COMPARISON OF EFFECTIVENESS AND PERSISTENCE OF THREE HEXAZINONE FORMULATIONS

R.E. GASKIN and J.A. ZABKIEWICZ

Forest Research Institute, Private Bag, Rotorua

SUMMARY

No significant difference in herbicidal effectiveness was found amongst the liquid, soluble powder, and granular hexazinone formulations tested in a forestry situation. The soluble powder formulation showed the fastest decline in soil concentration but all formulations decreased to less than 30% of initial concentration within 4 weeks. Good grass control (less than 50% ground cover) was obtained for approximately 20 weeks. Some tree mortality (10-15%) was observed.

INTRODUCTION

Hexazinone use in forestry has increased steadily since its introduction a decade ago. Initially introduced in a soluble powder formulation, it is now available in liquid and granular forms. Its persistence and efficacy seem to vary widely with soil type and environment (Rhodes 1980; Rahman 1981; Harrington *et al* 1982).

The present trial was designed to compare the field effectiveness of the three formulations in a forestry situation and determine their absolute and relative persistence in the target plants as well as the soil.

MATERIALS AND METHODS

The trial site was adjacent to Kinleith Mill at Tram Road, Tokoroa. Ground cover was a ryegrass dominant pasture sward. The soil, of Taupo ash origin, was a compact pumice sand with a 20 cm cover of sandy silt. Plots were 10 x 4 m with three replicates per treatment in a randomised block design. Each plot had been planted with two rows of 1½/0 (1½ years from seed) radiata pine (*Pinus radiata*) seedlings 7 months previously.

The soluble powder (Velpar S.P. 90% ai) and liquid (Velpar L 25% ai) formulations of hexazinone were applied at 5.4 kg ai/ha in 300 litres water at 207 kPa with a modified Oxford precision boom sprayer (held 1 m above ground and fitted with T-jet 730231 nozzles). The granular product (Velsorb 10% ai) was an experimental batch produced by Silicon Industries, Hamilton. Amounts equivalent to 5.4 kg ai/ha were sprinkled evenly by hand over the plots.

All applications were made on 8.2.84. Assessments were made and samples taken at the time of application and at 2- or 4-weekly intervals over a period of 25 weeks. Visual assessments of pasture damage and counts of tree death were made by a minimum of two observers.

Two radiata pine seedlings were randomly sampled from each plot 1 day and 2 weeks after herbicide application. The soil was washed from their roots, and the plants were divided into foliage plus stem, and root sections. The foliage was washed immediately with methanol, then dried. All tissues were kept frozen at -20°C until extracted for analysis. The methanol wash was made up to a standard volume and aliquots were analysed for hexazinone by high performance liquid chromatography (HPLC).

Soil cores (12 x 16 cm deep, two per plot including ground cover) were taken randomly at all assessment times and also stored at -20°C until required for analysis. Sieving separated the soil from the ground cover plant material. Two subsamples of soil (approx. 80 g each) were used for hexazinone extraction; a third was used to determine the moisture content.

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Total frozen plant tissues from each core were freeze-dried, ground in a Wiley Mill, and extracted with methanol after the addition of atrazine as an internal standard. The methanol extracts were filtered, concentrated, and analysed by HPLC. Hexazinone residues were extracted from soil samples in a similar manner but without freeze drying or grinding. A C8 reversed phase column with a C18 guard column using a water:methanol (1:1) solvent at 1.5 ml/min and uv detector at 254 nm was used for the HPLC analyses. All sample extracts were made up with water (1:1) before analysis to prevent peak distortion during quantification.

It was realized, after all the analyses were completed, that storage of samples resulted in progressive degradation of hexazinone. Consequently the following year a further set of five soil cores were taken from the same area, and a known quantity of hexazinone was added. The soil cores were stored under the same conditions and analysed at regular intervals over a 6-month period. Less than 60% of the applied hexazinone was recovered after 6 months, with losses obvious after 3 months. The mean recoveries were plotted against time and correction factors derived to adjust the hexazinone recovery results in the previous year's extracts.

RESULTS AND DISCUSSION

The level of grass control for the various treatments achieved over a 25-week period is shown in Fig. 1. It took approximately 2 weeks to achieve a 50% reduction in ground cover (due to vegetation brown-off and decay) and it stayed below this level for a further 18 weeks. Subsequent regrowth resulted in 60-75% ground cover after 25 weeks. There were no significant differences in either efficacy (after 4 weeks) or duration of grass control between the three formulations. There was no rainfall at the site within 24 h of herbicide application, 127 mm after 2 weeks, 420 mm after 20 weeks and more than 600 mm after 25 weeks.

Fig. 1: Grass control by hexazinone formulations.

Interception of herbicide by the pine seedlings was greatest from the liquid formulation, followed by the soluble powder, with negligible interception from the granules (Table 1). There was no trace of hexazinone in root tissues after 24 h. After 2 weeks no residues could be detected on the pine foliage, but small amounts were present within the plants indicating that uptake had taken place. Uptake into needles 24 h after

TABLE 1: Distribution of hexazinone on and within radiata pine seedlings — mg/20 trees in plot (mean of 3 plots).

Formulation	24 h after application†			2 weeks after application†		
	Surface wash	Foliage	Roots	Surface wash	Foliage	Roots
liquid	115.6(14.5)*	10.1 (2.8)	0	0.10(0.1)	0.67(0.57)	0.27(0.15)
powder	84.7(13.3)	7.9 (0.87)	0	0	0.23(0.15)	0.33(0.18)
granules	1.1(1.1)	0.47(0.33)	0	0	0.13(0.13)	0.33(0.18)

*SE values

†Rainfall nil within 24 h; 127 mm after 2 weeks

application of liquid and soluble powder formulations was approximately 10% of that deposited on the foliage. However, the amount in the needles had fallen to negligible levels after 2 weeks possibly due to plant metabolism. The maximum amount of herbicide intercepted by the seedlings was less than 0.6% of the amount of hexazinone applied.

Interception by the ground cover species (mainly grasses) was much higher (up to 40%), but the amount of herbicide present in the tissues declined rapidly (Table 2). Trends in interception of the three formulations by the ground cover species observed were similar to those for radiata pine seedlings. After 2 weeks the maximum amount recovered represented only 2% of the amount applied. Little or no hexazinone could be detected in grass samples after 4 weeks; this also coincided with the period of minimum ground cover. Grass regrew to cover more than 60% of the plot area after 25 weeks, but no hexazinone residues could be detected in the new plant tissues. This indicates that either there was no hexazinone available to the plants or (more likely, as there was detectable hexazinone in the soil extracts, Table 3) that the plants were capable of degrading any small amounts taken up.

TABLE 2: Recovery of hexazinone from ground cover species — g/plot (mean of 3 plots).

Formulation	Weeks after application					
	0	2	4	8	—	25†
liquid	8.63 (1.36)*	0.34 (0.19)	0.08 (0.02)	0	—	0
powder	7.17 (0.42)	0.32 (0.09)	0.08 (0.03)	0	—	0
granules	1.52 (0.89)	0.46 (0.04)	0.05 (0.02)	0	—	0

*SE values

†Zero values also for 12 and 19 week samplings.

As anticipated, the bulk of the herbicide was found in the soil itself (Table 3), initially amounting to over 55% of the total applied. The liquid and granule treatments showed a rise in soil hexazinone concentrations 2 weeks later, perhaps as a result of material being washed either off the foliage or out of the granules after rain. Soil concentrations then decreased steadily to become negligible 25 weeks after application. The soluble powder treatment seemed to show a different behaviour as no increase was seen at the 2-week sampling time. The rapid decline for the powder formulation may indicate faster soil leaching of this formulation. Subsequent reduction of soil concentrations followed a similar trend to the other two formulations, though levels were generally much less. The half-life of hexazinone in soil is generally greater than 1 month (Rhodes 1980; Rahman 1981) and so the low concentrations of herbicide were unlikely to be due to chemical degradation. This suggests that the herbicide was readily leached in the sandy pumice soil under the high rainfall conditions which existed.

TABLE 3: Hexazinone content of soil — g/plot (mean of 3 plots).

Formulation	Weeks after application						
	0	2	4	8	12	19	25
liquid	11.99 (0.41)*	16.37 (4.02)	5.69 (0.43)	3.03 (0.81)	1.48 (0.56)	1.20 (0.4)	0.50 (0.5)
powder	13.8 (1.55)	6.96 (1.98)	4.08 (1.54)	1.59 (0.22)	1.19 (0.43)	0.77 (0.17)	0
granules	12.69 (4.1)	15.61 (4.11)	5.92 (0.83)	3.49 (0.37)	2.45 (0.39)	0.40 (0.17)	0.60 (0.26)

*SE values

After 25 weeks 10-15% of the pine seedlings in the herbicide-treated plots were dead, compared with 2-3% in the untreated plots, and there were no obvious differences between the three treatments. This level of mortality in the treated plots may have been aggravated by the poor condition of the planting stock prior to treatment and the intense competition from the pasture prior to herbicide application. Although needle-tip burn and needle death were observed in all the seedlings some weeks after treatment, most seedlings recovered. Incorporation levels in these seedlings were equivalent to a maximum of 16 ppm which is insignificant compared to the 1000 ppm levels previously found in dead or dying radiata pine seedlings (Gaskin, unpublished data).

CONCLUSIONS

There is little interception of hexazinone by pine seedlings after spraying with liquid, soluble powder, or granular formulations. In contrast, interception by the other ground cover was high, with herbicidal effectiveness being maintained for 3 months or longer. Herbicide concentrations in the soil, which had declined to approximately 10% of original amounts after 12 weeks, were sufficient to maintain grass control. The soluble powder formulation showed the fastest decline in the soil (down to approximately 30% within 2 weeks) but the other formulations did not fall below 25% till the fourth week. No significant difference was observed between formulations in persistence or degree of weed control, presumably because of substantial and consistent rainfall (Rahman 1981).

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