EFFECT OF ADDITIVES ON BRACKEN CONTROL BY ASULAM AND GLYPHOSATE

D. S. PREEST

Forest Research Institute, Rotorua

Summary

In a small pilot trial asulam (4.4 kg/ha) and glyphosate (3.9 kg/ha) applied alone as aqueous foliar sprays (220 litres/ha) to mature fronds in mid-summer were completely ineffective in controlling bracken (*Pteridium aquilinum*). Neither ammonium sulphamate (11.2 kg/ha) nor dimethyl sulfoxide (2.2 litres/ha) added to the spray formulations effected any improvement; but the addition of 22 litres of diesel oil plus 0.4 litres of emulsifier caused a very highly significant reduction in frond numbers and total frond dry weight assessed 17 months after treatment. The improvement is attributed to increased entry and uptake of the herbicides due to the presence of the diesel oil emulsion.

INTRODUCTION

Responses of both the European bracken (*Pteridium aquilinum* var. *typicum*) and the New Zealand bracken (var. *esculentum*) to foliar herbicide sprays have been characterised by extreme variability. This has been attributed variously to weather conditions (Rohrig and Rozsnyay 1967), to variation in entry and uptake due to changes in cuticular development as the fronds mature (Veerasekaran and Kirkwood 1972) and to seasonal changes in the pattern of translocation within the plant (Volger 1969).

For good long-term control it is essential that the herbicides enter the fronds and be translocated to the rhizomes in sufficient quantities to kill a large proportion of the dormant and active frond buds. It has been found that maximum penetration and absorption of asulam, for instance, occur if the fronds are soft and immature; but at this stage movement to the rhizomes is slight (Veerasekaran and Kirkwood 1972). For best translocation from the fronds to the rhizomes, therefore, herbicides should be applied to actively photosynthesising (i.e., mature) fronds but these appear to be very resistant to the entry of normal aqueous spray herbicide formulations. Since nothing can be done about altering the seasonal pattern of transport of assimilates, the only alternative is to improve penetration of the mature fronds.

Two foliage-absorbed herbicides, asulam and glyphosate, have shown promise for short-term bracken control when applied to soft unfurling fronds in Forest Research Institute (FRI) trials (Chavasse and Davenport 1973) but neither were effective when applied to more mature fronds (cf. May and Baker 1974). There was some evidence for suspecting this might be associated with entry and uptake as Holroyd *et al.* (1970) found the use of a wetting agent increased asulam activity and Babiker and Duncan (1974) observed that the addition of 0.1% surfactant doubled asulam penetration. Soper (1972), however, reported that a wetter made little difference to the degree of control. It was decided to establish a small pilot trial to see if performance of asulam and glyphosate

Proc. 28th N.Z. Weed and Pest Control Conf.

Scrub Weeds

could be improved by using other additives in the spray formulation. Ammonium sulphamate (AMS, a foliage desiccant), dimethyl sulfoxide (DMSO, a membrane penetrant) and diesel oil plus an emulsifier* (found from microscopic examination to greatly enhance frond wetting and coverage) were the additives tried.

METHODS AND MATERIALS

The spray formulations used were as follows:

Control — unsprayed.
 Asulam — 4.4 kg/ha.
 Asulam — 4.4 kg/ha plus AMS — 11.2 kg/ha.
 Asulam — 4.4 kg/ha plus DMSO — 2.2 litres/ha.
 Asulam — 4.4 kg/ha plus diesel oil — 22.0 litres/ha plus emulsifier — 0.4 litres/ha.
 Glyphosate — 3.9 kg/ha.
 Glyphosate — 3.9 kg/ha plus AMS — 11.2 kg/ha.
 Glyphosate — 3.9 kg/ha plus DMSO — 2.2 litres/ha.
 Glyphosate — 3.9 kg/ha plus diesel oil — 22.0 litres/ha plus emulsifier — 0.4 litres/ha.

The carrier was water and the sprayers were applied at 220 litres/ha using a hand-held boom sprayer fitted with Spraying Systems Tee-jet 730077 nozzles and operated at 276 kPa.

The treatments were randomly allocated to 2 m x 4 m plots situated in the Forest Research Institute bracken-trial site at Kaharoa, near Rotorua. The bracken on this site is very vigorous, growing to heights in excess of 2 m following early spring burns. There were three replications. Application was in mid-January 1973 to mature fronds which had regenerated after a burn the previous September.

During the winter following treatment the fronds present in half of each plot at the time of treatment were cut off and removed to facilitate assessment of subsequent regrowth. The assessment, which was carried out 17 months after treatment, was on the basis of frond counts and total frond weight on a 1 m² quadrat centrally located in each half-plot from which the old fronds had been removed. Total frond weights per quadrat were determined after kiln drying for 2 days at approximately 66° C.

RESULTS AND CONCLUSIONS

Mean frond counts and kiln dry weights of fronds/m² for each treatment are shown in Table 1. Tables 2-4 summarise the statistical analyses performed. The findings are:

TABLE 1: REGROWTH RESPONSE OF BRACKEN TO ASULAM AND GLYPHOSATE AS INFLUENCED BY THREE SPRAY ADDITIVES: DMSO, DIESEL OIL AND AMS

<i>Herbicides</i> (factor H)	<i>Additives (factor A)</i>							
	<i>Nil</i>		<i>DMSO</i>		<i>Diesel oil</i>		<i>AMS</i>	
	<i>No.</i> <i>fronds</i>	<i>Dry wt</i> (g)	<i>No.</i> <i>fronds</i>	<i>Dry wt</i> (g)	<i>No.</i> <i>fronds</i>	<i>Dry wt</i> (g)	<i>No.</i> <i>fronds</i>	<i>Dry wt</i> (g)
nil	16.0	394	—	—	—	—	—	—
asulam	16.3	616	18.7	627	4.7	86	23.0	1108
glyphosate	21.7	501	22.0	750	7.3	163	19.0	638

Number of fronds and dry weight (g) are means/m² from three reps.

* Rohm and Haas Triton X-45.

Scrub Weeds

- (1) Neither asulam nor glyphosate alone applied in mid-January to matured fronds had any significant effect on bracken regrowth compared with the untreated controls (Table 2).
- (2) There were very significant differences between additives (Table 3).
- (3) The additives tended to influence the effect of both herbicides in a similar manner, i.e. no significant (herbicide) x (additive) interaction (Table 3).
- (4) The significant difference between additives was overwhelmingly attributable to the diesel oil plus emulsifier¹ (Table 4).

¹ The experimental design was such that any significant herbicidal effects due to the diesel oil emulsion alone, or to the emulsifier alone, could not be determined; nor could the effects of the emulsifier on herbicide activity be determined. Though improbable, these possibilities will need to be tested in a more comprehensive trial.

TABLE 2: F VALUES AND SIGNIFICANCE LEVELS FROM ONE-WAY ANALYSES OF VARIANCE OF DATA FOR TWO HERBICIDES WITHOUT ADDITIVES AND UNTREATED CONTROL

Source	d.f.	No. fronds		Dry weight	
		F	Sig.	F	Sig.
Herbicides	2	0.29	NS	2.89	NS
Residual	6				

TABLE 3: F VALUES AND SIGNIFICANCE LEVELS FROM TWO-WAY ANALYSES OF VARIANCE OF THE (TWO HERBICIDES) X (FOUR ADDITIVES) FACTORIALS

Source	d.f.	No. fronds		Dry weight	
		F	Sig.	F	Sig.
Herbicides (H)	1	0.39	NS	1.03	NS
Additives (A)	3	5.89	**	11.30	***
HA	3	0.48	NS	2.03	NS
Residual	16				

TABLE 4: F VALUES AND SIGNIFICANCE LEVELS FOR THREE SINGLE DEGREE OF FREEDOM CONTRASTS BETWEEN ADDITIVES

Contrast (Source)	d.f.	No. fronds		Dry weight	
		F	Sig.	F	Sig.
Nil v. DMSO	1	0.10	NS	0.94	NS
(Nil + DMSO) v. AMS	1	0.14	NS	4.64	*
(Nil + DMSO + AMS) v. (Diesel oil + emulsifier)	1	17.37	***	28.33	***
Residual	16				

NS = not significant at 5% level
 * = significant at 5% level
 ** = significant at 1% level
 *** = significant at 0.1% level.

Scrub Weeds

DISCUSSION

Aqueous sprays of asulam and glyphosate alone appear to be totally ineffective when applied to mature bracken fronds in mid-summer but for good translocation to the rhizomes this is when applications should be made. Diesel oil emulsified in the spray formulations can greatly enhance the effectiveness of both chemicals when applied at this time, presumably through aiding entry and uptake. Regrowth control 17 months after treatment was judged to be wholly adequate to ensure radiata pine establishment.

It is speculated that treatment should not be preceded by a spring burn but should be applied in late January or early February and followed by an early autumn burn. This would provide a clean planting site and also, perhaps, stimulate remaining inactive frond buds on the rhizomes into autumn activity. The buds would then constitute sinks for herbicide previously translocated to the rhizome (Veerasekaran and Kirkwood 1972) and thus be destroyed.

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