FOSAMINE FOR CONTROL OF NATURALLY REGENERATING RADIATA PINE AND COMPETING VEGETATION FOLLOWING WILDFIRE

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Summary. Fosamine was evaluated at 0, 3.6, 7.2, 14.4 and 28.8 kg a.i. ha^{-1} for control of radiata pine, *Pinus radiata*, regenerating naturally after fires in north-eastern Victoria. All herbicide rates significantly reduced the number of pine seedlings and the dry weight of competing vegetation compared to unsprayed plots. The low rate of 3.6 kg ha^{-1} reduced the number of pine seedlings from about 15,000 to 4,000 plants ha^{-1} and prevented further germination. Thus, fosamine is acceptable for managing dense radiata pine regeneration in fire-affected plantations.

INTRODUCTION

Dense thickets of natural regeneration of radiata pine, *Pinus radiata* containing up to several hundred thousand trees per ha (2) often develop after wildfire under the canopy of cone-bearing stand. If left unthinned these thickets are likely to produce stands of low value and often of low wind firmness (1). Occasionally, second rotation stands are established from this regeneration (3).

Techniques that have been used to control thickets include broadcast burning, crushing or macerating with heavy machinery, manually pulling young seedlings, mechanical brushcutting and application of herbicides.

Studies of the effectiveness of herbicides for controlling older natural regeneration have shown that the smaller trees shielded in the thickets by adjacent stems often survive, and that the cost of suitable chemicals is high. Minko (4) obtained satisfactory control of tall (up to 2 m) thickets of radiata pine using 60 kg a.i. ha^{-1} of the contact herbicide fosamine, but this treatment cost \$1,860 ha^{-1}. There is a need for further research to develop techniques for using lower herbicide rates. Fosamine is favoured over other, cheaper herbicides such as paraquat, because it is less toxic.

In 1982, wildfires killed more than 330 ha of pine plantations near Wangaratta, in north-eastern Victoria. Soon after the fires, the use of low rates of fosamine for the control of germination, cotyledon-stage seedlings of radiata pine, and the competing vegetation were evaluated in the affected areas.

METHODS

The study was carried out at the Bright Plantation, north-eastern Victoria, where on 24 November 1983, a thinned 43 year old stand of radiata pine was killed by wildfire. Some crown fires occurred, with flames reaching heights up to 160 m on to 30° slopes (Watson *et al.* unpublished data) (6). The crown fires consumed many pine cones and therefore fewer viable seeds were shed than expected from a less intensive ground fire. Dead trees were harvested and the resultant slash was then heaped and burnt.

Nine sites, unaffected by slash burn, were randomly selected for study in January 1983, well before germination of pine seeds. Five plots, each 3.1x 3.2 m, were established on each study site. The design was a randomised block

with five treatments and nine replications.

Rainfall was recorded throughout the study at Bright, about 2 km to the east. Germination commenced on 27 April 1983, 36 days after four substantial falls of rain (each greater than 25 mm) following the fire. Thereafter, seedling emergence was recorded each week, and the causes of any damage ascertained until spraying of the herbicide. Fosamine was applied in dry, clear and calm weather on 15 September 1983 using a compressed air knapsack equipped with a hollow-cone fan nozzle. Fosamine was applied at the following rates: 0, 3.6, 7.2, 14.4 and 28.8 kg a.i. ha^{-1} respectively. All treatments were applied in 200 L ha^{-1} water with non-ionic surfactant added at 0.5% (v/v). After spraying, plant counts of residual pine seedlings were recorded each week until 27 February 1984, and at regular intervals until March 1985.

The heights of all seedlings were measured on 6 January 1984 and 4 March 1985. To evaluate the effect of herbicides on vegetation other than radiata pine, all plant growth was harvested in January 1984, oven-dried for 24 h at 104°C and weighed. The results were statistically analysed using orthogonal comparisons (5).

RESULTS AND DISCUSSION

The mean numbers of surviving seedlings (healthy and temporarily chlorotic) are shown in Table 1.

Table 1 shows that the lethal effects of fosamine on pine seedlings appeared in November 1983, about nine weeks after application, and seedling mortality continued into 1984. In contrast to intermittent germination and concurrent mortality of pine in the control plots, no delayed germination was observed in plots treated with fosamine, suggesting that this herbicide suppressed germination of seed.

Table 1. Plant density (plant 10 m^{-2}) over time of naturally regenerating radiata pine treated with fosamine on 15 September 1983.

Assessment date	Dat	Rate of fosamine (kg ha^{-1}) 0	3.6	7.2	14.4	28.8
21 Sept. 83	6	20	14a	21a	16a	21a
21 Oct. 83	36	20	14a	20a	15a	19a
22 Nov. 83	68	18	7	6	2	1
20 Dec. 83	96	16	5	3	1	1
20 Jan. 84	127	16	4	3	1	0.2
22 Feb. 84	160	18	4	3	1	0.2
08 Aug. 84	328	16	4	3	1	0.3
22 Feb. 85	526	16	4	3	1	0.3

Means followed by the letter (a) do no differ significanlty (P = 0.05) from the control treatment (0 kg ha^{-1}).

Between November 1983 and January 1984, an indirect relationship became evident between the rate of the chemical and the stocking density of surviving seedlings (Table 1). The 3.6 kg ha^{-1} of fosamine resulted in about 4,000 residual seedlings per hectare at a cost of $128 ha^{-1}. This is considered a satisfactory and acceptable result. The control plots indicated that most

seeds germinated between April and October 1983, whereas all applications of fosamine reduced this seedling density to manageable levels.

By January 1984 fosamine had reduced the height of residual pine seedlings (Table 2). However, this reduction was no longer discernable by March 1985.

Table 2. The effect of fosamine applied in September 1983 on the height of residual radiata pine seedlings in January 1984 and March 1985, and dry weight (DW) of recolonising vegetation in January 1984.

Rate of Fosamine (kg ha^{-1})	Height of pine seedlings (cm) 1984	1985	DW of other vegetation (kg ha^{-1})
0	14.7	72	645
3.6	9	72	259a
7.2	7a	52	234a
14.4	7a	69	264a
28.8	6a	58	231a

Means followed by the letter (a) differ significantly from the control treatment (0 kg ha^{-1}).

All rates of fosamine significantly reduced the DW of vegetation competing with radiata pine regeneration (Table 2).

During the germination period, seedlings emerged only after rainfall. However, heavy rainfall, such as experienced in May and August 1983, eroded ash and surface soil and caused many deaths among seedlings. Other possible causes of mortality were dessication (due to rapid drying of the ash layer), damping-off disease, and attack by insects, particularly the larvae of cutworms, *Agrotis* spp..

The results show that spraying with as little as 3.6 kg ha^{-1} fosamine in September can reduce the number of naturally regenerating radiata pine seedlings from about 15,000 to 4,000 plants ha^{-1}. Furthermore, this treatment prevented further germination of seeds. It may be possible to combine this treatment with other management options, (e.g. hand pulling) to regulate seedling numbers in a system that utilises natural regeneration for a second crop.

Because fosamine reduced the DW of the competing vegetation by around 50%, it is likely that the surviving pines (about 4,000 plants ha^{-1} for the 3.6 kg ha^{-1} rate) will respond to this reduction in weed competition and grow at acceptable rates. The effectiveness combined with low toxicity to non-target organisms and relatively low cost ($17 per L), make fosamine very useful for managing the regeneration of radiata pine after fires.

REFERENCES

1. Cremer, K.W., Borough, C.J., McKinnel, F.H. and Carter, P.R. 1982. N.Z. J. For. Sci. 12, 224-269.
2. Flinn, D.W. and Minko, G. 1983. Aust. Weeds 2, 53-55.
3. Lea, D. 1982. Workshop on Establ. of Coniferous Plantations, Mt. Gambier, S.A., Sept. 1982, 11 pp.

4. Minko, G. 1985. Plant Protec. Qrtly. 1, 67-70.
5. Snedecor, G.W. 1957. Statistical Methods (The Iowa Stat. Coll. Press: Iowa) pp. 291-328.
6. Watson, N., Morgan, G. and Rolland, D. 1983. Int. Fire Res. Rep. Apr. 1983. For. Comm. Vic., Div. For. Prot., 5 pp. (unpubl.).