CONTROL OF CREEPING KNAPWEED (*ACROPTILON REPENS*) WITH HERBICIDES

G.H. PRITCHARD and K.A. SHAW[1]

Keith Turnbull Research Institute
Department of Crown Lands and Survey
P.O. Box 48
Frankston Vic. 3199

Summary. Single applications of herbicides were evaluated on creeping knapweed (*Acroptilon repens* syn. *Centaurea repens*) in three trials in volunteer annual pasture and one trial in a roadside situation. The trials commenced in the summer of 1977-78 and continued for either three years (three trials) or one year (one trial).

Only boom sprays of picloram/2,4-D[2] (0.55/2.2 kg ha^{-1}), dicamba (4.4 kg ha^{-1}), dicamba/2,4-D[3] (2/7.5 kg ha^{-1}), and spot sprays of picloram/2,4-D (0.05%/0.2% and 0.1%/0.4%) gave a high level of control for more than one year. Dichlobenil (11.8 and 23.6 kg ha^{-1}), triclopyr ester (7.2 kg ha^{-1}) and triclopyr amine (5.4 kg ha^{-1}) gave excellent control for one year but did not prevent regrowth in subsequent years, while 2,4-D amine (6 kg ha^{-1}), 2,4-D ester (3.5 kg ha^{-1}), 2,3,6-TBA (10 kg ha^{-1} and 0.1% as spot spray) and glyphosate (4 kg ha^{-1} and 0.36% as spot spray) failed to prevent regrowth in the first season after application.

Time of application (mid-November at the flower bud stage or late January at the seed head stage) did not appear to affect the level of control in the following season. Cultivation of one trial 16½ months after application resulted in a marked decline in the control of most treatments in the following spring.

INTRODUCTION

Creeping knapweed, known in Victoria as hardheads, is a spring and summer growing herbaceous perennial. The top growth dies off in late summer and autumn and new shoots appear from the perennial root system in the following spring. The root system consists of deep vertical roots and creeping horizontal roots. In dryland cereal areas of Victoria it is most prevalent in the Swan Hill, Piangil and Kerang districts where it has been present for over fifty years (Parsons 1973). In recent years there has been an increase in the number and size of infested areas. Creeping knapweed competes strongly with cereal crops, causing serious reductions in crop yield.

The herbicides recommended for its control in Victoria are 2,4-D, dicamba and picloram/2,4-D (Anon. 1977), but results have not always been satisfactory. Other herbicides which have been used with some success overseas are 2,3,6-TBA (Derscheid *et al.* 1963) and dichlobenil (Crafts 1975). The four trials reported here evaluated these herbicides plus glyphosate and triclopyr

[1] Present address: Division of Primary Industry, P.O. Box 2134, Alice Springs, N.T. 5750.
[2] Trade name Tordon 50-D.
[3] Trade name Amidi.

as single applications for the long term control or eradication of creeping knapweed.

MATERIALS AND METHODS

All trials used plots of 4 by 5 m laid out as randomized blocks with three replications. Boom spray applications were made with a portable field plot sprayer operating at a pressure of 245 kPa with cone nozzles to give a spray volume of 580 L ha^{-1}. Spot sprays were applied with a knapsack at a pressure of 200 kPa and a spray volume of approximately 1 300 L ha^{-1}. Granular treatments were applied by hand and raked into the soil.

The trials commenced in the summer of 1977-78 and were continued for three years, except for the smaller Trial 4 which was terminated after one year. No repeat applications were made. Trial 2 was rotary-hoed to a depth of approximately 15 cm in June, 1979, 16½ months after application when creeping knapweed top growth was dead. Details of the trials are set out in Table 1.

Table 1. Trial numbers and information on their location, situations and conditions at application.

Trial No.	Location	Situation	Application date	Growth stage[1]	Mean density[1] (shoots m^{-2})	Soil type	Soil moisture[1]
1	Lake Boga	Volunteer pasture	Nov.16 1977	Flower buds	16.4	Sandy loam	Moderate
2	Lake Boga	Volunteer pasture	Jan.24 1978	Post-flowering (seed-heads)	12.3	Sandy loam	Dry
3	Merbein South	Volunteer pasture	Jan.26 1978	Post-flowering (seed-heads)	19.4	Sand	Dry
4	Merbein South	Roadside	Nov.30 1977	Early flowering	23.0	Sandy loam	Moist

[1] At the time of application.

At each assessment, the number of creeping knapweed shoots in 1 m^2 were counted in each plot and the results expressed as the percentage of the number of shoots m^{-2} present prior to application.

RESULTS

The results of the four trials are given in Table 2. In the year following application, boom sprayed treatments which gave excellent control in the three trials in which they were evaluated were picloram/2,4-D at 0.55/2.2 kg ha^{-1}, dicamba at 4.4 kg ha^{-1}, dicamba/2,4-D at 2.0/7.5 kg ha^{-1} and triclopyr ester at 7.2 kg ha^{-1}. Spot sprays of picloram/2,4-D at 0.05%/0.2% and 0.1%/0.4% gave excellent control in all four trials. Granular dichlobenil at 11.8 and 23.6 kg ha^{-1} gave excellent control in three out of four trials.

Table 2. Effect of herbicides on creeping knapweed shoot density.

Herbicide	Rate (kg ha^{-1})	Shoot density relative to the density at application (%)									
		Trial 1			Trial 2			Trial 3			Trial 4
		Months after treatment									
		11	23	36	9	21	34	9	20	36	11
Boom sprayed:											
Picloram/2,4-D amine	0.55/202	0[1]	0[1]	12 abc	0[1]	13 de	81 abc	6 ef	0.9 e	0.9 ef	
Dicamba	4.4	0.8 h[2]	9 de	40 abc	1 c	2 e	45 c	0[1]	0.2 e	2 def	
Dicamba/2,4-D amine	1.0/3.75	43 a-e	160 ab	110 ab	65 a	302 abc	289 a	4 efg	10 cd	10 a-e	
Dicamba/2,4-D amine	2.0/7.5	2 gh	12 cde	18 abc	7 bc	202 abc	163 abc	0[1]	1 de	1 def	
2,4-D ester	3.5	198 a	305 a	140 ab	89 a	239 abc	174 abc	160 a	124 a	55 a	
2,4-D amine	6.0	88 abc	154 ab	111 ab	370 a	487 a	269 ab	54 abc	17 bc	33 ab	
Triclopyr ester	3.6	12 c-g	101 abc	72 abc	54 ab	262 abc	177 abc	8 def	11 bcd	6 a-f	
Triclopyr ester	7.2	6 e-h	53 a-d	52 abc	2 c	32 b-e	96 abc	0.7 g	1 de	0.4 f	
Triclopyr amine	2.7	160 ab	483 a	174 a	5 c	64 a-d	46 bc	90 ab	40 abc	38 ab	
Triclopyr amine	5.4	9 d-h	20 b-e	43 abc	3 c	136 a-d	84 abc	16 c-f	4 de	4 b-f	
Glyphosate	4.0	68 a-d	191 ab	157 ab	203 a	321 abc	250 abc	124 ab	136 a	17 a-d	
2,3,6-TBA	10.0	47 a-d	95 a-d	56 abc	112 a	207 abc	208 abc	113 ab	69 ab	28 abc	
Broadcast granules:											
Dichlobenil	11.8	4 fgh	123 abc	76 abc	2 c	226 abc	164 abc	43 abc	118 a	32 ab	5 c
Dichlobenil	23.6	1 gh	22 b-e	68 abc	3 c	26 cde	60 abc	32 bcd	118 a	26 abc	3 c
Spot-sprayed:	Conc.(%)										
Picloram/2,4-D amine	0.05/0.2	0[1]	5 e	18 abc	2 c	24 cde	54 abc	0[1]	2 de	6 a-f	0[1]
Picloram/2,4-D amine	0.1 /0.4	0[1]	2	12 abc	0[1]	39 a-d	52 abc	0.4 g	1 de	0.1 f	0[1]
Dicamba	0.1	21 b-f	123 abc	78 abc	89 a	209 abc	118 abc	20 cde	10 cd	3 c-f	
2,3,6-TBA	1.0	27 a-f	61 a-d	40 abc	47 ab	70 a-d	59 abc	14 c-f	0.4 e	0[1]	
Glyphosate	0.18							172 a	127 a	23 abc	23 b
Glyphosate	0.36										25 b
Untreated	-	154 ab	170 ab	95 abc	304 a	403 ab	260 abc	110 ab	120 a	35 ab	161 a

[1] Not included in analysis.

[2] Values within columns followed by the same letter are not significantly different ($P < 0.05$) according to Duncan's Multiple Range Test. Analyses performed on log $(x + 1)$ tranformed data.

In subsequent years control from these treatments decreased, although in the third year of Trial 3 this was masked by the decline in the creeping knapweed population (as evidenced by the results from the untreated plots). The only treatment which gave complete control after three years was 2,3,6-TBA at 1% in Trial 3, and this result was presumably contributed to by the population decline.

In Trial 2, control from almost all treatments declined markedly after the cultivation in the second year. Of the more effective treatments, only dicamba at 4.4 kg ha^{-1}, triclopyr ester at 7.2 kg ha^{-1} and dichlobenil at 23.6 kg ha^{-1} gave comparable control to that obtained by these treatments in the adjacent uncultivated Trial 1.

DISCUSSION

If single applications of picloram/2,4-D or dicamba are to achieve eradication of creeping knapweed the rates will need to be higher than those tested. This appears to agree with the majority of overseas results. There have been instances of excellent results with picloram at 0.56 kg ha^{-1} (Alley and Humburg 1978) and dicamba at 2.2 kg ha^{-1} (Jones and Evans 1973), but most published results indicate that the rates needed for long term control or eradication may be as high as 1.5 to 3 kg ha^{-1} for picloram and 5 to 20 kg ha^{-1} for dicamba (Berg 1977; Berezovskii and Krumzdorov 1972; Fisyunov *et al.* 1977; Gruzdev and Popov 1974; Mordovets and Golovin 1974). While these high rates of picloram and dicamba may be acceptable in Australia on small infestations, cost and the undesirability of applying such high rates of soil-persistent treatments prohibits their use on large areas. For broad scale infestations, rates of picloram/2,4-D at up to 0.55/2.2 kg ha^{-1} or dicamba at up to 4.4 kg ha^{-1} repeated over a number of years may be necessary to eradicate the weed.

With spot spraying, the trials showed no advantage in increasing the concentration of picloram/2,4-D from 0.05%/0.2% to 0.1%/0.4%. They also showed that the current recommendation for dicamba of 0.09% (Anon. 1977), is too low to give reliable control. The other herbicide currently recommended for creeping knapweed control in Victoria, 2,4-D, was ineffective in these trials. Overseas results (Derscheid *et al.* 1963) indicate that good levels of control can be maintained with repeated applications of 2,4-D, but only when combined with intensive cultivation and crop competition.

Triclopyr showed some activity but this only lasted one year except in Trial 3, and it is very expensive at the rates necessary. Dichlobenil was effective for one year at three out of four sites, but the rates tested were costly and too persistent against all other vegetation. Glyphosate significantly reduced shoot numbers only in the more moist situation of Trial 4, and even there the effect was insufficient.

Trials 1 and 2 which were alongside each other at Lake Boga, enable a comparison between application in mid-November at the flower bud stage and application in late January after flowering. Control from most treatments in the year following application was little affected by the time of application, particularly when account is taken of the greater increase in shoot numbers in Trial 2 (Table 2).

Since the differing times of application did not greatly affect the control from any treatments after one year, Trial 2 was cultivated in the second year. For most treatments the cultivation resulted in a greater decline in control than in the adjacent uncultivated trial. The cultivation apparently stimulated the production of shoots, either from the fragmented root pieces or from the root system below the severence level. While the former seems a probable source of shoots on untreated plots or where less effective treatments were used, it is less likely with the better treatments which appeared to kill the roots down to at least the depth of the subsequent cultivation. The results suggest that control may be more difficult when cultivation is involved. However, overseas results do not support this (Fisyunov *et al.* 1977; Gruzdev and Popov 1974; Mordovets and Golovin 1974) and cultivation at a different time or different interval after herbicide application may not stimulate regrowth. These factors are being investigated.

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