Bracken control with rope-wick applied glyphosate

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Summary

Rope-wick application provides a method of applying glyphosate to bracken fern that may reduce damage to low-growing pasture species.

A longitudinal rope-wick applicator was compared with a transverse rope-wick applicator in the south of Western Australia at four times of application (October–April) and at two speeds with single or double passes on bracken fern that had regrown after slashing.

Greatest control was achieved by the longitudinal rope-wick applicator, at a speed of 4 k.p.h, passing over the bracken twice in January. The longitudinal rope-wick applicator was about twice as effective as the transverse rope-wick applicator.

Treatments in December or January, when 75% of the bracken was fully unfurled, were slightly better than March treatments. October treatments, when only 40% of the bracken had unfurled, were ineffective. Double application gave better control than single application. The longitudinal rope-wick applicator performed similarly at both speeds, whilst the transverse rope-wick applicator was more effective at 8 k.p.h.

This demonstrated that the parameters developed for one type of wick applicator are not necessarily transferable to other types.

Introduction

Bracken fern (*Pteridium aquilinum* var. *esculentum*) is a serious weed of pastures in the south-west of Western Australia. It produces toxins that affect plants growing in association with it and animals grazing the fern (Braid 1959). Once established, it is strongly competitive and will tolerate a wide range of soil and climatic conditions (Braid 1959). Current control methods provide variable results, are uneconomic or are too damaging to pasture to be adopted by most farmers.

A method of applying herbicides by wick application has been developed for treating erect weeds (Campbell *et al.* 1981). The applicator smears herbicide from saturated ropes onto tall-growing target plants as it passes over them. This offers the following advantages over current spraying techniques: damage to lower growing pasture species is avoided, herbicide drift is obviated allowing application in conditions too windy for conventional sprayers, and lower rates of herbicide per ha should be possible because nearly all of the applied herbicide is contacting the target species.

Little is known of the efficacy of herbicides applied to bracken by this method or the practical importance of factors such as ground speed, degree of contact required, or optimum timing of application. Glyphosate has been used successfully in wick applicators on other weeds (Campbell *et al.* 1981) and is phytotoxic to bracken fern (Martin 1976; Scragg *et al.* 1974). The experiment reported here compares the efficacy of glyphosate applied by two types of wick applicator. We tested two applicators at two ground speeds, with single or double application at three and four times of treatment on bracken fern that had regrown after slashing.

Materials and methods

The site was uniformly infested with bracken fern near William Bay, Western Australia (lat. 34°57'S, long. 117°12'E.). It was a deep sand (Northcote Uc3) with a south-westerly aspect and an average rainfall of 1150 mm. Beef cattle were rotationally grazed on the area and before the start of the experiment; the bracken had been slashed twice a year for several years. An annual grass/clover pasture persisted beneath the fern throughout the trial.

The site was slashed on 12 August 1981 to ensure an even emergence of young fronds for treatment because pilot trials had shown that poor control could be expected, with treatments similar to those under investigation, on bracken that had significant proportions of old and dead fronds. (Preest (1975) has reported similar results for overall spraying.)

A factorial (4×2×2×2) design with four control plots giving a total of 36, (20 m×20 m) plots was used. The factors were: (1) Four times of herbicide application 19 October 1981, 8 December 1981, 25 January 1982 and 24 March 1982. (2) Two types of wick applicator: longitudinal (Bobar) and transverse rope-wick (Winstone) applicator both fitted with braided polyester and acrylic (Pistachio) rope wicks (Fig 1). (3) Two speeds of application: 4 and 8 k.p.h. (4) Two degrees of contact: single pass and double pass, with the second pass in the opposite direction to the first.

A standard solution of one part Roundup (36% glyphosate) and two parts water was used for all herbicide treatments. The applicators were operated at a height of 20–30 cm above the ground, which was the lowest practical height for the site. The transverse rope-wick applicator treatments for 8 December 1981 were not applied and the plots assigned to these treatments were used as extra untreated plots in the analysis. Frond densities were determined by counting 10 to 20 randomly thrown 1-m² quad-

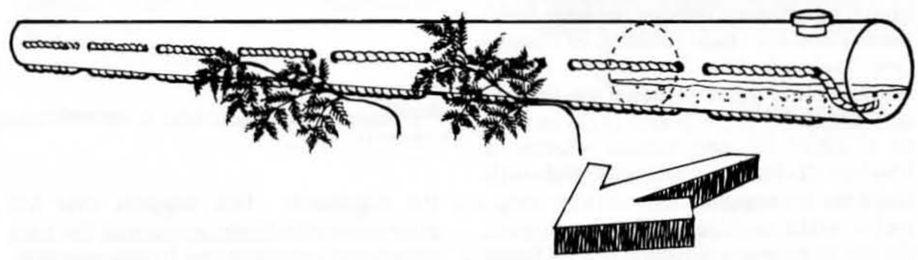
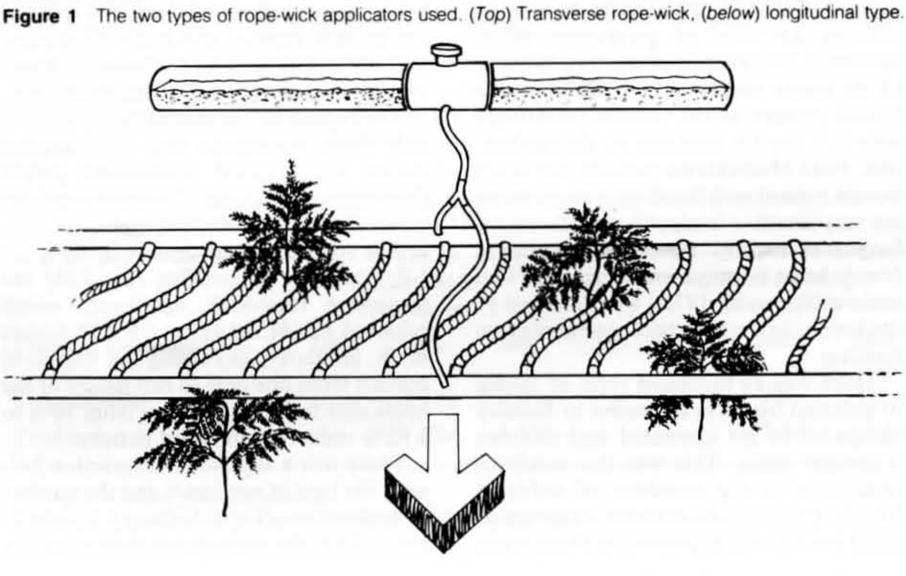


Figure 1 The two types of rope-wick applicators used. (*Top*) Transverse rope-wick, (*below*) longitudinal type.



rats on 10 November 1982. Visual rankings of kill were taken at each time of treatment and also on 24 May 1982, 10 November 1982 and 28 March 1983. Rankings presented in the results are those taken approximately 17 weeks after each treatment. Plots were visually ranked for bracken control on a scale of 1 to 36, where 1 corresponds with best bracken control and 36 corresponds with the plot with the least control. This method of ranking was used to supplement the information from frond counts because the counts did not reflect the size or vigour of the remaining bracken fern. All assessments were on the inner 10 m × 10 m area of the plot leaving a 5 m buffer to allow for edge effects.

Statistical analysis

Analysis for variance (Genstat Mark 4.03, Alvey *et al.* 1977) was used for all analyses.

For time of application the experiment was analysed as a factorial design with missing plot values substituted for the December transverse rope-wick applicator treatments. The square root of (x+0.5) transformation was applied to frond density data to help normalize their distribution. Figures presented are the retransformed values. Variance was estimated from the eight nil plots.

For all other factors the experiment was analysed omitting the October and nil treatments because the variance of those treatments was much larger than the variance of the more effective December to March treatments. Residual variance was estimated from the third- and fourth-order interactions.

Results and discussion

Treatments applied from December to March significantly reduced the total frond density and the visual rankings of control (see Table 1). The demography of the bracken stand over this period was reasonably constant (Table 2) and could be used as a guide for determining whether a bracken infestation is at a suitable growth stage for wick application. October treatments, whilst scorching the bracken fronds, did not provide any reduction in total frond density (Table 1). This could be due to reduced amounts of glyphosate being applied to the bracken at this time because of its lower height. About 60% of the fronds present at the October treatment were too low for contacts by the applicators. Field observations indicate that short fronds treated with hand-held applicators are very sensitive to glyphosate. However, long-term control after treating young fronds needs investigation because, as with asulam (Wasmuth 1973), translocation of the herbicide into the root system may be limiting.

There was an increased ratio of young to unfurled fronds in December to January compared to the untreated and October treatment times. This was due solely to reductions in the numbers of unfurled fronds. There was no evidence of increased numbers of young fronds resulting from the treatments. This suggests that the glyphosate effectively permeated the root system and prevented new fronds emerging. Treatments such as slashing that control top growth without affecting the root system invariably lead to increased numbers of emerging fronds following treatment.

The remainder of this section concerns only those treatments that were applied during the practical application period (December to March). Throughout these treatments the longitudinal rope-wick applicator reduced frond density by 90% (to 1.2 fronds m^{-2}) excelling ($P<0.05$) the transverse rope-wick applicator which achieved a 76% reduction (to 2.75 fronds m^{-2}). Similarly, increasing the degree of contact from one pass to two passes of the applicator improved control from 74% to a 92% reduction in frond density.

There was a significant interaction between the type of applicator and the number of applications (Table 3) though this probably reflects the assessment methods used. When frond numbers are very low, the visual ranking is more precise and as frond density increases the precision of frond counts increases and visual ranking decreases. As the trends in both sets of data are consistent, I propose that the double application is superior to single application and the interaction with applicator type is an artefact. This indicates that the amount of Roundup being applied, or its distribution, on the bracken was at least limiting the kill with the single application. Comparison of applicator types highlights the relative ineffectiveness of the transverse applicator.

The commercial nature of the applicators and the size of the plots made accurate measurement of the quantity of herbicide applied on each plot impossible. More detailed investigation is required to determine the effects of both the quantity of herbicide required for effective kill of bracken fern and the optimal distribution of the herbicide on the plant. Distribution

Table 1 Effect of time of application on frond density and ratio of young to fully unfurled fronds on 10 November 1982 and the visual ranking of control 17 weeks after application

Time of application	Bracken (fronds m^{-2})	Control ranking[A]	Young: unfurled fronds
Untreated	11.24a[B]	31.5a	0.107a
19.x.1981	11.60a	22.6b	0.114a
8.xii.1981	1.58b	9.8c	0.625c
25.i.1982	1.18b	9.8c	0.338b
24.iii.1982	2.70b	11.4c	0.205ab
Coef. variation	28.8%	22.2%	

[A] 1 = least bracken, 36 = most bracken.
[B] Treatments with the same letter do not differ significantly ($P<0.05$).

Table 2 Growth stages (pre-treatment) of the bracken at the four times of application. Values are percentages

	Application time			
Growth stage	Oct.	Dec.	Jan.	Mar.
Mature	0	0	0	0
Fully unfurled	40	75	75	80
½ unfurled	30	15	15	20
Crozier	30	10	10	0

Table 3 Effect of number of applications by each type of applicator during the December to March period on frond density (10 November 1982) and visual ranking of control 17 weeks after application

Applicator	Bracken (fronds m^{-2})			Visual ranking of control[A]		
	No. of applications					
	0	1	2	0	1	2
Longitudinal	11.57a[B]	2.0c	0.45c	31.5c	10.5d	2.7f
Transverse	11.57a	4.06b	1.44c	31.5c	16.1e	13.9de
	(l.s.d.: 2.64)			(l.s.d.: 5.3)		

[A] 1 = best, 36 = worst.
[B] Treatments with the same letter do not differ significantly ($P<0.05$)

over the plant surface could be as important as the quantity applied. This experiment indicates that a single pass with the longitudinal rope-wick applicator is equivalent to a double pass with the transverse rope-wick applicator.

Bracken control was more dependent on speed of application for the transverse applicator than the longitudinal applicator. At 4 k.p.h. the longitudinal rope-wick applicator gave better control than the transverse rope-wick applicator. Increasing the speed to 8 k.p.h. did not significantly reduce the control achieved by the longitudinal applicator, but did improve the control rankings for the transverse rope-wick applicator. Observations during application revealed that at slow speeds, the transverse applicator tends to push the fronds in front of it down and away from the wicks so that each frond does not receive its full dose of herbicide. At the higher speed the applicator enters the stand more forcefully so that each frond is hit harder and often for longer since the fronds tend to wrap themselves around the applicator. These observations were confirmed by photographs taken in a similar stand, after completion of this experiment. This is shown diagramatically in Figure 2. The extra pressure exerted by the fronds on the wicks could increase the amount of herbicide being transferred to the frond; also more of the frond appears to be contacted. With the longitudinal design, increasing speed should not increase the frond pressure on the wick, because the frame of the applicator contacts the bracken first. At the higher speed the bracken appears to be rolled over in front of the applicator and by the time it has stood up, the wicks have already passed over. At the slower speed there is enough time for the fronds to recover their stature more fully before the wicks have passed. Accordingly, a greater area of frond may be wiped with herbicide (see Figure 3). There was a trend in the data to support this contention, but it was not significant.

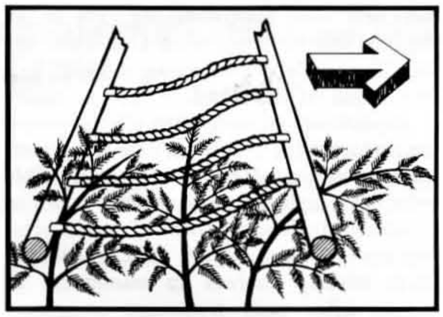
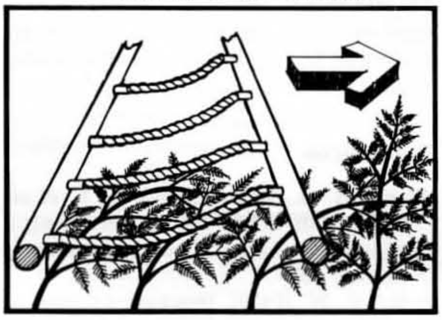


Figure 3 Effect of speed on the contact made with bracken by a longitudinal rope-wick applicator. (*Top*) At slow speeds the bracken recovers its stature to make greater contact with the wicks, while (*below*) at fast speeds the applicator has passed over before the bracken has recovered its stature.



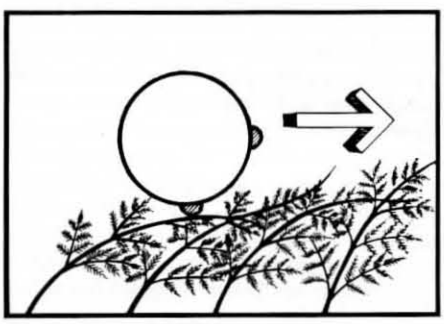
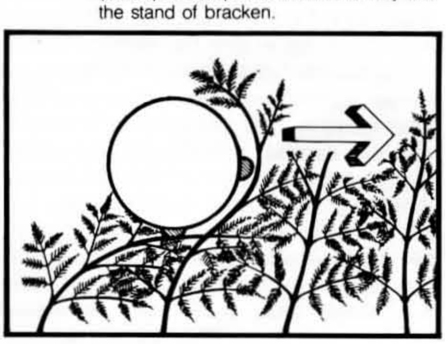


Figure 2 Effect of speed on the contact made with bracken by a transverse rope-wick applicator. (*Top*) At slow speeds the bracken folds away from the applicator, while (*below*) at fast speeds it forces its way into the stand of bracken.



For each applicator and target weed there will be an optimum speed for application and this should be determined by experimentation. The apparent lack of effectiveness of the transverse applicator in the trial reported here may have been due to the ground speed being much less than ideal (see Table 4).

There was a significant interaction between the time of application and the type of applicator (Table 5). I think this interaction is probably an artefact of the precision of the assessment methods used as explained for the interaction between type of applicator versus number of applications in Table 3. January applications with the transverse rope-wick applicator had less fronds than March applications but similar control rankings. For the longitudinal rope-wick applicator the control rankings were better for the January than the March application. The frond densities had the same trend but were not significantly different probably because the numbers of fronds were so low.

With experiments where the treatments span several months there is always a problem of determining the effect that time of assessment may have on the conclusions drawn. This experiment was visually rated at six times after treatment. There were no significant differences between the rankings taken approximately 17 weeks after each treatment and those taken when the fronds were counted in the November after treatment. However, for the May assessment (17 weeks after the last treatment and 38 weeks after the first treatment), speed of application, applicator by time of application interaction and the applicator by speed of application interaction had changed significantly. The control rankings of the plots treated at 4 k.p.h. had improved, whilst those treated at 8 k.p.h. had deteriorated when the May assessment was compared with the 17-week assessment. Assessment at a constant time after treatment reflected more closely the long-term effects

Table 4 Effect of type of applicator and ground speed on bracken frond density (10 November 1982) and control ranking 17 weeks after application for treatments applied between December and March

Applicator	Bracken (fronds m^{-2})		Visual ranking of control[A]	
	Ground speed			
	4 k.p.h.	8 k.p.h.	4 k.p.h.	8 k.p.h.
Longitudinal	0.9a	1.55ab	5.51c	7.7c
Transverse	3.24b	2.26ab	18.01e	12.0d

[A] 1 = best, 36 = worst.
[B] Treatments with the same letter do not differ significantly ($P<0.05$).

Table 5 Effect of type of applicator and date of application on frond densities (10 November 1982) and control rankings 17 weeks after treatment

Type of applicator	Bracken (fronds m^{-2})			Visual ranking of control[A]		
	Dec.	Jan.	Mar.	Dec.	Jan.	Mar.
Longitudinal	0.92a	0.70a	2.05a	7bc	4b	8.8c
Transverse	–	1.92a	4.35b	–	15.5d	14.1d

[A] 1 = least bracken, 36 = most bracken.
[B] Treatments with the same letter do not differ significantly ($P<0.05$).

than did a single assessment at one date. If it is practical to take only one assessment then this should be delayed as long as possible in order to reduce the effect of treatment time to assessment time transient effects.

Conclusions

The longitudinal rope-wick applicator operated at speeds between 4 and 8 k.p.h. with a 120 g a.i. l^{-1} glyphosate solution was more effective than the transverse rope-wick applicator for controlling bracken fern. Each applicator has its own set of optimal operating conditions. Conditions determined for one type of applicator cannot be used for another type with confidence. The best speed of application was dependent on the type of applicator with the transverse rope-wick applicator performing better at the higher speed and the longitudinal rope-wick applicator performing similarly at both speeds. Passing over the bracken twice with the applicators provided increased control which may have been due to both increased rate of herbicide application and better distribution of the herbicide on the target weed. A single application with the longitudinal rope-wick applicator provided similar control to a double application with the transverse rope-wick applicator. Little control was achieved when only 40% of the stand of bracken comprised fully unfurled fronds. Control was best when approximately 75% of the fronds had fully unfurled and when the height of the applicator was, at most, half the height of the stand.

Assessment of long-term effects should be performed at a constant time after treatment or as long after treatment as possible where a single assessment only is to be made. A single assessment 17 weeks after the last treatment did not reflect the longer term effects, whereas an assessment 17 weeks after each treatment accurately reflected the long-term result.

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References

Alvey, M. G., and Banfield, C. F. *et al.* (1977). 'GENSTAT – a general statistical program'. Rothamsted Experimental Station 1977.

Braid, K. W. (1959). Bracken: a review of the literature. Commonwealth Agricultural Bureaux. Mimeographed publication No. 3/1959.

Campbell, D. S., Fulton, R. G., Ruzic, I. M., and Somervaille, A. J. (1981). Selective application of glyphosate to erect weeds in pasture using weed wipers. Proceedings of the 6th Australian Weeds Conference 1981.

Martin, D. J. (1976). Control of Bracken. *Botanical Journal of the Linnean Society* **73**, 241–6.

Preest, D. S. (1975). Review of and observation on current methods of bracken control in forestry. Proceedings of the 28th New Zealand Weed and Pest Control Conference 1975, pp.49–52.

Scragg, E. B., McKelvie, A. D., and Kilgour, D. W. (1974). Further work on the control of bracken in the north of Scotland. Proceedings of the 12th British Weed Control Conference 1974, pp.761–9.

Wasmuth, A. G. (1983). 'The control of bracken with asulam". Proceedings of the 26th New Zealand Weed and Pest Control Conference 1973, pp.7–12.