J. Adelaide Bot. Gard. (15)1: 65-70 (1992)

ESTABLISHING NATIVE PLANTS IN THE ARID ZONE

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Abstract

Thirteen establishment techniques were tested to determine the effect of weed control, watering frequency and mulches on survival and early growth of tree seedlings in an arid zone near Port Augusta.

Fortnightly watering and residual weed control for a 3m diameter circle were found to be the two most important factors, while organic and bitumen mulches were contributing no advantage. Bi-monthly watering was found to be insufficient. Removal of weed competition at planting, without any residual weed control, was of no major benefit, and residual weed control over a 1m diameter circle was also of no benefit.

While the advantages of weed control were shown in this work the above average rainfall for the period of the trial suggests that the work should be repeated in a more representative year before the weed control techniques can be confidently used.

Introduction

An arid zone has been defined as an area with 150-300mm/annum rainfall (Meigs 1953, cited by Hall et al. 1972), and on this basis 76.3% of South Australia is arid zone.

Tree planting in arid zones can be difficult due to the lack of available moisture during the establishment phase. Seedlings are usually watered as rainfall is so irregular or, where there is a sloping site with sufficient clay in the soil, water-harvesting techniques can be used (Wilson 1980). On flat sandy sites water-harvesting is not an option so that watering becomes the standard practise. Hall et al. (1972) state that watering of newly planted shrubs and trees is usually essential to ensure successful establishment in arid zones and they suggest weekly watering for at least six months. Zwar (personal communication, 1986) successfully established hundreds of plants at Port Augusta (see site description below) by fortnightly watering of 40-50 litres. Sandell et al. (1986) achieved successful establishment by weekly watering with 20 litres of water for the first month, then once per fortnight for a further six months.

Another way of increasing available moisture to seedlings is by removing weed competition. Hall et al. (1972) state that grass is usually so sparse in arid zones that competition is not serious, but they do not present any evidence to support this statement. Dalton (1987), working in 340 and 400mm/annum rainfall zones, found that after 12 months seedlings which did not receive supplementary watering but had the weeds controlled around them had 16-20 times the canopy volume of seedlings which didn't have weed control. In more extreme arid zones there may not be such a large growth conferred by weed control; the degree of advantage is not known. Nor is it known whether watering frequency can be reduced if weeds are controlled. Furthermore, optimum width of weed control around the seedling and the relative advantage of mulches in arid zone plantings is not known.

This paper reports on a trial in which the effect of weed control, watering frequency and mulches was investigated on survival and early growth of tree seedlings in an arid zone location near Port Augusta.

Materials and methods

The trial site was at the Australian Arid Lands Botanic Garden, Port Augusta, South Australia; latitude 32°32'24"; longitude 137°46'50"; altitude 4.34m; average maximum temperature 32°C; average minimum temperature 7.3°C; mean annual rainfall 257mm (Table 1); mean relative humidity (3p.m.) 38.6%; mean annual pan evaporation 2,500mm.

The soil is a deep red sand and the existing vegetation consisted of *Maireana sedifolia*, *Sclerolaena obliquicuspis*, *Atriplex holocarpa*, *Sida intricata*, *Carrichtera annua*, *Enneapogon avenaceus*, and a *Stipa* sp.

Tree seedlings were established using the treatments detailed in Table 2. All planting sites were disturbed with a post-hole digger to enable easy planting and basins large enough to hold 20 litres of water were made for the treatments which received watering (1-6). Organic mulch consisted of chopped-up leaves and small branches from prunings of various plant species. The dimensions 1m and 3m refer to clearance circles of 1m and 3m diameter, respectively. For all weed control treatments the appropriate areas were cleared of woody vegetation (eg: *Maireana* sp.) with hand tools because the action of knockdown herbicides on these species is not known.

After hand-clearing and planting a knockdown herbicide containing paraquat and diquat was applied at the rate of 400g/ha and 200g/ha, respectively, to all the herbicide treatments. To the residual weed control treatments oxyfiuorfen at 720g/ha and oryzalin at 3kg/ha was also applied. For all herbicide spraying the planted seedlings were protected so that no herbicide contacted their foliage. Herbicides were applied using a knapsack sprayer with a water output of 300 l/ha. The bitumen was mixed as 1 part to 20 parts of water and sprayed onto the soil surface to create a thin film.

	Post Office	Power Station	
	Average for 1860-1962	Average for 1958-1983	1986/87 Totals
July	20	22	74.4
August	23	21	49.0
September	22	23	14.2
October	23	29	56.1
November	18	19	13.0
December	16	14	6.4
January	15	22	61.4
February	17	23	45.8
March	17	10	19.2
April	19	16	2.8
May	26	31	50.4
June	27	27	20.4
Annual	**243**	**257**	**413.1**

Table 1. Port Augusta rainfall records in mm showing long term monthly averages and monthly totals for the year of the trial (1986/87)

Seedlings were planted on 27th August, 1986, after good July and August rains (Table 1). Because the soil was moist at planting the seedlings were not watered in. The organic mulch (30-60mm deep) and herbicide treatments were applied on 28th August, 1986, and the bitumen was applied on 3rd October, 1986. The *Sclerolaena* sp. quickly regenerated in the residual weed control treatments and were hoed out on 10th December, 1986. Oxyfluorfen and oryzalin did not control the new germination of this species, and seedlings were removed because the concept of a weed free situation was being investigated, not herbicide efficacy.

Eucalyptus socialis and *Eucalyptus transcontinentalis* both occur in rainfall zones as low as 250mm/annum (Chippendale 1973, Costermans 1983) and were planted at 5m x 5m intervals, as single tree plots in a randomised complete block design of seven replicates for each species. On 18th June, 1987, seedling survival was counted, and the stem diameter 20-30mm above ground level, and height was measured for each seedling. A dead seedling was recorded as having a 'zero'diameter or height.

Results and discussion

(i) Survival

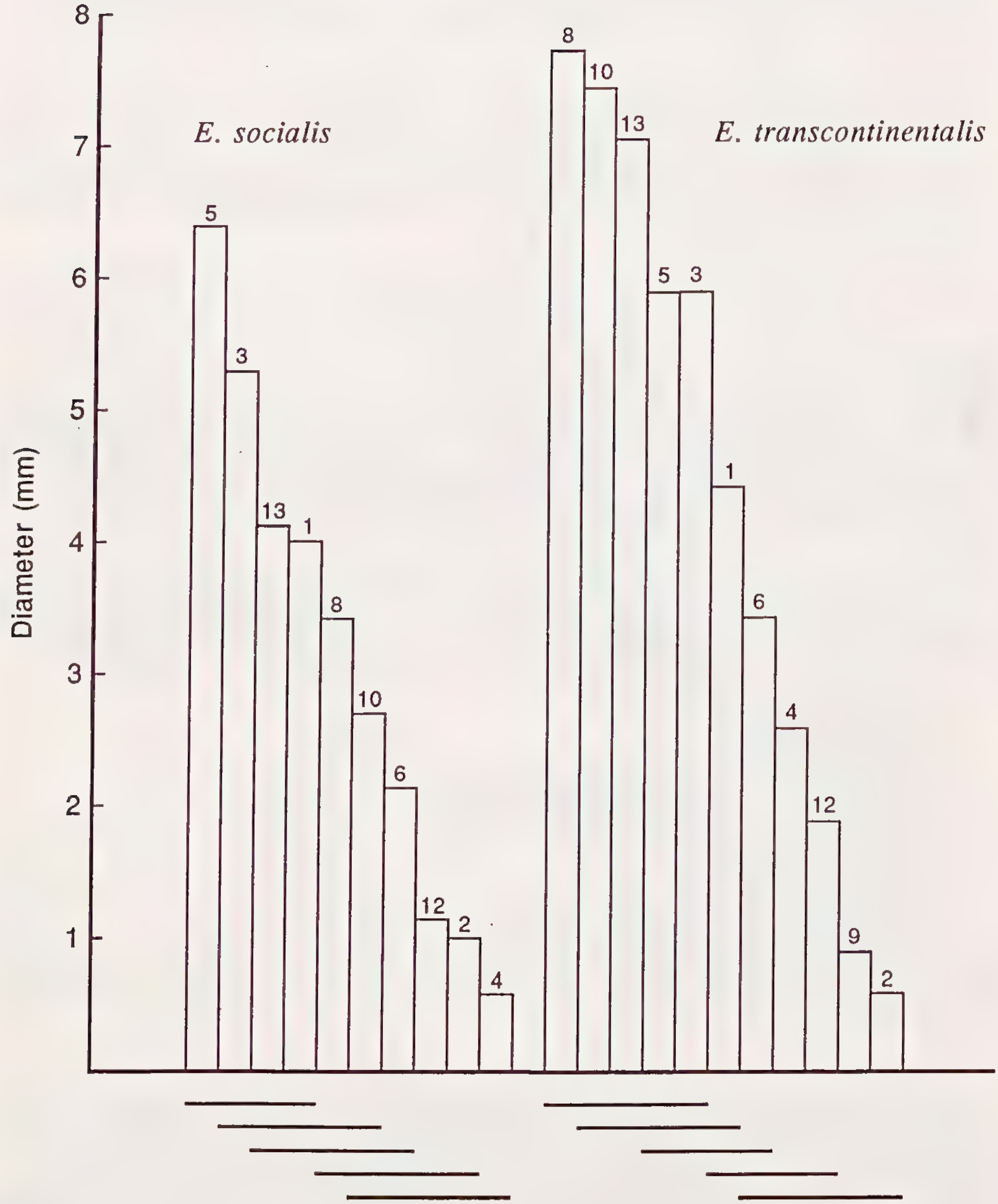
Survival counts are given in Table 2. A count of 6 or 7 was considered acceptable and lower counts unacceptable. Acceptable survival occurred with treatments which received fortnightly watering treatments (1,3 and 5) or had a 3m diameter residual weed control area (treatments 8, 10 and 13 for *E. transcontinentalis* and treatment 13 for *E. socialis*).

		Number survived	
Number	Treatments	*E. socialis*	*E. transcontinentalis*
1.	Organic mulch, fortnightly watering	6	6
2.	Organic mulch, bi-monthly watering	2	1
3.	Fortnightly watering	7	7
4.	Bi-monthly watering	1	4
5.	Residual weed control 1m, fortnightly watering	7	6
6.	Residual weed control 1m, bi-monthly watering	3	5
7.	Organic mulch	0	0
8.	Organic mulch, residual weed control 3m	5	7
9.	Residual weed control 1m	0	2
10.	Residual weed control 3m	3	7
11.	No mulch, weed control or watering	0	0
12.	Knockdown weed control 3m, bitumen mulch 3m	2	5
13.	Residual weed control 3m, bitumen mulch 3m	6	7

Table 2. The thirteen establishment treatments tested for two species and the count (out of seven) of survival 10 months after planting.

With fortnightly watering treatments, acceptable survival was achieved without the mulch (1) or small weed control areas (5). This showed that if fortnightly watering is practised then mulches or small areas of weed control do not have to be used. If watering is less frequent than fortnightly, the benefit from the mulch and the small weed control area may become more apparent. However, the benefit is not sufficient to give acceptable survival when watering is reduced to bi-monthly (2, 6).

As seedlings were not watered in, the acceptable survival achieved with some of the 3m diameter weed control treatments was done without the seedlings receiving any watering at all. Treatments 8 and 10 for *E. socialis* did not have acceptable survival counts, but because of the advantage from weed control, it may be that with a few waterings at critical periods their survival counts would have been acceptable as they were for *E. transcontinentalis*. The



F9, 54 = 5.16, EMS = 5.0574

F10, 60 = 6.72, EMS = 7.1917

Fig. 1. Stem diameter, of two species, 10 months after planting, as affected by establishment technique (see Table 1). Treatments joined by the same line were not different ($p = 0.05$) using Duncan's multiple range test.

data suggests that 3m diameter weed control clearance and strategic waterings may be sufficient to achieve acceptable survival in arid zones; which is a cheaper technique than fortnightly watering.

Of the treatments which had unacceptable survival counts that with no mulch, weed control or watering resulted in the plants dying (11); bi-monthly watering was not frequent enough (discussed above); 1m diameter weed control clearance areas were inadequate (9); killing the weeds at planting (12) does not produce as good survival as keeping the soil weed-free (8, 10, 13).

(ii) Stem diameter

With all 13 treatments included, the Bartlett's test for homogeneity of variance showed that treatments had heterogeneous variances for both species. When treatments that had 100% mortality were excluded from the data (i.e. treatments 7, 9 and 11 for *E. socialis* and treatments 7 and 11 for *E. transcontinentalis*) homogeneity of variances existed (X 2/9 = 12.109 for *E. socialis* and X 2/10 = 12.57 for *E. transcontinentalis*) so an analysis of variance was performed on the data. The results are presented in Figure 1. Treatments not significantly different (p=0.05) from the highest mean are the group of best treatments, this group comprising treatments which had either fortnightly watering or a 3m diameter residual weed control clearance area.

The use of residual herbicides may not always be practical in arid zone situations because of the need for rainfall for their incorporation. However this work shows the importance of keeping the soil weed free which can be done by other means such as cultivation.

Table 1 shows there was above average rainfall for October 1986, January and February 1987, and for the total year of the trial. These falls may have increased growth, especially for the unwatered treatments, and the benefit of the 3m diameter residual weed clearance area control should be tested in a year with less rain before being recommended as a plant establishment technique.

		E. socialis	*E. transcontinentalis*
Organic mulch			
With fortnightly watering	(1 vs. 3)	X	X
With bi-monthly watering	(2 vs. 4)	X	X
With residual weed control 3m	(8 vs. 10)	X	X
Bitumen mulch			
With residual weed control 3m	(13 vs. 10)	X	X
Fortnightly vs. bi-monthly watering			
With organic mulch	(1 vs. 2)	G	G
With no mulch	(3 vs. 4)	G	G
With residual weed control 1mm	(5 vs. 6)	G	X
Weed control			
3m vs. 1m	(10 vs. 9)	G	G
Residual 3m vs. knockdown 3m	(13 vs. 12)	G	G

Table 3. Comparisons of stem diameter to determine the effect of individual factors. The comparisons are between treatments which differ only in the factor mentioned. (X = the two treatments did not produce significantly different growth; G: the former treatment produced significantly greater growth.)

Table 3 shows that there was no advantage derived from the organic or bitumen mulch and confirms the value of fortnightly watering and 3m residual weed control. The bitumen mulch may be of more benefit if the site is subject to sand drift and any mulch would be expected to be of more benefit on soils of high evaporative potential.

(iii) Plant height

For *E. socialis* the correlation co-efficient for stem diameter and plant height was $r(9)=0.990$, which is a significant correlation at $p<0.001$; and is described by the equation $y=1.2094 + 7.198X$; where y=height in centimetres and x=diameter in millimetres. For *E. transcontinentalis* the same correlation gave $r(10)=0.98$ (significant correlation at $p<0.001$) described by the equation $y=4.7612 + 5.9009X$. These correlations show that stem diameter was a good indicator of tree growth and useful for determining seedling heights for relating to other work.

Conclusion

This trial shows that residual weed control over a 3m diameter circle can give results comparable to those achieved with fortnightly watering. However, the rainfall was above average for the year of the trial so the advantage from the weed control needs to be evaluated in a more typical year with less rain. Nevertheless, there is an advantage from weed control and it is likely that the most economical establishment technique will be a combination of weed control with waterings during extended dry periods. This should be tested.

Of significance in terms of weed control are the facts that a 1m diameter circle of weed control is of negligible value; and that non-residual weed control will not give as much growth advantage as will be achieved by keeping the sites weed free.

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