TOLERANCE OF TREE SEEDLINGS TO PRE- AND POST-EMERGENCE HERBICIDES

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Abstract

Pre- and post-emergence herbicides were applied to seeds or seedlings of a number of tree species in soil in glasshouse flats and their tolerance to the herbicides recorded. Pinus radiata tolerated oxyfluorfen, flupropanate, atrazine, glyphosate and Forest Mix? (hexazinone + atrazine). Eucalypts tolerated high rates of flupropanate and low rates of oxyfluorfen and Eucmix? (terbacil + sulfometuron methyl). Although some herbicides showed promise in assisting the establishment of eucalypts from seed, none were completely safe at rates needed to kill weeds. Therefore, one of the major priorities on research into the establishment of eucalypts sown from seed remains, the discovery of safe pre- and post- emergence herbicides.

Key words: Herbicide tolerance, Pinus radiata, Eucalyptus spp., Acacia sp. Casuarina sp., flupropanate, oxyfluorfen, atrazine, glyphosate, Forest Mix?, Eucmix?.

Degenerate pastures that occur over large areas of steep, rocky country in New South Wales (NSW) are a source of weeds, dry land salinity, soil erosion and increasing soil acidity. Profitable production from pastures on this type of country is not possible under the present economic conditions (3). Returning this country to the original climax vegetation, trees, would be a sustainable solution to the problems posed. Pinus radiata has been used to replace pastures dominated by serrated tussock (Nassella trichotoma), but the cost of establishment by manual planting of young trees is $1500/ha. As it is possible that trees could be established much faster and cheaper by aerial sowing or direct drilling than by manual planting (1), investigations were undertaken in 1995 (2) and 1996 (M.H. Campbell, unpublished data) to examine this possibility. Results showed (2) that some tree species are well adapted to establish from aerial sowing and/or direct drilling. The major factor limiting establishment was competition from weeds in the first six months after sowing. Therefore, investigations were begun in 1996 to examine the tolerance of a number of tree species to pre- and post-emergence herbicides so that weeds could be selectively removed from establishing seedlings.

Methods

Four experiments were carried out by sowing tree seeds in glasshouse flats (28 x 33 cm), applying herbicides and recording the number of seedlings that survived. Sufficient seed and chaff were sown to give 25 tree seedlings/row in the flats. Seeds were treated with Apron? to reduce damping-off. Water was applied by misting, equivalent to 2 mm rain/day in cold months and up to 9 mm/day in hot months. Treatments (flats) were arranged in three randomised blocks and species randomised within each flat.

Experiment 1: pre-emergence; high rates

Three herbicides were each applied at two rates (Table 1) to sterilised soil derived from shale in glasshouse flats on 5 June 1996 and seed of eight tree species (Table 1) sown on 6 June, 1996, by pressing seeds into the soil surface and covering each row with 5 mm of fine sand. The number of seedlings to emerge and survive to 58 days after sowing was recorded. An unsprayed control treatment was included.

Experiment 2: pre-emergence; low rates

Treatments included two herbicides x two rates (Table 2) x two rainfalls (0 and 24 mm in the 16 days between spraying and sowing) applied to sterilised soil derived from shale in glasshouse flats. Herbicides were applied on 11 March, 1997, and seed of seven tree species (Table 2) sown by pressing seed into

the soil surface on 27 March, 1997. The control treatment remained unsprayed. The number of seedlings to survive to 56 days after sowing was recorded.

Table 1: Effect of pre-emergence herbicides on establishment of trees meaned for herbicide rate recorded 58 days after sowing; establishment expressed as a percentage of the number to establish on the control.

	Establishment (%)							
Herbicide	*P. radiata*	*E. globulus*	*E. fastigata*	*E. macarthurii*	*E.viminalis*	*A. dealbata*	*E. aggregata*	*C. cunninghamiana*
Oxyfluorfen[b]	100a[a]	75b	47b	36b	33b	4b	3b	0b
Atrazine[c]	47b	0c	1c	0c	0c	2b	0b	0b
Flupropanate[d]	100a	100a	100a	100a	100a	78a	100a	85a

[a] Values in columns not followed by a common letter differ significantly at P<0.05.
[b,c,d] Meaned for rates of : [b] 0.48 and 0.96; [c] 1.0 and 2.0; [d] 1.5 and 3.0 kg a.i./ha.
P. Pinus, E. Eucalyptus, A. Acacia, C. Casuarina.

Table 2: Effect of pre-emergence herbicides on establishment of trees meaned for rainfall between spraying and sowing and rate of herbicide recorded 56 days after sowing; establishment expressed as a percentage of the numbers to establish on the control.

	Establishment (%)						
Herbicide	*P.radiata*	*E. globulus*	*E. viminalis*	*E. fastigata*	*E. pauciflora*	*C. cunninghamiana*	*E. aggregata*
Oxyfluorfen[b]	94a[a]	88a	84a	68a	68a	42a	36a
Atrazine[c]	92a	0b	0b	0b	3b	19b	0b

[a] Values in columns not followed by a common letter differ significantly at P<0.05.
[b, c] Meaned for 0 and 25 mm rainfall between spraying and sowing and for rates of : [b] 0.24 and 0.48; [c] 0.5 and 1.0 kg a.i./ha

Experiment 3: post emergence; glyphosate

Treatments included spraying 3- and 5-month-old seedlings of 12 tree species with different rates of glyphosate (Table 3). Tree seeds were sown 5 mm deep in sterilised soil derived from basalt in glasshouse flats with open lattice bases on 3 May 1996, grown in a glass- house for one month, and then, when the roots were beginning to emerge through the lattice holes in the base of the flats, each flat was planted 5 cm deep in the soil in the field. The flats were watered at planting but thereafter rain supplied adequate moisture for growth. On 23 July, 1996, seedlings on three treatments were sprayed with glyphosate at 0.36, 0.72 and 1.44 kg a.i./ha. On 27 September, 1996, a further three treatments were sprayed with 0.09, 0.18 and 0.36 kg a.i./ha glyphosate. The control treatment remained unsprayed. Survival of seedlings was recorded on 21 November, 1996.

Experiment 4: post emergence; granular

Two post emergence herbicides were applied to 6-week-old tree seedlings growing on unsterilised basalt soil in glasshouse flats on 13 October 1997. The first, a mixture of terbacil (4.4% a.i.) and sulfometuron methyl (0.2% a.i.), named Eucmix[?], was applied at four rates to seedlings of seven tree species (Table 4). The second, Forest Mix[?], a mixture of hexazinone (5% a.i.) and atrazine (15% a.i.), was applied at two rates to P. radiata seedlings (Table 4). Unsprayed controls for both groups of trees were also included. At spraying the following seedlings weeds, 1 to 10 cm high, were present in order of frequency: Anagallis arvensis, annual legumes, Juncus bufonius, Vulpia spp., Ploygonum vulgare, Cerast-ium glomeratum, Lamium amplexicaule, Phalaris aquatica, Cirsium vulgare. Survival of trees and weeds was recorded on 14 November, 1997.

Results

Experiment 1: pre-emergence, high rates

Results are presented meaned for herbicide rate because there were few significant differences (P<0.05) between rates. Most species tolerated flupropanate, two tolerated oxyfluorfen and only P. radiata tolerated atrazine (65% and 30% establishment on the low and high rate, respectively).

Experiment 2: pre-emergence, low rates

Results are presented meaned for rainfall and rate of herbicide because these treatments had no significant effect (P<0.05). More species tolerated the lower rates of oxyfluorfen in this experiment than in Experiment 1 but again, as in Experiment 1, P. radiata was the only species to tolerate atrazine (Table 2).

Experiment 3: post emergence; glyphosate

P. radiata tolerated 0.36 kg a.i./ha glyphosate but other species could only tolerate 0.18 or 0.09 kg a.i./ha (Table 3). Some eucalypt species were more tolerant to glyphosate than others (Table 3). Based on the common rate of 0.36 kg a.i./ha, there was little difference in effect on trees 3- and 5-months-old for most species (Table 3).

Table 3: Tolerance of tree seedlings to glyphosate; survival expressed as a percentage of that on the control.

Age at spraying	Rate of glyphosate	Survival (%)											
(months)	(kg a.i./ha)	*P. radiata*	*E. viminalis*	*E. melliodora*	*C. cunninghamiana*	*E. globulus*	*E. macarthurii*	*E. camaldulensis*	*A. dealbata*	*E. manniferа*	*E. aggregata*	*E. fastigata*	*E. macrorhyncha*
5	0.09	100a[a]	96a	77a	67a	99a	80a	82a	88a	96a	90a	59a	34a
	0.18	100a	98a	66a	60a	60b	52b	59b	54b	66b	45b	33b	25ab
	0.36	100a	34b	34b	30b	26c	19c	4d	32c	8c	14c	12c	20b
3	0.36	100a	29b	44b	33b	2d	27c	37c	8d	5c	18c	8c	0c
	0.72	44b	12c	7c	11c	0d	21c	3d	12d	4c	0d	0d	0c
	1.44	13c	0d	0d	0d	0d	0d	0d	5d	0d	0d	0d	0c

[a] Values in columns not followed by a common letter differ significantly at P<0.05.

Experiment 4: post emergence; granular

Most of the species sown tolerated Eucmix? at 5 kg/ha and two were tolerant at 10 kg/ha (Table 4). P. radiata was tolerant to Forest Mix? at 10 kg/ha but not to 20 kg/ha. Herbicide treatments controlled seedling weeds that establish with the trees.

Discussion

Results showed P. radiata was tolerant to the pre- and post-emergence herbicides used but Eucalyptus, Acacia and Casuarina species were much more sensitive. The rates tolerated by P. radiata were high enough to kill the grass and broadleaved weeds that compete in the first six months after sowing. Thus, a weed control program could be devised to assist P. radiata establish from direct drilling. P. radiata does not establish well from aerial sowing, even if weeds are controlled, possibly due to birds taking the seeds (2) or because its large radicle, relative to the eucalypts, finds it difficult to enter the soil.

Table 4: Tolerance of tree and weed seedlings to granular herbicides; survival expressed as a percentage of that on the control and measured 32 days after spraying.

Herbicide	Rate	Survival (%)								
	(kg/ha product)	*E. albens*	*E. melliodora*	*C. cunninghamiana*	*E. blakleyi*	*E. viminalis*	*E. pauciflora*	*E. macarthurii*	*P. radiata*	Weeds
Eucmix®	5	70a[a]	68a	93a	83a	72a	82a	62a		11a
	10	72a	64a	40b	35b	25b	38b	35b		2b
	15	68a	32b	22c	25b	38b	12c	27b		3b
	20	7b	0c	0d	0c	0c	3d	5c		0b
Forestmix®	10								89a	1b
	20								29b	0b

[a] Values in columns not followed by a common letter differ significantly at P<0.05.

The eucalypts were sensitive to all herbicides used except flupropanate. However some species were tolerant to low rates of oxyfluorfen, glyphosate and Eucmix?. Oxyfluorfen could be used to augment the effects of glyphosate applied before sowing, however low rates (0.24 to 0.48 kg a.i./ha) and an interval of 16 days between spraying and sowing would be necessary to assist establishment of even the less sensitive species E. globulus, E. viminalis, E. fastigata and E. pauciflora. Some eucalypts tolerated post emergence glyphosate at 0.09 and 0.18 kg a.i./ha, but these rates would have little effect on the weeds that compete with trees during establishment. The granular herbicide Eucmix? was effective at 5 and 10 kg/ha in killing weeds and allowing some eucalypts (E. albens, E. melliodora) to establish. However, it requires even application, moist soil on application and rain after application to be effective. Even at the above rates, some tolerant eucalypts were killed because it was difficult to get even distribution on glasshouse flats, indicating that problems in the field from aerial or ground application may be substantial.

References

1. Bird, R., Cumming, K.N. and Kearney, G.A. 1990. Proc. Direct Seeding and Nat. Reveg. Conf. pp. 65-74.

2. Campbell, M.H. and Nicol, H.I. 1996. Proc. 11th Aust. Weeds Conf. Melbourne, pp. 493-496.

3. Vere, D.T., Auld, B.A. and Campbell, M.H. 1993. Weed Tech., 7, 776-782.