EFFICACY OF A CERTIFIED ORGANIC HERBICIDE BASED ON PINE ESSENCE

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ABSTRACT

Six trials were conducted to evaluate a new certified organic herbicide, Organic Interceptor™ (680 g/litre pine essence), which is the only weedkiller approved for use by BIO GRO NZ. This herbicide was trialled on both newly emerged and established weeds. On newly emerged weeds in freshly cultivated soil, pine essence at rates of 50 – 100 kg/ha was as effective as traditional systemic herbicides such as glufosinate-ammonium or glyphosate. Larger, established weeds required higher rates per hectare to achieve good control. Pine essence is a contact weedkiller which causes rapid plant dehydration through cuticle damage and finally resulting in cell rupture. For best results full plant coverage must be achieved. Therefore, optimum application volumes are dependent on weed canopy density and height. On a dense pasture sward mown to 50 mm, optimum application volumes ranged from 1600 to 3200 litres/ha.

Keywords: pine essence, organic herbicide, Organic Interceptor™, weed control, application volume.

INTRODUCTION

Organic methods of agriculture and horticulture are becoming more common in New Zealand and with this is a growing need for integrated weed management and biologically based organic herbicides. To meet the strict requirements of the organics industry, organic herbicides must be derived from natural substances by physical means and not be chemically transformed in any unnatural way. In the early 1990s Greenscape™, formulated from C_8 – C_{10} fatty acids, was introduced as an organic weedkiller (Anon. 1991; James & Rahman 1992) but did not have organic certification. Organic Interceptor™ is the first certified organic herbicide and is the only weedkiller to get a "BIO GRO Farm Inputs Approval". This approval allows restricted use of Organic Interceptor™ on BIO GRO certified properties but only after gaining written approval prior to use (Anon. 2001). This herbicide is also approved by AgriQuality CERTNZ, Biological Farmers Australia (BFA), National Association for Sustainable Agriculture Australia (NASAA) and other members of the International Federation Of Organic Agriculture Movements (IFOAM) around the world. In addition to agricultural and home garden uses, some local authorities in New Zealand have also put in place regulations requiring contractors to use organic herbicides instead of synthetic chemical herbicides.

Organic Interceptor™ is a non-selective contact herbicide which disrupts membrane permeability causing rapid dehydration, desiccation and brown-off within a few days. It has no systemic action. It is derived from the liquid residues created during processing of pine trees for pulp and paper and contains 680 g/litre of emulsifiable pine essence. It has low acute oral and dermal toxicity, deactivates on contact with soil and is claimed to be eco-friendly (Anon. 2001). It is currently registered in New Zealand for domestic use for control of annual weeds, grasses and burn-off of perennial species.

The objective of this study was to evaluate pine essence for control of weeds by (a) determining its efficacy against weed seedlings in cultivated soil and on established

weeds, and (b) assessing the effects of different application rates and application volumes on its efficacy.

MATERIALS AND METHODS

All trials were conducted at the Waikato Research Orchard near Hamilton on a Horotiu silt loam soil with 6.5 - 6.8% organic C and a pH of 5.1 – 5.6. In each case the trial layouts were randomised blocks with 4 replicates. Plots were 1.5 m x 5 - 10 m long. All treatments (Tables 1 and 2) were applied with a CO_2 powered backpack sprayer with differing application rates achieved by either altering the nozzle size or by repeat applications over the same plot. All the pine essence treatments were applied at 400 kPa for greater penetration of the canopy, while the other herbicides were applied at 200 – 210 kPa.

For Trials 1 and 2 the treatments were applied to newly emerged weeds on recently cultivated ground. For Trial 1 the soil was cultivated on 5.10.01 and the treatments applied on 31.10.01. The corresponding dates for Trial 2 were 1.3.02 and 12.3.02. In Trial 1 the weeds were 30 – 40 mm tall when treated, while in Trial 2 they were 10 – 30 mm tall. Conditions at application were partly cloudy and 20°C for Trial 1, and sunny and 19°C for Trial 2. Treatment efficacy was visually assessed for weed control (% of total number of weeds) on several occasions, and also by harvesting and drying the weeds present in two 0.1 m^2 quadrats from each plot at 15 and 30 days after application.

Trials 3 and 4 were on established weeds in apple orchards with different weed spectra. The main weeds in both trials were annual poa (*Poa annua*), white clover (*Trifolium repens*), chickweed (*Stellaria media*), daisy (*Bellis perennis*) and scrambling speedwell (*Veronica persica*). In addition, Trial 3 also contained small-flowered mallow (*Malva parviflora*) and tall willowherb (*Epilobium obscurum*), while Trial 4 also contained frilled liverwort (*Fossombronia* sp.), musky storksbill (*Erodium moschatum*) and dandelion (*Taraxacum officinale*). Both trials were laid down on 28.9.01 when it was sunny and about 20°C, the weeds had not recently been mown and were mostly 40 – 80 mm tall with the occasional weed up to 300 mm. The treatments (Table 2) were re-applied in both trials to the same plots 27 days later (25.10.01) to control new seedlings and any regrowth. Conditions at the time were sunny and 19°C and most of the weeds were much smaller than for the first application. In mid summer (23.1.02) the plots were mown to 40 mm high and the treatments re-applied for a third time. However, for this application the rate of pine essence was increased to 163 kg/ha and it was applied in two different application volumes (1200 and 2400 litres/ha). At the time it was sunny and 22°C and the weeds all less than 50 mm tall. Application volume for glufosinate–ammonium was always 287 litres/ha, while for pine essence it was 800 litres/ha for the first two applications. Assessments for these trials were similar to those for Trials 1 and 2.

Trial 5 was laid down among grape vines on 22.1.02. The site was prepared by mowing to 40 mm, 5 days before application. This trial compared application of pine essence through custom built foaming applicators (made by Certified Organics) that applied either 1.1 or 2.2 litres/min with flat fan nozzles applying 1200 litres/ha. The application using the foaming nozzles was timed to determine application rate. Taking about 80 seconds to treat a plot resulted in application volumes of approximately 1600 and 3200 litres/ha. In all cases a 13.6% concentration of pine essence (20% product) was used. Herbicide efficacy was visually assessed for weed control (% of total no. weeds) on several occasions and also after 30 days by mowing (to 40 mm high), drying and weighing the herbage from a 4.1 m x 0.45 m strip in the centre of each plot.

Trial 6 was laid down on previously mown, run out pasture on 30.1.02. At the time the pasture was 40 – 50 mm high, it was sunny and 21 – 23°C. The aim of this trial was to determine the effect of water rate on the efficacy of pine essence. Three different rates of the herbicide were applied in several different application volumes (Fig. 1). Assessments were the same as those for Trial 5.

The data collected from all trials were subjected to ANOVA to separate the means. The observational data were analysed unmodified but the weed dry matter data were

transformed [log (x + 0.1)] before analysis to reduce heterogeneity of variance, with back-transformed means presented in the tables.

Herbicide formulations used in these trials were: pine essence, Organic Interceptor™, 680 g/litre; glufosinate-ammonium, Buster, 200 g/litre SC; glyphosate, Roundup Dry, 680 g/kg WSG.

RESULTS AND DISCUSSION

Results from Trials 1 and 2 are summarised in Table 1. Except for the low rate of pine essence, all of the herbicide treatments controlled nearly all the weeds present at treatment. However, within a few days of treatment new weeds began to emerge in all plots. In this trial pine essence provided very rapid knockdown of the weeds with most being brown and totally shrivelled after 5 days. Comparatively, glufosinate-ammonium and glyphosate took up to 12 and 20 days respectively to achieve the same level of plant knockdown. Smooth witchgrass (*Panicum dichotomiflorum*) and scrambling fumitory (*Fumaria* spp.) were the most abundant weeds to reinfest the treated plots. In these trials the high rate of pine essence applied in 680 - 1600 litres/ha water was as effective as the glufosinate-ammonium and glyphosate treatments (Table 1). The lower rate of pine essence was less effective. The weeds effectively controlled by pine essence in Trials 1 and 2 included willow weed (*Polygonum persicaria*), black nightshade (*Solanum nigrum*), redroot (*Amaranthus* spp.), summer grass (*Digitaria sanguinalis*), smooth witchgrass, catchfly (*Silene gallica*), corn spurrey (*Spergula arvensis*), speedwell (*Veronica* spp.), fumitory, twin cress (*Coronopus didymus*), annual mouse-eared chickweed (*Cerastium glomeratum*), dock (*Rumex* spp.), scarlet pimpernel (*Anagallis arvensis*) and dandelion.

Results from the orchard trials (Trials 3 and 4) are summarised in Table 2. These data show that glufosinate-ammonium provided excellent control of all weeds present. The low rate of pine essence used was effective on many of the weeds that were less than 50 mm tall but against the taller weeds it was less effective than glufosinate-ammonium. The higher rate of pine essence gave better control than the lower rate, but 27 days after the first application the maximum level of weed control was only about 70%. After 27 days the treatments were re-applied and the level of control achieved from this re-treatment was

TABLE 1: Average weed dry matter yield (kg/ha) at 15 and 30 days after treatment for Trials 1 and 2.

Treatment	Rate (kg ai/ha)	Application volume (litres/ha)	Dry matter yield (kg/ha) Day 15 Trial 1	Day 15 Trial 2	Day 30 Trial 1	Day 30 Trial 2
Untreated	-	-	277 a[1]	52	653 a	812.3 a
Glufosinate	0.6	300	5 c	0	36 c	8.4 bc
Glufosinate	1.0	300	9 c	-[2]	27 c	-
Glyphosate	0.34	300	46 b	0	51 c	8.3 bc
Glyphosate	0.51	300	33 b	-	24 c	-
Pine essence	46.2	680	31 b	-	137 b	-
Pine essence	92.5	680	6 c	-	23 c	-
Pine essence	54.4	400	-	0	-	8.3 bc
Pine essence	54.4	800	-	0	-	11.8 b
Pine essence	108.8	800	-	0	-	3.2 c
Pine essence	108.8	1600	-	0	-	3.2 c

[1]Numbers followed by different letters are significantly different from each other ($P<0.05$).

[2] - Treatment not included (higher application volumes for pine essence were used in Trial 2).

much better than from the first treatment, with the high rate of pine essence resulting in 85% control after a further 30 days in both Trials 3 and 4. After a further 2 months the surviving weeds and some new seedlings had grown to more than 500 mm tall and above the lower branches of the apple trees so the whole trial area was mown and the treatments re-applied. Overall, the level of weed control achieved with this application was better than from the two earlier treatments. As with the fatty acid based herbicide Greenscape™, the large size of the treated weeds appeared to be the main factor in the poor performance of pine essence (James & Rahman 1992). Since these herbicides are contact weedkillers which cause rapid plant dehydration through cuticle damage, the whole plant needs to be effectively covered with the herbicide to achieve good control. With the third application pine essence was applied at a higher rate and at higher application volumes. This resulted in better control of the weeds and both pine essence treatments gave results similar to the glufosinate-ammonium treatments.

TABLE 2: Overall weed control (% of total no. weeds) and dry matter yield of weeds (kg/ha) in Trials 3 and 4.

		Weed control							Dry matter
	Rate	Days after application							(kg/ha)
Treatment	(kg ai/ha)	12[1]	20[1]	27[1]	12[2]	20[2]	30[2]	22[3]	30[3]
		Trial 3							
Untreated	-	0	0	0	0	0	0	0	374
Glufosinate	0.6	98	99	95	100	95	81	96	21
Glufosinate	1.0	100	100	98	100	98	85	96	27
Pine essence	54.4 (163)[4]	76	63	41	85	86	73	93	48
Pine essence	108.8 (163)	91	81	70	100	93	85	94	29
LSD (P<0.05)		3.4	4.2	3.4	2.7	3.2	4.6	3.5	35.9
	Trial 4								
Untreated	-	0	0	0	0	0	0	0	274
Glufosinate	0.6	100	98	91	100	96	88	97	7
Glufosinate	1.0	100	99	95	100	98	90	98	2
Pine essence	54.4 (163)	85	71	53	96	86	73	93	11
Pine essence	108.8 (163)	93	85	71	98	95	85	93	29
LSD (P<0.05)		3.4	4.6	4.9	2.1	4.6	6.2	4.9	25.2

[1]Days after the first application (28.9.01).
[2]Days after the second application (25.10.01).
[3]Days after the third application (30.1.02).
[4]The rate in parenthesis is the rate used at the third application on 30.1.02.

Due to the incomplete weed control observed in Trials 3 and 4 when treating established weeds with pine essence in low water volumes, Trial 5 was laid down using different application equipment that applied pine essence in a much larger application volume and also in a different form. As the same concentration of pine essence was used in each case the application rate of the herbicide differed for each treatment. After 30 days the average dry matter weights from each of the treatments were: untreated 2306 kg/ha; flat fan nozzles (163 kg pine essence/ha) 928 kg/ha; foam nozzle 1 (245 kg pine essence/ha) 742 kg/ha and foam nozzle 2 (490 kg pine essence/ha) 484 kg/ha. All of the four treatments were significantly different (P<0.05) from each other. This trial produced an open ended result that showed increasing both the herbicide rate and application volume resulted in better control of established weeds.

Trial 6, on a dense pasture sward with high organic matter understorey, determined the relationship between herbicide rate and application volume by applying each of the three herbicide rates in different application volumes. This resulted in differing pine essence concentrations ranging from 10 – 80% of the formulated product. Concentrations above 40% were difficult to apply as the spray mix was very viscous, much more so than pine essence alone. Results from this trial are presented in Figure 1. Weed dry matter yields 30 days after application show that with each application rate there is a significant trend of increasing efficacy with increasing application volume, although the incremental improvements decreased markedly for volumes of 1600 litres/ha and above. Changes in application volume often alters the droplet size, which can affect herbicide efficacy (Knoche 1994). The mean droplet size for applications in our trial, estimated from manufacturer's data sheets (Anon. 1995a), were between 270 and 400 μm. When also considering that droplet size actually ranged from 170 to 740 μm (Anon. 1995b) then the droplets were not at large variance from the optimum required (400 – 500 μm) for maximum performance of contact herbicides such as paraquat and diquat (Douglas 1968) and would have little influence on these results. Optimum volume with dense pasture under storey appears to be about 1600 litres/ha for the 218 kg/ha rate and about 3200 litres/ha for the 435 kg/ha rate. However, as pine essence is a contact type herbicide reliant on totally wetting the plant, the rate per hectare will vary with the weed type and density. Alternatively by opening a thick dense weed or pasture canopy up through grazing or mowing, the rates of pine essence required per hectare could reduce as the plant leaf area is reduced. These results are similar to those found with the fatty acid type herbicides where application volume, herbicide rate and plant size were shown to be inter-related (James & Rahman 1992). Dry matter yields from a second cut 20 days later showed that most of the herbicidal effects of pine essence had greatly diminished with considerable regrowth/new growth in all treatments.

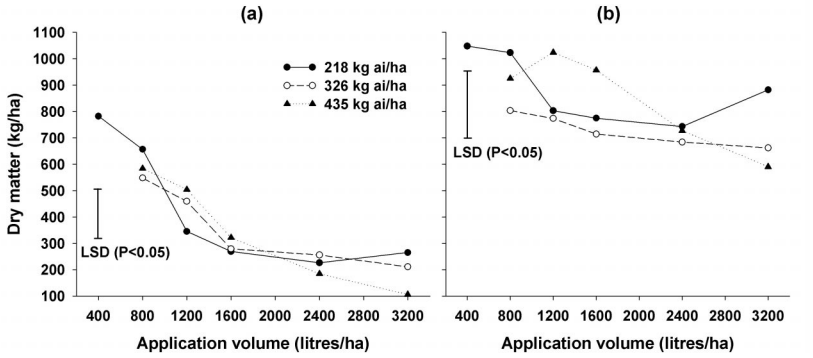

FIGURE 1: Effect of application volume and rate of pine essence on dry matter yield (a) 30 and (b) 50 days after treatment. Dry matter yield of untreated plots was 1306 and 901 kg/ha for the 2 harvests, respectively.

CONCLUSION

This study shows that use rate of pine essence must be related back to weed canopy maturity, density and height. The pine essence was effective at rates of 50 – 100 kg/ha on newly emerged weeds in freshly cultivated ground. These same rates were not sufficient for established weeds in an orchard. Against the smaller weeds the efficacy of pine essence was quite comparable to that of glufosinate-ammonium or glyphosate. When used on established weeds, higher rates of 150 – 450 kg/ha were required and these needed to be applied in proportionately larger application volumes. Optimum

application volumes are related to weed maturity, canopy density and under thick pasture conditions, appear to be in the range of 1600 to 3200 litres/ha.

REFERENCES

Anon. 1991: Greenscape Product Information. Yates New Zealand Limited, Auckland, New Zealand. 3 p.

Anon. 1995a: Data Sheet No. 11825-68M. Spraying Systems Co. Wheaton, Il, USA. 1 p.

Anon. 1995b: Data Sheet No. 37043-14M. Spraying Systems Co. Wheaton, Il, USA. 1 p.

Anon. 2001: Organic Interceptor™ Weed Killer (Concentrate) Product Manual. Certified Organics Limited, Auckland, New Zealand. 23 p.

Douglas, G. 1968: The influence of size of spray droplets on the herbicidal activity of diquat and paraquat. *Weed Res. 8*: 205-212.

James, T.K.; Rahman, A. 1992: Influence of some factors on performance of the fatty acid herbicide 'Greenscape'. *Proc. 45th N.Z. Plant Prot. Conf.:* 235-238.

Knoche, M. 1994: Effect of droplet size and carrier volume on performance of foliage-applied herbicides. *Crop Prot. 13*: 163-178.