
- Every biofertilizer responds better if soil is enriched with sufficient quantity of available phosphate (apply super phosphate), organic matter (apply FYM), soil of neutral pH (apply lime).

- To obtain best effect, treatment with biofertilizers is advised 3-4 hour before sowing.

Conclusion

In recent years, biofertilizers have emerged as an important component for biological nitrogen fixation. Biofertilizer offer an economically attractive and ecologically sound route for providing nutrient to the plant. They comprise a promising tool in agricultural ecosystems as a supplementary, renewable and eco friendly source of plant nutrients. As they have an ability to transform nutritionally important elements from non usable to highly assimilable forms without deleterious effects on natural environment, they are an important component of Integrated Plant Nutrient System (IPNS) (Alley and Vanlauwe, 2009). Application of biological fertilizers is thought to be a key element in maintaining soil fertility and crop productivity on the sufficiently high level, indispensable to achieve sustainability of farming. Biofertilizers may also help mitigate difficulty arising from the growing demand of global population for food and from the widespread chemicalization in agro-ecosystems. The changing approach to the agricultural practices makes biofertilizers a vital part of modern day crop production and emphasizes significance of biological inoculants in forthcoming years.

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ORGANIC ACIDS IN AQUAFEEDS: A POTENTIAL ALTERNATIVE TO ANTIBIOTICS

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Abstract

There are many approaches to controlling the development of bacterial diseases in aquaculture, and one of the most common methods of control is the use of antibiotics. However, consumers are increasingly opposed to the use of antibiotics in aquaculture production. This means that some farmers are currently banned from selling marine products on the export market. Widespread use of such antibacterial agents is associated with the development of antibiotic-resistant strains and the transfer of resistance genes between different bacterial species. The emergence of drug-resistant bacteria adversely affects not only the aquaculture industry but also human health. It additionally has a poor effect on customer perception. It additionally has a poor effect on customer perception. Therefore, the demand for more environmentally friendly alternatives is higher than ever. Potential alternatives to Aquafeed's antibiotic growth promoters are organic acids and / or their respective salts. Recently, the use of organic acids in the aqua-farming has been the focus of much research and commercial interest. This review comprehensively summarizes the current state of knowledge about the use of organic acids and their salts in aqua feeds and describing results of earlier studies which mainly focuses the effects of OA on growth, nutritional utilization, gut flora, and disease resistance.

Introduction

Aquaculture performs a big function in casting off hunger, malnutrition in most developing countries and promoting the socio-economic status of the poor (FAO, 2016). Food demand has grown enormously over the last two decades due to the growing world population and awareness of health benefits. Fish is the most inexpensive supply of animal protein, and are becoming increasingly important to meet the demand for food shortages. In order to increase the production of fish per unit area, aquaculture has gone through numerous tiers of intensification. Nonetheless, strengthening aquaculture not only increases the stress levels of fish, but also affects the growth and immune response to pathogens, ultimately leading to the development of various diseases and the economic loss of poor farmers. (Gupta *et al.,* 2014). Fighting infectious diseases and maintaining the health of farmed fish are paramount to achieving the development of sustainable aquaculture. To remedy this situation, antibiotics may have been used to irradiate the disease-causing bacteria, but overuse of them can lead to antibiotic-resistant bacteria. In addition, such widespread use of a wide variety of antibiotics in the aquaculture industry, both therapeutic and growth-promoting agents, has increased potentially harmful effects on human and animal health and the aquatic environment. (Cabello 2006). For this reason, antibiotics in animal production have been banned by the European Union and are increasingly being watched and criticized in other parts of the world. Possible alternatives to Aquafeed's antibiotic growth promoters are organic acids and / or their respective salts. The use of dietary organic acids in the cultivation of aquatic animals has recently been the focus of much research and commercial interest.

The first indication in animal feeds for piglets was that organic acids kept the intestinal gastric pH low, causing digestive problems (Easter, 1988). Acidulants are believed to be more specific for growth activity that can reduce harmful microorganisms and promote colonization of beneficial microbial flora in the gastrointestinal tract of fish (Cromwell, 1990).

Organic acids

Organic acids are basically organic compounds that contain one or more carboxyl groups. These include saturated straight-chain monocarboxylic acids (C1–C18), unsaturated (cinnamic, sorbic), hydroxyl (citric, lactic), phenols (benzoic, cinnamic, salicylic) and multi carboxylic acids (azelaic, citric, succinic) (Cherrington *et al*.,1991). Organic acids are produced by microbial fermentation of carbohydrates by different types of bacteria under different metabolic pathways and conditions. Some low molecular weight organic acids, like acetic acid, propionic acid and butyric acid are also formed in high concentrations in the large intestine of humans and animals by anaerobic microbial communities. Many short-chain organic acids (C1-C7) are ordinal contents of plant and animal tissues. Such commonly known as acidulants, are promising alternatives to antibiotic growth promoters (AGPs) and are receiving increasing attention from aquaculture researchers (Luckstadt, 2008a and Ng & Koh, 2011).

However, most of the organic acids commercially used in the food and feed industry are made synthetically. Organic acids can also be combined with potassium (K), sodium (Na), calcium (Ca), etc., to form single or double salts of those acids. Organic acids, such as benzoic acid, formic acid, lactic acid and propionic acid have traditionally been used as storage preservatives in food and feed ingredients to prevent product degradation caused by fungi and microorganisms (Ricke, 2003 and Van Dam, 2006). Some organic acids have a strong antibacterial effect against major food borne pathogens.

He most common organic acid in animal feeds is propionic acid, followed by fumaric acid, formic acid, lactic acid, and / or salts thereof. In animal nutrition, acidulants affect their performance through three different mechanisms: (a) in the feed; (b) in the gastro-intestinal tract of the animals; and (c) effects on the animal’s metabolism. The use of these acidulants, which consist primarily of organic acids and their salts or mixtures thereof, has received enormous attention as a potential alternative for improving fish performance and health. Weak lipophilic organic acids and their salts are considered “generally regarded as safe” (GRAS) substances and have been used as preservatives in meals and liquids for centuries. They are listed in EU regulations as feed additives permitted in livestock. Organic acids, their salts, or their combinations have been successfully used in livestock feed as substitutes for antibiotics.

Different Organic acids in Aquafeeds

Citric acid and its salt

Citric acid/salts (CA) is the well-studied organic acid in aquaculture for the growth and immune system purposes. Many studies have reported that citric acid can improve the growth, feed conversion ratio, and availability of minerals, especially phosphorus, in various fish species. Citrate supplemented red drum, *Sciaenops ocellatus* tends to lower pH of stomach and rainbow trout, Oncorhynchus mykiss has been observed to improve weight gain, feed efficiency ratio, protein efficiency ratio and improve activity of digestive enzymes (Castillo *et al*., 2014). Hernandez *et al.* (2012), observed an improvement in growth, SGR, FCR, phosphorus absorption/retention when Beluga Sturgeon, *Huso huso* fed on citrate supplemented diet. Also, observed reduction in Phosphorus pollution in the environment. Addition of CA in feed resulted in improved weight gain, SGR, PER, and FCR and digestibility of protein, Ca and P in yellowtail, *Seriola quinqueradiata* (Khajepour and Hosseini, 2012). Similarly, *Oreochromis niloticus*, *Oreochromis aureus* increased the activity of protease and amylase in the gastrointestinal tract and did not affect lipase activity when citric acid was added to the diet (Li *et al.,* 2009).

Lactic acids or their salts

The use of lactic acid (LA) as a feed additive to rainbow trout, *Oncorhynchus mykiss,* increased bone zink. However, Red sea bream, *Pagrus major* did not showed improvement in weight gain and feed utilization, but improved Phosphorus absorption (Hossain et al., 2007). Gislason *et al*. (1994) fed Atlantic salmon, *S. salar* with LA, they observed no effects on fish growth, mortality and overall chemical composition of the faeces. Whereas Ringo *et al.* (1994) supplemented LA to Arctic charr, *S. alpines,* reported an improved weight gain and FER but no effect on lipid/fatty acid composition of muscle tissue and carcass proximate composition.

Use of butyric acids or their salts

Na-butyrate supplemented diet enhanced growth in Sea bream, *Sparus aurata* but there were no effects on SGR feed intake and feed conversion. Also, metabolic patterns at the intestinal level also changed (Robles *et al*., 2013). Butyric acids added in feed acts as a nutrient attractant and feed intake in Pacific white shrimp, *L. vannamei,* and had no effect on phosphorus digestibility (Silva *et al*., 2013). In addition, Silva *et al.* (2016) found that feed efficiency and growth performance improved without affecting phosphorus retention. However, it altered the intestinal flora and increased serum cohesion titers.

Sodium butyrate as a feed additive for the omnivorous tropical catfish (*Clarias gariepinus*) was used at 2kg/ton in both fish meal and soya defatted concentrates diet. The observed result showed that there are no significant differences in supplemented sodium butyrate compared to control group. However, especially for catfish fed fishmeal, the SGR was slightly higher, the observed weight gain was higher in the sodium butyrate group than in the control group, and at the same time the FCR of the supplemented fish was reduced. Apparently, sodium butyrate supplementation increased the proportion of gram-positive bacteria in the posterior region in intestine of catfish.

Formic acid

Very less research are been done for the addition of potassium-diformate (KDF) (a double-salt of formic acid) in herbivorous, carnivores, filter feeders' fish and shellfish which shown clear increase in weight gain, feed conversion ratio and the ability of fish to combat bacterial infections. Abu Elala and Ragaa (2015) found that ingestion of 2 or 3 g/kg KDF in diets of Nile tilapia (*O. niloticus*) significantly improved growth capacity, FCR and apparent crude protein digestibility, which results in lower gastric pH. Similarly, commercially available white shrimp fed with Na-formate supplemented diet, showed no improvement in growth response, FCR and survival rate (Silva *et* *al.,* 2015). In another study, *Chuchird et al*. (2015) observed, addition formic acid to shellfish did not give good results, but it turned out to be good for finfish.

Acetic acid

A 50g/kg acetic acid supplemented diet tended to lower the pH of stomach and appendix, but did not reduced the pH of gastrointestinal tract contents in trout fish. It suggests that trouts are efficient in regulating endogenous gastric acid secretions to maintain their gut pH normal. However, it has been observed that the addition of acetic acid to trout feed significantly increases the availability of fish phosphorus. The use of acetic acid as a supplement in fish and shellfish feed is less common (Sugiura *et al*., 2006).

Propionic acid

The energy of propionic acid is 1 to 5 times that of wheat (Diebold and Eidelsburger 2006). Use of formic acid and propionic acid and their salts on a sequential release medium has been successful in the grow-out of Turkish rainbow trout (Karl Sacherer, personal communication, 2006). Shrimps fed propionic acid and butyrate fortified feeds resulted in increased final weight, feed efficiency, nitrogen retention, protein efficiency rate, survival rate and yield. Certain shrimp feeds containing 2% butyric acid were found to be higher in weight compared to control treatment (Silva *et al*., 2013).

Fumaric acid

The addition of 0.5 g/kg of fumaric acid improved the hematological parameters of the fish. Overall, the ingestion of fumaric acid in *C. gariepinus* diets improved fish survival when *Aeromonas sobria* challenge (Omosowone *et al*., 2015).

Conclusion

There is currently great interest in the commercial use of organic acids in aqua feeds to improve growth performance and control disease. Studies reviewed show that many studies report that organic acids, their salts or mixtures thereof can improve aquatic animal growth, feed conversion ratio, gut health and disease resistance. Although most studies report nutritional supplies in organic acid-supplemented diets, there are conflicting results on growth-promoting effects, depending on the species of aquatic animals, the organic acids tested, their types and dosages. Due to the increase in mineral utilization due to the acidification of the diet, the excretion of phosphorus and nitrogen is reduced, which will greatly promote the formulation of more environment friendly aquatic feeds. The reduction in microbial load caused by the excretion of farmed fish fed supplements containing organic acids benefits aquafarming systems in reservoirs and circulation.

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EFFECT OF PHOSPHORUS AND SULPHUR ON GROWTH YIELD AND QUALITY OF INDIAN MUSTARD (*BRASSICA JUNCEA* L.)

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An agronomic investigation entitled as "Effect of phosphorus and sulphur on growth yield and quality of Indian mustard (*Brassica juncea* L.)" was conducted at Experimental Farm, Agronomy Section, College of Agriculture, Latur, during *Rabi* 2020-21. The objective of present study was to study the effect of phosphorus and sulphur levels on growth, yield and quality of mustard and to study the economics of mustard cultivation.

The soil of experimental plot was clayey in texture, slightly alkaline in reaction, low in available nitrogen, medium in available phosphorous, very high in available potassium and low in available sulphur. The experiment was laid out in Factorial Randomized Block Design (FRBD) with nine treatment combinations, consisting of two factors i.e. different phosphorus levels and sulphur levels, which includes three levels each of different phosphorus levels and sulphur levels application. The different fertilizer levels were 25 kg P ha^{-1} (P_1), 37.5 kg P ha^{-1} (P_2) and 50 kg P ha^{-1} (P_3) whereas, sulphur levels were 15 kg S ha^{-1} (S_1), 30 kg S ha^{-1} (S_2) and 45 kg S ha^{-1} (S_3). The gross plot size of each experimental unit was 5.4 m × 4.5 mand net plot size was 4.5 m × 3.9 m. Sowing was done on 09th November, 2020 by dibbling method at spacing 45 cm x 15 cm. The crop was harvested on 22rd February, 2021.

Table 1: Seed yield (kg ha^{-1}), gross monetary returns (Rs. ha^{-1}), cost of cultivation (Rs. ha^{-1}), net monetary returns (Rs. ha^{-1}) and benefit cost ratio of mustard as influenced by different treatments at harvest.

Treatments	Seed yield (kg ha^{-1})	Gross monetary returns (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	Benefit cost ratio
(A) Phosphorus (P)					
P_1 – 25 kg ha^{-1}	1499	59960	35419	24541	1.69
P_2 – 37.5 kg ha^{-1}	1849	73960	36998	36962	1.99
P_3 – 50 kg ha^{-1}	1897	75880	36331	39549	2.09
SE±	63	2232	-	2332	-
CD at 5%	188	6692	-	6692	-
(B) Sulphur (S)					
S_1 – 15 kg ha^{-1}	1510	60400	34926	25474	1.73
S_2 – 30 kg ha^{-1}	1722	68880	36063	32817	1.91
S_3 – 45 kg ha^{-1}	1864	74560	37920	36640	1.97

Treatments	Seed yield (kg ha^{-1})	Gross monetary returns (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	Benefit cost ratio
SE±	63	2232	-	2232	-
CD at 5%	188	6692	-	6692	-
(C) Interaction (P X S)					
SE±	109	3866	-	3866	-
CD at 5%	NS	NS	NS	NS	NS
General mean	**1724**	**69940**	**36276**	**33664**	**1.99**

The result of the experiment (Table 1) revealed that higher growth and yield attributes, seed yield (1897 kg ha^{-1}), straw yield (4723 kg ha^{-1}), oil yield (779.92 kg ha^{-1}), GMR (Rs.75880 ha^{-1}), NMR (Rs. 39549 ha^{-1}) and B:C ratio (2.09) was observed with an application of 50 kg P ha^{-1} (P_3) Higher growth and yield attributes, seed yield (1864 kg ha^{-1}), straw yield (4843 kg ha^{-1}), oil yield (718.27 kg ha^{-1}), GMR (Rs.74560 ha^{-1}), NMR (Rs.36640 ha^{-1}) and B:C ratio (1.97) was observed with an application of 45 kg S ha^{-1} (S_3). In case of seed yield and net monetary returns (Rs. ha^{-1}), application of 50 kg P ha^{-1} and 45 kg S ha^{-1} performed better.

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ROLE OF AGRICULTURAL JOURNALISM IN FARMING

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Journalism is the activity of collecting, production and distribution of news and related material using different media such as newspaper, radio, television, books, social media sites etc. There are so many forms of journalism working on different fields covering different groups of people. Few examples are broadcast journalism, photojournalism, yellow journalism, tabloid journalism, citizen journalism, watchdog journalism and agricultural journalism etc. Agriculture journalism is that branch of journalism which is related to receiving, writing, editing, and reporting the content and information related to agriculture, it refers to the collection of information on modern agriculture and taking it to the people using different mass media. Development through agricultural journalism refers to helping and supporting the farmers to grow, learn new agricultural techniques to improve their living conditions and also to earn more profit in agriculture. Role of different mass media in agricultural development: The success of different agricultural development depends on the extent and nature of mass media used. Press, radio, television, internet, mobile proved to be the most effective media for the diffusion of the scientific knowledge to more and more people. In India where people are not that educated television, radio can be more effective media in this field. Main objectives of agricultural journalism are: [1] To educate or giving correct information. [2] To motivate the people engaged in agriculture to improve their performance. [3] To make a link between government and the farmers. [4] To help in development of farmers and ultimately the country.

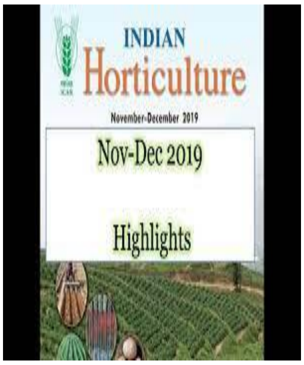
Role of agriculture journalism in adoption of new farm innovations

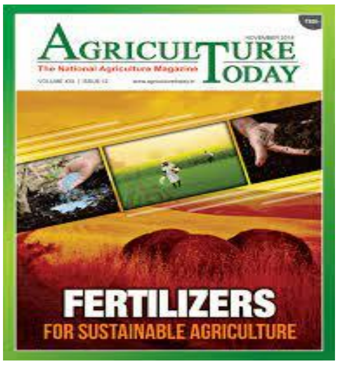
Agricultural innovation is basically purposed to increase socio economic growth to ensure food and nutrition security, to reduce poverty, henceforth helping to achieve sustainable development goals, and agriculture journalism has its main role in dissemination of information and innovation to the farmers through tools such as social media, radio, magazines, television etc. It shows the farmers, new information on the modern technologies that could improve their performance in farming. Agricultural journalism provides farmers with the necessary knowledge about innovation which could help them make the decision for adoption of farm technologies. For disseminating the knowledge of an agricultural innovation the media person should know that the language farmers understand in the area and the media tool they use often.

Role of agricultural journalism in generating employment

Agriculture journalism will provide education or employment from Agriculture Journalism University and agriculture corporate. The agriculture radio station, the agriculture information and broadcasting, will be implemented at each state of India. This journalism will create employment in writing, advertisement, broadcasting, photojournalism, editing and design. This would provide opportunity to agriculture journalism degree holder to work on this field and earn profit. The agriculture profession would function in block, village and district of the state. The agriculture journalism will also involve more and more farmers to work and henceforth creating employment. The agriculture journalism will remove unemployment in agriculture through communication technology. This would bring revolution into agriculture academic system and opportunity at future in India. Few examples: During green revolution, All India Project (AIR) started Radio Rural Forum in 1956, a pilot project for the dissemination of information related agriculture, the success of this project inspired AIR to make farm forum a permanent content for rural broadcasting programs. This opened up path for more mass media content related to agriculture and rural development. One example for print media includes The Hindustan Times feature "our village chhatera" brought out on February 1969, other farm related monthly magazine is Adike Patrike started by a group of farmers in 1987 in Karnataka.

Popular magazine published from India: [1] Indian Horticulture (bimonthly magazine in English) [2] Indian Farming (monthly magazine in English) [3] Kheti (monthly magazine in Hindi) [4] Phal Phool (bimonthly magazine published in Hindi) [5] Krishika (a half yearly peer reviewed research journal in Hindi) [6] Horticulture today [7] Agricultural today [8] Agro India [9] Modern Kheti [10] Liesa India [11] Farm Food.





Case study

A farmer, Appa B Patil has agricultural land of 18 acres and his family including 7 members depends on the agriculture only, he is educated to S.S.C. level and he takes monthly issue of shetkari agricultural bulletin. He told that in the issue of December 2006, method of modern technology related to sugarcane rooten management was given with the help of chemical fertilizer, by using that method he was able to increase his production from 45 to 65 tones that means 20% increase was there so the magazine turns helpful.

Conclusion

Agriculture journalism although plays a vital role in disseminating important agriculture related information among people in villages which could lead to the agriculture and rural development but there is a big gap as there are still many remote areas where information could not reach out so government with the help of mass media and agricultural journalism sources should provide them with the correct knowledge related diffusion of technologies and new implemented schemes for their welfare.

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VERMICOMPOSTING PRODUCTION TECHNOLOGY – A CRITICAL REVIEW

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Abstract
Now a days, the increasing demand for food goes on increasing with the increasing population. Hence, various techniques are needed to utilize the available resources. Even the wastes we dispose could be utilized efficiently. The wastes that are degradable are categorized and are to be exploited for the usage as manures. A technology that utilizes earthworms for the conversion of biodegradable wastes into organic manure called vermicompost that is rich in nutrients is called Vermicomposting. Through this efficient technology, major wastes are recycled into manures thereby creating an ecofriendly environment.

Keywords : biodegradable , earthworms , vermicompost , wastes

Introduction
Earthworms are wonder organisms that are present in earth over 20 milllion years. They play a very important vital role in the environment in various manner. They feed on the dead and decaying organic matter thereby converting all types of wastes into organic nutrients need for the crop ecosystem. This is a simple process called vermicomposting. Vermicomposting is a process wherein the wastes and debris with the action of earthworms gets converted into worm castings that could be used as a form of manure to the crops. The resultant product is called vermicompost which is nothing but the excreta of the earthworm that is highly useful to plants. This article briefs about the entire process of vermicomposting in a detailed manner.

Materials Required for Vermicomposting

- Any type of biodegradable wastes
  - Crop residues, weed biomass, vegetable wastes, wastes from agro industries, household wastes, urban and rural wastes, etc...
- Earthworms
  - **African earthworm (*Eudrillus euginiae*)**
  - Red worms (*Eisenia foetida*)
  - Composting worm (*Peronyx excavatus*)

Phases of Vermicomposting

Phase 1: Collection of wastes like agriculture wastes, vegetable wastes and household wastes; shredding them and removing any harmful substances.
Phase 2: Partial digestion of these wastes is done for easy consumption by earthworm
Phase 3: preparation of earthworm bed and introducing the worms into it
Phase 4: Collection of earthworm after vermicompost collection. The partially composted material will be again put into vermicompost bed.
Phase 5: Storage in proper place

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Essentials for earthworms:

- A good bedding
- Adequate moisture
- Proper food source
- Adequate aeration
- Protection from extreme weather conditions

Vermicompost Production methodology

Selection of suitable earthworm

The surface dwelling earthworms which lives in the top of the soil are preferred rather than the ones that lives below the surface of the soil. The African earthworm (*Eudrillus engenial*) (Fig.1), Red worms (*Eisenia foetida*) (Fig.2) and composting worm (*Peronyx excavatus*) (Fig.3) are promising worms used for vermicompost production. Among these three worms, the African earthworm (*Eudrillus engenial*) is preferred, because it produces higher production of vermicompost in short period of time


Fig.1 African earthworm


Fig.2 Red worms


Fig.3 composting worm

Selection of site for vermicompost production

The highly suitable place for vermicompost production should have high humidity, must be shady and cool. Abandoned cattle shed, poultry farms could be used. In case of an open area, the place must be shady enough with a thatched roof across it in order to protect it from environment.

Containers for vermicomposting

A cement tub may be constructed to a height of 2½ feet and a breadth of 3 feet (Fig.4). The length may be fixed to any level depending upon the size of the room. The bottom of the tub is made to slope like structure to drain the excess water from vermicompost unit. A small sump is necessary to collect the drain water. In another option over the hand floor, hollow blocks / bricks may be arranged in compartment to a height of one feet, breadth of 3 feet and length to a desired level to have quick harvest. In this method, moisture assessment will be very easy. No excess water will be drained.


Fig.4 cement tub

Vermiculture bed

A vermiculture bed or worm bed (3 cm) can be prepared by placing after saw dust or husk or coir waste or sugarcane trash in the bottom of tub / container. A layer of fine sand (3 cm) should be spread over the culture bed followed by a layer of garden soil (3 cm). All layers must be moistened with water. The below table 1 shows various bedding materials and their absorbency, bulking potential and C:N ratio.

Bedding Material	Absorbency	Bulking Pot.	C:N Ratio
Horse Manure	Medium-Good	Good	22 - 56
Peat Moss	Good	Medium	58
Corn Silage	Medium-Good	Medium	38 - 43
Hay – general	Poor	Medium	15 - 32
Straw – general	Poor	Medium-Good	48 - 150
Straw – oat	Poor	Medium	48 - 98
Straw – wheat	Poor	Medium-Good	100 - 150
Paper from municipal waste stream	Medium-Good	Medium	127 - 178
Newspaper	Good	Medium	170
Bark – hardwoods	Poor	Good	116 - 436
Bark -- softwoods	Poor	Good	131 - 1285
Corrugated cardboard	Good	Medium	563
Lumber mill waste -- chipped	Poor	Good	170
Paper fibre sludge	Medium-Good	Medium	250
Paper mill sludge	Good	Medium	54
Sawdust	Poor-Medium	Poor-Medium	142 - 750
Shrub trimmings	Poor	Good	53
Hardwood chips, shavings	Poor	Good	451 - 819
Softwood chips, shavings	Poor	Good	212 - 1313
Leaves (dry, loose)	Poor-Medium	Poor-Medium	40 - 80
Corn stalks	Poor	Good	60 - 73
Corn cobs	Poor-Medium	Good	56 - 123
Paper mill sludge	Good	Medium	54
Sawdust	Poor-Medium	Poor-Medium	142 - 750
Shrub trimmings	Poor	Good	53
Hardwood chips, shavings	Poor	Good	451 - 819
Softwood chips, shavings	Poor	Good	212 - 1313
Leaves (dry, loose)	Poor-Medium	Poor-Medium	40 - 80
Corn stalks	Poor	Good	60 - 73
Corn cobs	Poor-Medium	Good	56 - 123

Table 1. Various bedding materials

Putting the waste in the container

The predigested waste material should be mud with 30% cattle dung. The moisture level should be maintained at 60%. Over this material, the selected earthworm is placed uniformly. For one-meter length, one-meter breadth and 0.5-meter height, 1 kg of worm (1000 Nos.) is required. There is no necessity that earthworm should be put inside the waste. Earthworm will move inside on its own.

Watering the vermibed

Daily watering is not required for vermibed. But 60% moisture should be maintained throughout the period.

Harvesting vermicompost

In the tub method of composting, the castings formed on the top layer are collected periodically. The collection may be carried out once in a week. With hand the casting will be scooped out and put in a shady place as heap like structure. The harvesting of casting should be limited up to earthworm presence on top layer. This periodical harvesting is necessary for free flow and retain the compost quality. Otherwise the finished compost get compacted when watering is done.

In small bed type of vermicomposting method, periodical harvesting is not required. Since the height of the waste material heaped is around 1 foot, the produced vermicompost will be harvested after the process is over.

Harvesting earthworm

After the vermicompost production, the earthworm present in the tub / small bed may be harvested by trapping method. In the vermibed, before harvesting the compost, small, fresh cow dung ball is made and inserted inside the bed in five or six places. After 24 hours, the cow dung ball is removed. All the worms will be adhered into the ball. Putting the cow dung ball in a bucket of water will separate this adhered worm. The collected worms will be used for next batch of composting.

Storing and packing of vermicompost

The harvested vermicompost should be stored in dark, cool place. It should have minimum 40% moisture. Sunlight should not fall over the composted material. It will lead to loss of moisture and nutrient content. It is advocated that the harvested composted material is openly stored rather than packed in over sac. During selling time, it is packaged as a packet and sold out. Fig.5 shows a packet of vermicompost that is ready for sale.

Fig.5 Vermicompost packet

Proposed methods for evaluating the stability & maturity of compost:

- Colour
- Odour
- pH
- EC

- C/N ratio
- Plant nutrient content
- Humification index
- Phytotoxic compounds

Nutritive value of compost

Organic carbon : 9.5 – 17.98%
Nitrogen : 0.5 – 1.50%
Phosphorous : 0.1 – 0.30%
Potassium : 0.15 – 0.56%
Sodium : 0.06 – 0.30%
Calcium and Magnesium: 22.67 to 47.60 meq/100g
Copper : 2 – 9.50 mg kg-1
Iron : 2 – 9.30 mg kg-1
Zinc : 5.70 – 11.50 mg kg-1
Sulphur : 128 – 548 mg kg-1

Advantages of Vermicomposting

- Vermicompost is rich in all essential plant nutrients.
- Provides excellent effect on overall plant growth, encourages the growth of new shoots / leaves and improves the quality and shelf life of the produce.
- Vermicompost is free flowing, easy to apply, handle and store and does not have bad odour.
- It improves soil structure, texture, aeration, and waterholding capacity and prevents soil erosion.
- Vermicompost is rich in beneficial micro flora such as a fixers, P- solubilizers, cellulose decomposing micro-flora etc in addition to improve soil environment.
- Vermicompost contains earthworm cocoons and increases the population and activity of earthworm in the soil.
- It neutralizes the soil protection.
- It prevents nutrient losses and increases the use efficiency of chemical fertilizers.
- Vermicompost is free from pathogens, toxic elements, weed seeds etc.
- Vermicompost minimizes the incidence of pest and diseases.
- It enhances the decomposition of organic matter in soil.
- It contains valuable vitamins, enzymes and hormones like auxins, gibberellins etc.

Conclusion

Vermicomposting has gained popularity in both industrial and domestic settings because, as compared with conventional composting, it provides a way to treat organic wastes more quickly. In manure composting, it also generates products that have lower salinity levels. Thus this amazing technology should become an alternative for nutrient source thereby creating a pollution free environment.

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MANAGEMENT STRATEGIES OF CUCURBIT FRUIT FLY (*BACTROCERA CUCURBITAE*)

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Bactrocera cucurbitae is an extremely serious pest of cucurbit crops. The pest has been recorded nearly in 125 plants species including the members other than Cucurbitaceae family. They are strong fliers. Adult flies spend much time on green vegetation in nearby cultivated fields. They usually found on the vegetation of any dense plant, bush or tree. In hot weathers the flies hide on the shaded areas or underside of leaves. Flight is most common in the morning hours and in late afternoon. Adult flies feeds on juices from damaged fruits and nectar from flowers.

Host range

It has been reported that the flies has a host range around 80 plants including cucumbers, tomatoes, zucchini, hyotan, pumpkins, eggplant, togan, peppers, squashes, melons and gourds in which cucurbitaceous vegetables are major.

Distribution

Fruit flies are distributed widely in, tropical, sub-tropical and temperate regions of the world.

Nature of damage

Fruit fly damage starts during summer season and ends in rainy season. The extent of damage losses by fruit flies varies from 30 to 100% depending on the season and their abundance. Maggots feed inside the fruits and also sometimes feed on flowers and stems. Infected fruits can be identified easily by the presence watery fluid oozes from the punctures made by the flies which gradually becomes concave with seepage of liquid, and then later transforms into a brown resinous deposit. Occasionally pseudo-punctures have been observed on the fruit which reduces the market value. Larvae feeding from inside the fruits are the most damaging stage. Larval attack in matured fruits develops a water soaked appearance. The tunnels made by the larvae offers entry points for other micro organisms like bacteria and fungi for causing fruit rot as secondary damage with necrotic regions. The attacked fruit consequently rot or become distorted, malformed and fall prematurely. The larvae in addition attack young seedlings in all plants.

Biology

Generally, the female prefers to lay the eggs in unopened flowers soft tender fruit tissues by piercing them with the ovipositor. The eggs are slender, white and measure 0.8 inch in length. They hatch in 2 to 4 days. After hatching, the maggots bore into the fruits by making feeding galleries. These maggots reach approximately 0.5 inch in length upon maturity. The larval period is about from 6 to 11 days, with each stage more or less 2 days depending on the host and climatic conditions. Pupation takes place in the soil at 0.5 to 15 cm below. Pupae are 0.2 to 0.25 inch long, elliptical and dull white to yellowish brown in color with each segment ringed by distinct narrow yellow bands around. Pupae are barrel shaped and brown colored from which adult flies emerge in two weeks from the puparium. Adult measure about 0.3 to 0.5 inch long with a wingspan of 0.5 to 0.6 inch. The head and eyes are dark brown with yellowish brown bodies having yellow spot above the base of the first pair of legs. Oviposition of females takes place in about 10 days after emerging as adult and continues to deposit eggs at regular intervals. One female is capable of laying around 1,000 eggs, in natural conditions. With high mobility and fecundity, each one is able to destroy more fruits in their lifespan. Adults feed on honey and nectar of flowers and juices of ripened fruits. Adults generally live for 10 months to a year and there are several generations in a year. The pest population is lowest during hot and dry weathers and highest during rainy seasons.

Management

Keeping in view the importance of the pest and crop, cucurbit fruit fly management could be done using IPM practices which include several components as it becomes a serious pest for marketing and as well as for self-consumption. Therefore, management of the pest depends on different components other than insecticides. If the use of insecticides has become necessary, then one has to rely on soft insecticides with low residual toxicity and short waiting periods. Repetitive use of insecticides by the farmers to control this fruit fly has become threat to the safety of the environment and also there are chances of increasing poisonous residues in the vegetables and also in the soil as well through accumulation. Keeping in view the importance of the fruit fly in cucurbits, management strategies should be done using different possible components of IPM listed as below.

Cultural Control

- Deep summer ploughing is recommended to expose pupae to hot sun.
- Collect infested, deformed and fallen fruits and buried in deep pits under soil surface.
- Change the sowing dates in endemic areas from rainy season to hot dry weather conditions.
- Weeds within 100 metres of fields should be removed.
- Grow tall plants I field borders like jowar, maize etc. as the flies have the habit of resting on such plants.
- Dispose all crop residues immediately after harvest.

Mechanical Control

- Bagging of fruits on the tree with paper or polythene covers as a protective covering.

Physical control

- By using attractants like eucalyptus oil, citronella oil, vinegar (acetic acid), and lactic acid flies can be trapped.

Chemical control

- When more than 10% of fruits are infected by the flies, spray the solution of malathion @ 1 ml with 20 grams of sugar or molasses per litre of water.
- Mix malathion + methyl eugenol @ 1:1 ratio and keep 10 ml of the bait in open pot lids around the field @ 25/ ha.
- Spray dichlorvos or malathion at 2 ml/litre, repeated at weekly interval if the attack is serious.

Monitoring with pheromone traps.

- Lure traps are commercially available for use against fruit flies which are effective for monitoring and controlling.

Host plant resistance

- HPR is an important component in IPM programs. Incorporating the resistance genes through wide hybridization to the cultivated susceptible genotypes from the wild relatives protect the crop against fruit flies.

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