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Chemical control of weeds in seedling leucaena (Leucaena leucocephala)—post-emergence applications

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Summary

The post emergence herbicides prometryne (1.0 kg ha^{-1}), diuron (0.3 kg ha^{-1}), MSMA (2.0, 2.4 and 3.0 kg ha^{-1}), 2,4-D (0.25, 0.5 and 1.0 kg ha^{-1}) and 2,4-DB (1.0 kg ha^{-1}) were applied to leucaena *(Leucaena leucocephala* cv. Peru) from 1 to 8 weeks after planting. The first three trials contained leucaena plus weeds while the fourth trial contained leucaena only.

All herbicides and the remaining weeds suppressed leucaena growth compared to the unweeded control. 2,4-DB and 2,4-D had similar effects on leucaena. Effective weed control will require interrow cultivation and directed post-emergence herbicide spray.

1. Introduction

Early growth of leucaena (*Leucaena leucocephala* cv. Peru) is slow, making it susceptible to weed competition (Takahashi and Ripperton 1949; Hill 1970). Weeds can be controlled by hand weeding (Shaw 1965) or mechanical cultivation. Protracted periods of rainfall and wet soil, however, can reduce the effectiveness of cultivation.

Four trials were conducted from 1971 to 1973 to examine the effect of five herbicides (MSMA, prometryne, diuron, 2,4-D and 2,4-DB) on the growth of leucaena and the control of weeds. The herbicides were sprayed uniformly over the leucaena and weeds at varying stages of growth up to 8 weeks from planting.

2. Materials and methods

The trials were conducted at 'Brian Pastures', Pasture Research Station, Gayndah, situated 25° 38′ S, 151° 47′ E, altitude 130 m. The soil type was Ug 5.12 (Northcote 1971) in an area heavily infested with broad-leaved weeds and grasses.

General techniques

Prior to sowing, the leucaena seed was treated for optimum germination and inoculated with *Rhizobium* CB 81. The soil was irrigated and wet to a depth in excess of 15 cm before or after sowing. The seed was sown 2.5 cm deep (by hand in trials 1 to 3) and 4 to 5 cm deep (by cone planter (Fletcher 1970) in trial 4).

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The herbicides were applied in water at 580 L ha^{-1} (trial 1) or 500 L ha^{-1} (trials 2 to 4) through flat fan nozzles at 205 kPa.

For each treatment, the number of leucaena plants, grasses and broad-leaved weeds were counted, harvested at ground level, oven dried, and weighed.

Trial 1. Leucaena seed was sown into dry soil and irrigated on 23 November 1971, or into moist soil next day. The treatments (table 1) were arranged in a randomized block design with three replications. Each plot contained four rows of leucaena 0.5 m apart and 1.4 m long. Rainfall totalling 34 mm fell between days 1 and 7 and 102 mm fell between days 14 and 42 (harvest). Emerged live and dead leucaena seedlings were counted each day to day 14, then weekly until harvest, when on 4 and 5 January 1972 the central 0.8 m^2 was harvested. All live plants were identified and counted.

Trial 2. The treatments (table 3) plus a weeded control were arranged in a randomized block design with three replications. The plots were 2.4 m long and 1.5 m wide. Forty-eight leucaena seeds were sown into dry soil and irrigated on 6 September 1972. The soil surface was rewetted next day to enhance germination. The herbicides were applied on 14, 20 and 27 September 1972. There was 20 mm and 19 mm of rain on 27 September and on 2 October respectively. This rain germinated more leucaena seeds which were counted but not harvested. Live and dead leucaena counts were made daily from the centre 2.0 m^2 of the plot until harvest. The weeds were identified and counted 14 days after herbicide application and at harvest on 10 October 1972 (day 34).

Trial 3. The treatments (table 4) plus one weeded and two unweeded controls were arranged in a randomized block design with three replications. The plots were 2.4 m long and 1.5 m wide. Forty-eight leucaena seeds were sown into dry soil on 9 October 1972 and irrigated over the following 2 days. The herbicides were applied on 24 October, 7 and 14 November 1972. Rainfall totalling 124 mm fell between 24 October and 14 November and a further 76 mm fell up to 28 November 1972 (harvest). The leucaena plants were counted daily until day 14, weekly to day 28, and daily to day 49. The leucaena and weeds were counted and harvested from the central 1.6 m^2 of the plot on 28 November 1972.

Trial 4. The treatments (table 6) were arranged in a factorial design with three replications. The plots were 2.5 m long and 1.79 m wide. The area was irrigated on 9 October, and 125 leucaena seeds were sown in 5 rows on 11 October 1973. Weeds were removed by hand chipping. Where 2,4-D and MSMA were applied to the one plot, two sprayings were carried out 30 minutes apart. Plant counts were taken weekly from the centre 2.14m^2 until harvest on 18–19 December 1973. Plant heights and colour were also recorded at harvest.

3. Results

Trial 1. Prometryne and diuron rapidly killed most leucaena seedlings. MSMA caused only a slight reduction in leucaena numbers but severely depressed growth of those remaining to a yield similar to the unweeded leucaena (table 1). All herbicides and times of application significantly ($P < 0.05$) reduced the number and oven-dry-weight of grass seedlings. Prometryne and diuron, applied at day 14, caused the greatest reduction in numbers and oven-dry-weight of broad-leaved weeds at harvest (table 2).

Table 1. Effect of MSMA, prometryne and diuron on the percentage of live leucaena seedlings at 7, 14 and 42 days after planting and irrigating, and oven-dry-weight of live leucaena plants at day 42 (trial 1)

Herbicides (kg ha^{-1})	% of leucaena seedlings alive on day			Mean ODW (g m^{-2})
	7	14	42	
MSMA 2.4 applied day 7*	69.0	79.2	70.8	4.00
Prometryne 1.0 applied day 7*	64.2	8.3	5.0	0.55
Diuron 0.3 applied day 7*	63.4	19.2	15.8	1.38
MSMA 2.4 applied day 14	72.5	83.3	66.7	3.71
Prometryne 1.0 applied day 14	67.3	74.8	0.0	0.00
Diuron 0.3 applied day 14	75.9	82.5	0.0	0.00
Hand-weeded control	73.3	84.2	79.2	26.63
Unweeded control	74.2	81.4	78.5	3.54
LSD P = 0.05	NS	7.8	9.8	4.17

* When the herbicide was applied on day 14, there was a significant ($P < 0.05$) increase in the number of unsprayed live leucaena seedlings between days 7 and 14 due to delayed emergence.

Table 2. Effect of herbicides on the number and oven-dry-weight of grasses and broad-leaved weeds by day 42 (trial 1)

Herbicide kg ha^{-1}	MSMA 2.4		Prometryne 1.0		Diuron 0.3		Unweeded control	LSD P = 0.05
Day applied (after irrigating) ..	7	14	7	14	7	14		
Grass weeds Plants m^{-2} ..	31.6	26.1	21.7	42.5	38.6	28.8	132.2	24.1
OD yield g m^{-2}	197.0	66.3	158.1	129.6	167.9	161.5	329.7	84.3
Broad-leaved weeds Plants m^{-2} ..	24.8	10.2	5.8	0.5	19.8	2.1	36.3	10.1
OD yield g m^{-2}	19.7	2.5	1.6	0.2	8.9	0.4	11.6	5.1

Trial 2. MSMA at 3.0 kg ha^{-1} applied at day 14 significantly ($P < 0.05$) reduced leucaena seedling survival by day 25. At harvest, MSMA applied at day 21 and 2,4-DB applied at day 14 significantly ($P < 0.05$) suppressed leucaena oven-dry-weight per plant. Leucaena yield per plant was not significantly ($P > 0.05$) different for weeded or unweeded leucaena. Total number of weeds was significantly ($P < 0.05$) reduced 14 days after the first and second herbicide spray but not ($P > 0.05$) after the third spray. The herbicides did not significantly ($P > 0.05$) reduce weed weight at harvest. 2,4-D and 2,4-DB affected leucaena in a similar manner (table 3).

Trial 3. Weed-free leucaena significantly ($P < 0.05$) outyielded leucaena in other treatments which were not significantly ($P > 0.05$) different from one another. Only MSMA significantly ($P < 0.05$) reduced the dry matter yield of grass weeds (table 4).

Table 3. Effect of herbicides on the number and oven-dry-weight of leucaena and weeds (trial 2)

Herbicide treatment kg ha^{-1}	Percent leucaena survived (day 25)	Leucaena yield plant^{-1} mg (day 35)	Total no. of weeds m^{-2} (14 days after herbicide application)		Weed yield (g m^{-2}) (day 35)
Unweeded control*					
day 8	94	83	20.50	(4.6)†	7.32
day 14			30.43	(5.6)	..
day 21					
Weeded control					
day 8	89	85			
MSMA 2 day 8	93	98	0.88	(0.8)	0.56
MSMA 2 day 14	92	47	3.47	(1.4)	0.10
MSMA 2 day 21	92	36	..	..	0.55
MSMA 3 day 8	97	80	2.30	(1.1)	0.76
MSMA 3 day 14	55	69	2.27	(1.1)	0.03
MSMA 3 day 21	94	41	..	..	0.38
2, 4–D ¼ day 8	93	71	8.18	(2.1)	3.35
2, 4–D ¼ day 14	83	64	12.52	(2.6)	1.80
2, 4–D ¼ day 21	100	61	..	..	1.83
2, 4–D ½ day 8	98	80	2.90	(1.3)	0.33
2, 4–D ½ day 14	100	87	7.72	(2.0)	1.58
2, 4–D ½ day 21	95	72	..	..	1.06
2, 4–D 1 day 8	100	65	9.20	(2.2)	1.65
2, 4–D 1 day 14	85	45	10.73	(2.3)	0.83
2, 4–D 1 day 21	81	52	..	..	1.50
2, 4–DB 1 day 14	100	23	23.08	(3.4)	4.65
2, 4–DB 1 day 21	86	72	..	..	0 75
Mean	91	66	10.32		1.91
LSD 5%	21	42		(2.20)	N.S.
LSD* 5%	18	36		(1.90)	N.S.

* For LSD of unweeded control versus other treatments use LSD on lower line.
† $\sqrt{x + \frac{1}{2}}$ transformation

Table 4. Effect of herbicides on the number and oven-dry-weight of leucaena and weeds (trial 3)

Herbicide treatment (kg ha^{-1})	ODW (g m^{-2})		
	Leucaena	Weeds	
		narrow leaf	broad leaf
Nil weed removal*	3.7*	116*	7*
Full weed removal	10.7		
MSMA 2.0 day 14 and 2.0 day 28 ..	3.3	69	10
MSMA 2.0 day 14 and 2.0 day 35 ..	2.8	57	8
MSMA 2.0 day 14 and 3.0 day 28 ..	3.1	26	8
MSMA 2.0 day 14 and 3.0 day 35 ..	2.1	53	14
2, 4–D 0.25 day 14 and 0.25 day 28 ..	2.5	175	2
2, 4–D 0.25 day 14 and 0.25 day 35 ..	2.2	138	1
2, 4–D 0.25 day 14 and 0.5 day 28 ..	2.4	95	0
2, 4–D 0.25 day 14 and 0.5 day 35 ..	2.5	133	3
2, 4–D 0.25 day 14 and 1.0 day 28 ..	1.3	138	1
2, 4–D 0.25 day 14 and 1.00 day 35 ..	2.3	95	0
2, 4–DB 1.0 day 14 and 1.0 day 28 ..	1.6	151	3
2, 4–DB 1.0 day 14 and 1.0 day 35 ..	1.8	105	2
Mean	3.1	105	5
LSD P = 5%	2.4	44	7
LSD* P = 5%	2.1	38	6

* For LSD of nil weed removal versus other treatments use the LSD on the lower line.

Trial 4. All herbicides and times of application significantly ($P < 0.05$) reduced leucaena yield below that of the control. By harvest, the foliage of the early sprayed plants was least affected (table 5). Seedling mortality increased from 1% to 10% as herbicide concentration increased and decreased from 17% to zero as the plant aged at the time of spraying. The low rate of 2,4-D had the least effect on reducing leucaena height (table 6). The leucaena leaves developed a red tinge from the MSMA and a blue tinge from the 2,4-D.

Table 5. Effect of MSMA and 2,4-D separately and in combination on the oven-dry-weight of leucaena by week 10 (trial 4)

Time of herbicide application (weeks)	Leucaena yield (g)		Herbicide application (kg ha^{-1})	Leucaena yield (g)	
	m^{-2}	plant^{-1}		m^{-2}	plant^{-1}
3	22.0	2.29	MSMA 2.0	31.8	3.12
4	11.1	1.09	MSMA 3.0	18.4	2.23
5	21.9	2.03	2,4-D amine 0.25	32.3	3.18
6	17.9	1.83	2,4-D amine 0.5	26.0	2.22
7	19.7	1.78	MSMA 2.0 + 2,4-D 0.25	13.9	1.34
8	26.5	2.61	MSMA 2.0 + 2,4-D 0.5	11.7	1.08
Nil herbicide	44.9	3.91	MSMA 3.0 + 2,4-D 0.25	14.3	1.25
			MSMA 3.0 + 2,4-D 0.5	9.3	1.07
			Nil herbicide	44.9	3.91
LSD for treatments P = 0.05	8.1	0.62		9.4	0.71
LSD for treatments versus LSD for nil herbicide P = 0.05	9.6	0.73		9.0	0.68

There were no significant interactions (P = 0.05).

Table 6. Effect of MSMA and 2,4-D separately and in combination on the height of leucaena by week 10 (trial 4)

Week of spraying	Leucaena height (cm) Herbicides (kg ha^{-1})								Mean
	MSMA		2,4-D		MSMA 2.0 + 2,4-D		MSMA 3.0 + 2,4-D		
	2.0	3.0	0.25	0.5	0.25	0.5	0.25	0.5	
3	9	25	33	28	18	8	13	8	17
4	20	18	20	18	8	9	8	9	14
5	20	13	35	25	15	13	8	9	17
6	18	18	20	23	15	11	10	10	15
7	23	15	23	15	13	13	15	9	15
8	30	18	18	18	20	20	15	15	19
Mean	20	18	25	21	15	12	11	10	
Control	32								

	P = 0.05
LSD for herbicide	4
time	3
interaction	10
control v herbicide	4
control v time	4
control v interaction	7

4. Discussion

An emergence of 84% was achieved in trial 1, while lower, patchy establishment occurred in the other trials. This led to high error terms and loss of sensitivity in the analysis of variance of yields per plot. Accordingly, herbicide effect was analysed on leucaena yield per plot and per plant.

Weed numbers and dry matter yield were reduced to less than 25% of the unweeded control with 2,4-D at 0.5 kg ha^{-1} in trial 2.

There was a similar pattern in trial 3, except that the decrease in broad-leaved weeds was linked with an increase in grass weed numbers. In trial 4, in the absence of weeds, 2,4-D at 0.25 kg ha^{-1} and 0.5 kg ha^{-1} suppressed leucaena growth, indicating that the opportunity for selective control of broad-leaved weeds in leucaena with 2,4-D does not appear to exist. 2,4-DB at 1.0 kg ha^{-1} showed similar herbicide activity to 2,4-D in trials 2 and 3.

The effect of MSMA and the remaining weeds suppressed leucaena's growth to that of the control. The low rate applied at week 8 in trial 4 did not suppress the mean leucaena height. Thus, MSMA may have application as a directed spray to the base of the leucaena plant.

Prometryne and diuron at the rates used in the trials cause unacceptable damage to leucaena as overall sprays. While prometryne may be applied as directed post-emergence sprays, the weeds usually smother the leucaena before it is sufficiently tall to receive a directed spray.

Weeds may be controlled at planting by allowing them to germinate and then cultivating when sowing the leucaena seed into a moist seed bed. An alternative is to apply a post-emergence herbicide before the leucaena plants emerge. However, rain soon after planting can germinate a fresh suite of weed seeds. The other alternatives are for late applications of herbicides directed to the base of the leucaena, interrow cultivation, or immediate applications of post-planting herbicides.

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References

Barrier, G. E. (1970), Herbicide handbook of the Weed Science Society of America, 2nd edition, W. F. Humphrey Press, Geneva, New York.

Crafts, A. S. (1961), The chemistry and mode of action of herbicides, 3rd printing 1967, Interscience Publishers, New York.

Fletcher, D. S. (1970), A field plot cone planter, *Queensland Agricultural Journal* 96, 337.

Hill, G. D. (1970), Studies on the growth of *Leucaena leucocephala* 1. Effect of clean weeding and nitrogen fertilizer on early establishment, *Papua and New Guinea Agricultural Journal* 22, 29.

Northcote, K. H. (1971), A factual key for the recognition of Australian soils, 3rd edition, Rellim Technical Publications, Glenside, South Australia.

Shaw, N. H. (1965), Weed control in *Leucaena leucocephala,* Annual Report, Division of Tropical Pastures, CSIRO, Australia 1964–65, p. 42.

Takahashi, M. and Ripperton, J. C. (1949), Kao haole (*Leucaena glauca*). Its establishment, culture and utilization as a forage crop, Bulletin 100, University of Hawaii Agricultural Experiment Station.

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