THE INFLUENCE OF CLOPYRALID AND GLYPHOSATE ON YARROW RHIZOME REGENERATION

ROGER J. FIELD and C.S. JAYAWEERA

Plant Science Department, Lincoln College, Canterbury

SUMMARY

Seasonal applications of clopyralid (0.5 kg ai/ha) and glyphosate (2.16 kg ai/ha) to yarrow (*Achillea millefolium*) plants in the field did not result in a total kill of rhizome buds. Autumn applications resulted in the most effective control, following rhizome fragmentation, with glyphosate and clopyralid controlling greater than 85% and 70% of rhizome buds, respectively. Simulation of cultivation by fragmentation of rhizomes suggested that shorter fragments (40 mm) were more effective in improving efficacy of glyphosate while longer fragments (160 mm) assisted the performance of clopyralid.

INTRODUCTION

There are no firmly established herbicide recommendations for selective or non-selective control of mature yarrow plants that have developed an extensive rhizome system. Tentative recommendations have been made for glyphosate (Matthews 1976) and clopyralid (Robocker 1977) on mature, rhizomatous plants while Bourdot and Hurrell (1984) recently evaluated a large number of herbicides for use on seedling plants. In the latter study clopyralid at 0.25 kg ai/ha resulted in 99% mortality of three to six leaf seedlings, that were not rhizomatous.

The present study involved an evaluation of glyphosate and clopyralid on rhizomatous plants and consideration of the effects of post-spray rhizome fragmentation on subsequent rhizome bud growth. The experiments simulated post-spray cultivation treatments but did not attempt to evaluate performance in a typical no tillage situation.

MATERIALS AND METHODS

Single yarrow plants were established from 100 mm fragments on 12 November 1981, in a Wakanui silt loam soil at Lincoln College. Plants were spaced 1 m apart, regularly irrigated and weeds removed. These spaced plants were used for two experiments involving application of the herbicides clopyralid and glyphosate. Herbicides were applied with a CO₂ pressurised sprayer, fitted with Teejet 8002 nozzles, operating at a pressure of 275 kPa and delivering 250 litres at a forward velocity of 1 m/second. Adjacent plants were screened at the time of spraying. Plants were carefully removed from the soil at pre-determined times after spraying and rhizomes removed at random for cutting into specific length fragments. Total dry weight of intact rhizomes was determined. Applications of clopyralid (0.5 kg ai/ha) and glyphosate (Roundup) (2.16 kg ai/ha) were made at specific dates and all experiments had five replicates in a randomised block design.

In the first experiment there were three treatment dates, autumn (9 March 1982); winter (25 July 1982) and spring (26 November 1982), each one being analysed separately. Applications were made to plants at the appropriate stage of development for the season and in the absence of grazing or regular mowing pre-treatments. At autumn application foliage was 300 mm high and flowering virtually completed. The trial area was mown to 100 mm on 25 May 1982 and the re-growth sprayed in the winter application. The spring application was to plants that had commenced bolting but did not exceed 450 mm in height. After each spraying rhizomes were sampled on four occasions; 2, 7, 14 and 28 days after spraying. Randomly selected rhizomes were cut to isolate single node fragments which were placed on damp filter paper in trays that were

Proc. 38th N.Z. Weed and Pest Control Conf.

partially sealed with a plastic bag and incubated for 14 days at 25 °C in the dark. Bud growth activity was assessed as positive when buds exceeded 20 mm in length.

The second experiment was an autumn application sprayed on 9 March 1982, using the same treatments as previously described. Rhizomes were retrieved 7 days after spraying and cut into 40 mm, 80 mm and 160 mm lengths. Twenty fragments of each length were placed in trays containing unsterilized Wakanui silt loam soil, at a depth of 30 mm. The trays were placed in a glasshouse at approximately 20 °C and half the rhizomes retrieved at 2 days with the remainder at 42 days. Bud activity was positive if shoots exceeded 5 mm after 2 days, while bud emergence was calculated from shoots breaking the soil surface. The weight of emerging shoots plus the lengths of intact, unrotted rhizomes were determined. All bud activity and emergence measurements were related back to the original number of planted rhizome buds. A 160 mm rhizome fragment had 6.6 ± 0.5 buds at planting.

RESULTS AND DISCUSSION

Application of either glyphosate or clopyralid to yarrow plants reduced subsequent rhizome bud growth, in all seasons, (Table 1). Glyphosate was consistently more effective than clopyralid and in both cases there was consistently and usually significantly better performance in autumn applications. The timing of rhizome retrieval after spraying did not significantly affect the performance of the herbicides, indicating that translocation to rhizomes was effected within two days. This is consistent with findings for the translocation of glyphosate (Sprankle *et al* 1975) and clopyralid (Whitesides and Appleby 1978) in other species. Rhizomes retrieved 2 and 7 days after spraying showed no visible symptoms of herbicide damage, while those removed at 14 days and particularly those at 28 days showed some damage following glyphosate treatment. Thus in plants treated with glyphosate in spring there was a 13.3% and 30.0% reduction in rhizome weight 14 days and 28 days after spraying, respectively. Because calculations of bud activity were based on the number of buds at planting, reductions in total rhizome weight lead to over-estimates of the percentage bud activity following glyphosate treatment. Thus the mean percentage bud activity for autumn applications of glyphosate were probably less than 10% of the total buds at the time of spraying. Developmentally, plants treated in March had ceased flower initiation (Bourdote *et al* 1979) and physiologically the subterranean organs were the dominant sinks for available assimilates, favouring co-translocations of herbicide to rhizomes.

The sprouting of single bud rhizome fragments is a convenient bioassay for assessing herbicide activity in yarrow rhizomes (Table 1) but does not necessarily reflect the nature of fragmentation following cultivation (Bourdote *et al* 1982). Therefore a second experiment was conducted to investigate the interactions between autumn applied herbicides to investigate the interactions between autumn applied herbicides and subsequent fragmentation of rhizomes.

TABLE 1: Effect of herbicide treatment, season of application (autumn (A), winter (W) and spring (S)) and timing of rhizome retrieval on bud growth.

		Percentage bud growth			
		Time of sampling (days after spraying)			
		2	7	14	28
control	A	68	71	68	75
	W	76	78	73	77
	S	83	76	77	79
clopyralid	A	28	26	30	28
	W	45	43	36	40
	S	37	38	38	35
glyphosate	A	15	11	14	13
	W	27	25	22	23
	S	21	17	15	17
LSD 5%	5.7	(maximum value for all comparisons)			

Bud activity was assessed 2 days after burial in soil and in the control there was a significant reduction, as rhizome fragment length was increased (Table 2). Similar results were found for clopyralid, whereas glyphosate significantly stimulated bud activity, particularly in 160 mm fragments. Comparable figures were found when rhizomes were retrieved only 2 days after spraying, indicating rapid translocation and bud growth stimulation by glyphosate. The biochemical and physiological basis of bud stimulation by glyphosate is unknown but could be advantageous in limiting the number of dormant buds that could subsequently establish new plants. However the crucial biological factor is whether bud activity develops into healthy bud growth and leads to shoot emergence. The results in Table 2 indicate that this is not the case and bud emergence from 40 or 80 mm long fragments was only 12% for glyphosate treated plants.

TABLE 2: Effect of herbicide treatment and rhizome length on bud activity (2 days after burial), bud emergence (42 days after burial) and rhizome rotting (42 days after burial; mean for all fragment lengths). All rhizomes retrieved 7 days after spraying.

	Rhizome fragment length (mm)			LSD 5%	
	40	80	160		
	Percentage bud activity				
control	61	48	37	7	
clopyralid	51	44	41	7	
glyphosate	70	66	77	7	
LSD 5%	10	4	6		
	Percentage bud emergence				Percentage rhizome rotting
control	57	38	29	6	10
clopyralid	41	34	22	6	20
glyphosate	12	12	22	6	38
LSD 5%	4	5	4		4

In the control treatment the reduction in bud emergence as rhizome fragment length increased was similar to previous findings by Bourdot *et al* (1982) and emphasises the difficulty of releasing all buds from dormancy by cultivation. A similar trend, but with consistently lower emergence, was noted for clopyralid. The overall reduction in bud emergence with glyphosate was associated with poor vigour of emerging shoots which had a mean weight of 81 mg, compared to 155 mg and 141 mg for the control and clopyralid treatments, respectively. The reduced vigour of bud growth with glyphosate was associated with the increased time (27 days) taken to 50% bud emergence compared to the control (9 days), (emergence after 42 days was considered at 100%). There was a slight, but non-significant increase in time to 50% bud emergence with increased rhizome fragment length. Associated with the reduced bud emergence with herbicide treatments was an increase in the rotting of rhizome fragments after incubation in soil for 42 days (Table 2). The increased rhizome rotting following glyphosate treatment was the most significant effect. No longer term assessments were made to establish if the slow rotting of rhizomes continued after the 42 day evaluation.

CONCLUSIONS

The complete control of mature yarrow plants was not brought about by glyphosate or clopyralid. Applications in autumn were most effective and glyphosate controlled more than 85% of rhizome buds, while the corresponding figure for clopyralid was 70%. The efficacy of herbicide treatments was influenced by the length of fragmented rhizome with more severe fragmentation to 40 mm lengths favouring glyphosate applications and longer fragments of 160 mm favouring clopyralid treatments. These results have implication for the type of post-spray cultivation.

These experiments have examined the performance of herbicides in relation to a post-spray simulated cultivation. Under such conditions significant control of yarrow could be achieved by application of glyphosate and to a lesser extent clopyralid. Multiple cultivation treatments could be advantageous when used with either herbicide, particularly glyphosate (Bourdote and Butler 1985). However these experiments did not determine herbicide efficacy in the absence of cultivation and it seems likely that performance under conditions of direct drilling and no tillage could be further reduced, but requires testing.

REFERENCES

- Bourdote, G.W. and Butler, J.H.B., 1985. Control of *Achillea millefolium* L. (yarrow) by rotary cultivation and glyphosate. *Weed Res.*, (in press).
- Bourdote, G.W., Field, R.J. and White, J.G.H., 1982. Yarrow: numbers of buds in the soil and their activity on rhizome fragments of varying length. *N.Z. J. Exp. Agr.* 10: 63-67.
- Bourdote, G.W. and Hurrell, G.A., 1984. A screening of herbicides for yarrow seedling control. *Proc. 37th N.Z. Weed and Pest Control Conf.*: 167-171.
- Bourdote, G.W., White, J.G.H. and Field, R.J., 1979. Seasonality of growth and development in yarrow. *Proc. 32nd N.Z. Weed and Pest Control Conf.*: 49-54.
- Matthews, L.J., 1976. The journal guide to weed control. 1. Pasture weeds. *N.Z. J. Agr.* 133: 38-49.
- Robocker, W.C., 1977. Germination of seeds of common yarrow (*Achillea millefolium*) and its herbicidal control. *Weed Sci.*, 25: 456-459.
- Sprankle, P., Meggitt, W.F. and Penner, D., 1975. Absorption, action and translocation of glyphosate. *Weed Sci.*, 23: 235-240.
- Whitesides, R.E. and Appleby, A.P., 1978. Canada thistle response to DOWCO 290. *Down to Earth*, 35(1): 14-17.