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Control of Johnson grass patches in cultivation using glyphosate

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Summary

In a field experiment glyphosate [N-(phosphonomethyl) glycine] applied in November and repeated in February and April resulted in complete control of Johnson grass [*Sorghum halepense* (L.) Pers.] patches in cultivation at concentrations down to 0.09%. Applications in November repeated in February (at concentrations up to 0.24%) or single applications in November or April (at concentrations up to 0.36%) failed to completely control the weed.

At concentrations of 0.24% and 0.18% there were no significant differences in initial control achieved irrespective of timing or number of applications. However, at the lower concentrations of 0.09% and 0.045% there were indications of greater activity of glyphosate when applied in autumn rather than in early or late summer.

INTRODUCTION

Johnson grass [*Sorghum halepense* (L.) Pers.], a perennial weed, occurs in cultivation and along roadsides in the eastern Darling Downs region of south-eastern Queensland. In cultivation the weed establishes as isolated patches following introduction of seed with sown crops or in cattle dung or of seed and rhizomes in flood water. Rhizomes may be initiated within three to five weeks of emergence (Oyer, Gries and Rogers 1959; Anderson, Appleby and Weseloh 1960; McWhorter 1961). These rhizomes tolerate winter soil temperatures to -9°C (Stoller 1977) and produce fresh aerial growth the following spring. The production of dormant seed (Taylorson and McWhorter 1969) contributes to the difficulty of eradicating the weed.

Glyphosate [N-(phosphonomethyl) glycine] is a foliar-absorbed translocated herbicide of negligible soil persistence with outstanding activity against a number of rhizomatous weeds (Spurrier 1973), including Johnson grass (Spurrier 1973; Connell and Derting 1973; Derting, Andrews, Duncan and Frost 1973; McWhorter 1977). Spurrier (1973) reported that for most effective control of Johnson grass with glyphosate, the weed should be treated at the early head stage and that, in temperate areas, late summer or early autumn treatment is superior to spring treatment. Tillage practices for crop production can be resumed seven days after treatment of perennial plants (Caulder 1973).

The objective of this research was to compare the efficacy of early summer, autumn and repeated applications of glyphosate at a range of spray concentrations for control of established patches of Johnson grass in cultivation on the Darling Downs.

MATERIALS AND METHODS

The experiment was conducted on a heavy self-mulching black earth clay on the Hermitage Research Station (lat. 28° 13′S, long. 152° 6′E) at an elevation of 480 m. January is the warmest month with a mean maximum temperature of 28.9°C and a mean minimum of 16.3°C. The coldest month is July with a mean maximum of 16.9°C and a mean minimum of 1.7°C. Rainfall is summer dominant and averages 717 mm annually.

Establishment of plots

Rhizomes obtained from an apparently uniform roadside Johnson grass population were sectioned into segments each having five nodes. The segments were placed between damp jute bags for two days prior to selecting those with similar bud development for planting.

Individual segments, planted 7.5 cm deep in cultivated moist soil on 19 September 1975, were positioned at each corner of a 40 cm square in the centre of plots. Plot centres were 4 m apart. Apart from removing inflorescences to prevent seed contamination of the area the patches were not treated and developed to approximately 1.25 m square with mature rhizome systems in November 1976.

Treatments and design

Glyphosate (360g/L) was applied at concentrations 0.045, 0.9, 0.18 and 0.24% a.i. as a: single early summer application; repeated application in early summer, late summer and autumn; single autumn application. Other treatments were a single early summer application, an autumn application (each at 0.36% a.i.) and an untreated control. The 15 treatments were each replicated four times in a randomised block design.

Application of treatments and data collection

Dates of application of treatments and associated Johnson grass growth stages are presented in Table 1. Although early heading is the preferred growth stage of the grass for application of glyphosate, some repeated treatments were applied to vegetative regrowth so that date of application, and hence environmental conditions at applications time, would be uniform for repeated treatments.

Table 1. Environmental conditions and Johnson grass growth stages for each spray application date

	Date and seasonal timing of application			
	26 November 1976	10 February 1977	15 April 1977	
	Early summer and initial repeated applications	Late summer repeated application	Autumn repeated application	Single summer application
Spray concentration (% a.i.):				
0.045	Early flowering[1]	Early flowering	Early flowering	Early flowering
0.09	Early flowering	Early flowering	Early flowering	Early flowering
0.18	Early flowering	Vegetative	Vegetative	Early flowering
0.24	Early flowering	Vegetative	Vegetative	Early flowering
0.36	Early flowering			Early flowering
Temperature (°C):				
Time of spraying	24	25	15	
Maximum for next 24 hours	30	28	23	
Minimum for next 24 hours	15	13	10	
Growth conditions	Excellent	Hot and dry for the previous 2 weeks	Excellent	
First rainfall after spraying	1.8 mm after 8 hours	0.7 mm after 2 days	1.0 mm after 8 hours	

[1] Johnson grass growth stage tabulated is that of the most advanced tillers for that treatment.

Treatments were applied as aqueous sprays through twin cone nozzles on a lance attached to an Oxford Precision Sprayer. Spraying pressure was 207 kPa. Plants were sprayed to overall visible wetness without runoff. Volume of application approximated 1900 L/ha for single applications and considerably less for the second and third repeated applications, as patch vigour had been considerably reduced by previous application. Environmental conditions at, and immediately following, the various spraying times are shown in Table 1.

All plots were slashed 17, 18 and 11 days after the first, second and third application dates respectively. The slashing was done to promote fresh early-flowering regrowth for following spray application timings. It also simulated top-growth removal by tillage after spraying which would be the normal procedure in ground preparation for cropping. Cultivation of the trial area was undesirable in that rhizome fragments could be spread from plot to plot.

Visual estimates of percentage control of regrowth were made on three occasions following the three application dates. On 9 November 1977, in the growing season following that of treatment application, tiller numbers per patch were recorded and above-ground growth was harvested, oven-dried at 82°C for 24 h and weighed. Final observations were taken on 4 April 1978 to confirm permanent control in plots that were without regrowth on 9 November 1977.

Statistical analyses

Analysis of tiller numbers and Johnson grass dry weight was performed using a log (x+1) transformation because of the wide range of values encompassed in the data. The three treatments with no surviving grass in any replicate were excluded from these analyses and also from the analysis of estimated percentage control of regrowth. Protected l.s.d. tests were used to compare treatments for significant differences. One-tail tests were used for comparing other treatments with the nil-regrowth treatments. The figures in Table 2 are the re-transformed natural means for each treatment together with letters to indicate the pattern of significant differences based on the tests outlined.

Table 2. Effect of time and concentration of glyphosate application on control of Johnson grass as determined on 9 November 1977

Treatment		Johnson grass regrowth*	
Time of application	Spray concentration (% a.i.)	Tiller number per patch	Dry weight per patch (g)
Early summer (26 Nov 76)	0.045	638*ab*	577*a*
	0.09	548*ab*	517*a*
	0.18	289*ab*	322*ab*
	0.24	164*b*	236*ab*
	0.36	128*bc*	155*bc*
Autumn (15 Apr 77)	0.045	221*ab*	71*c*
	0.09	29*cd*	13*de*
	0.18	14*de*	14*de*
	0.24	4*ef*	5*ef*
	0.36	2*f*	2*fg*
Repeated (26 Nov 76, 10 Feb 77 and 15 Apr 77)	0.045	24*cd*	21*d*
	0.09	0*g*	0*g*
	0.18	0*g*	0*g*
	0.24	0*g*	0*g*
Untreated		897*a*	650*a*

* Means within columns followed by the same letter are not significantly different ($P<0.05$).

RESULTS AND DISCUSSION

Single applications of glyphosate in early summer or autumn failed to completely control Johnson grass patches irrespective of the concentration used (Table 2). Also, with repeated applications, some regrowth occurred in all four replications at all concentrations tested after the second application (Table 3). Complete control was achieved following

three repeated applications at concentrations of 0.09% and greater (Table 2). Observations in April 1978 confirmed no regrowth and hence permanent control with these treatments, as Johnson grass rhizomes do not survive longer than the growth season following that of their development (Anderson *et al.* 1960).

Table 3. Estimated mean percentage control of Johnson grass regrowth following different application dates of glyphosate

Spray concentration (% a.i.)	Mean % control			
	Applied 26 Nov 76[1]	Applied 26 Nov 76 and 10 Feb 77[2]	Applied 15 Apr 77[3]	Applied 26 Nov 76 10 Feb 77 and 15 Apr 77[3]
0.045	41*e* §(4)#	70*d* (4)	86*bc* (4)	96*ab* (3)
0.09	78*cd* (4)	98*ab* (4)	97*ab* (4)	100*a* (0)
0.18	95*ab* (4)	99*ab* (4)	98*ab* (4)	100*a* (0)
0.24	99*ab* (4)	99*ab* (4)	99*ab* (3)	100*a* (0)

* Visual estimates of % control of regrowth compared with untreated. The estimates were taken at flowering of the regrowth of the least successful treatments.
[1] Estimated 3 Feb 77.
[2] Estimated 13 Apr 77.
[3] Estimated 9 Nov 77.
§Means followed by the same letter are not significantly different ($P<0.05$).
#In parenthesis are the number of replicates of that treatment in which regrowth was present.

Although a high level of initial control was achieved at the higher concentrations with the single early summer applications (Table 3), the level of control in these treatments had deteriorated greatly by November 1977 (Table 2). This indicates the necessity of timely re-spraying of regrowth to prevent the rapid re-establishment of the problem in treated areas.

In this trial, the relative effectiveness of different times of glyphosate application can be compared by the differences obtained in estimates of control of Johnson grass when the regrowth in the least effective treatments was at early flowering (Table 3). There was a significant interaction ($P<0.01$) between timings of application and spray concentration. At concentrations of 0.24% and 0.18% there were no significant differences in initial control achieved irrespective of timing or number of applications. However, at lower concentrations there were differences in degree of initial control associated with time of application in that single early summer applications were markedly inferior to single autumn applications. Moreover two applications of 0.045% in early and late summer were inferior to a single application at the same concentration in autumn. Thus, with the growth stage of the grass the same (early flowering) for all three timings of application, the activity of glyphosate in Johnson grass was greater in this trial in autumn than in early or late summer.

The results indicate that for complete control of rhizomes of Johnson grass growing in cultivation, repeated applications of glyphosate may be necessary. With repeated applications there would appear to be no final advantage in use of spray concentrations above 0.09%.

With naturally occurring Johnson grass patches, where dormant seed has been shed prior to chemical treatment, a programme of seedling control will need to be maintained for a number of seasons following eradication of the rhizomatous plants.

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