The herbicidal control of wild radish (*Raphanus raphanistrum* L.)

G.R. Code, T.G. Reeves, H.D. Brooke
Department of Agriculture
Rutherglen Research Station
Rutherglen 3685, Victoria

C.M. Piggin
Keith Turnbull Research Institute
Vermin and Noxious Weeds Destruction Board
Department of Crown Lands and Survey
Frankston 3199, Victoria

SUMMARY

Wild radish (*Raphanus raphanistrum* L.) is widespread in cereal crops in southern Australia and can cause serious reduction in grain yield and can contaminate the harvested grain. This paper reports experiments investigating the control of wild radish with a range of herbicides in cereal crops near Rutherglen, Victoria, in 1976 and 1977.

Early spraying with RH5205, methabenzthiazuron + 2,4-D sodium salt, methabenzthiazuron + 2,4-D sodium salt + metribuzon and bromoxynil + MCPA gave good control (95 to 100%) of wild radish and resulted in significant increases in grain yield. Many other herbicides and herbicide mixtures were tested, but were less effective. In a time of spraying experiment with methabenzthiazuron + 2,4-D sodium salt effectiveness was reduced when spraying was delayed later than 5 to 6 weeks after sowing.

Late sowing with 2,4-D or MCPA generally gave little control of wild radish and no increase in grain yield, but did reduce seeding of wild radish and thus reduced contamination of the cereal grain.

It is recommended that heavy infestations of wild radish in cereal crops (>10 plants per m^2) be sprayed with methabenzthiazuron + 2,4-D sodium salt or with bromoxynil + MCPA about 5 to 6 weeks after sowing. These mixtures are currently registered for control of wild radish. RH5205, and a mixture of methabenzthiazuron, 2,4-D sodium salt and metribuzon are promising herbicides that may be recommended in the future, particularly in view of their apparent residual activity, but are not yet registered for wild radish control.

Contamination of grain from light infestations of wild radish that are not sprayed early or have emerged since early spraying, can be reduced by spraying 2,4-D amine (850 g a.i./ha) or MCPA (500 g a.i./ha) post-tillering.

INTRODUCTION

Wild radish (*Raphanus raphanistrum*) is a widespread and troublesome weed in cropping land throughout the world. Piggin, Reeves, Brooke and Code (1978) have outlined its distribution in Australia and throughout the world; reasons for it being considered a serious weed in cereal crops, and the way in which its germination behaviour contributes to its "weediness" in crops.

The most serious effects of wild radish on cereal crops are to reduce grain yield and to contaminate harvested grain. Blackman and Templeman (1938) have reported in detail the nature of competition between cereal crops and wild radish in England. They found that competition was severe, especially early, and grain yields could be increased by up to 160% by removal of wild radish depending on crop species, wild radish density, season and time of wild radish removal. Competition appeared to be mainly for nitrogen and partly for light and moisture. Experiments at Rutherglen (unpublished data) have shown similarly that densities of 10, 50, 100 and 200 plants per m^2 of wild radish in a crop of Egret wheat reduced grain yield by 11, 26, 35 and 49% respectively. Wild radish seed is frequently harvested with the cereal grain and the two are difficult to separate because they are of similar size and weight. Contaminated grain may be docked at the silo. Thus, it is essential to control wild radish in crops in order that maximum yield and return can be approached.

Meadly and Pearce (1954) have reported in Western Australia that wild radish can be controlled in crops with MCPA and 2,4-D, but failed to observe yield differences between treated and untreated plots because of problems with experimental technique, seasonal conditions and time of spraying.

The experiments reported here investigate the effect of various herbicides on wild radish density in, and grain yield from, cereal crops infested with wild radish.

MATERIALS AND METHODS

Six experiments were conducted on naturally occurring populations of wild radish in cereal crops near Rutherglen in north-east Victoria. Sowing dates and cultivars are listed in Table 1.

Plots measuring 1.8 m x 10 m (1976) or 1.8 m x 15 m (1977) were arranged in randomized block fashion and replicated three times. Herbicide treatments, listed in Tables 2 and 3 and in the results section, were applied in 100 ℓ/ha of water at 210 kPa. Spraying times and stages of growth of weeds and crops are listed in Tables 1 and 3.

Density of wild radish was recorded at various times (Table 2) from six 25 cm x 25 cm (1976) or five 20 cm x 20 cm (1977) quadrats per plot. Crop yield was measured by cutting a 1.4 m wide strip along the length of each plot with a "Hege" plot harvester. Harvested grain was threshed, weighed and sub-sampled (2 x 100 ml samples) to determine the proportions of wild radish and cereal seed.

RESULTS AND DISCUSSION

Wild radish densities and crop yields for selected treatments in five screening trials are presented in Table 2. It is apparent that treatments had variable effects between years and sites. In some cases, spraying had no significant effect on wild radish density (Fisher's site, 1976) or crop yield (Chambers' A and B sites, 1977). However, generally, early spraying reduced wild radish density

Table 1. Details of experimental sites for wild radish control experiments

	Fisher's 1976	Fisher's 1977	Briggs' 1977	Chambers' A 1977	Chambers' B 1977
Sowing date	27 May	11 June	25 May	15 May	15 May
Cereal cultivar	Egret wheat	Egret wheat	Lara barley	Olympic wheat	Olympic wheat
Early spraying					
Date	26 August	12 August	1 July	23 June	4 July
Crop growth stage	E.tillering	E.tillering	3-4 leaf	2-3 leaf	3-4 leaf
Weed growth stage	4-7 leaf	Cot. - 4 leaf	Cot. - 3 leaf	Cot. - 2 leaf	Cot. - 4 leaf
Late spraying					
Date	24 September	30 September	22 August	22 August	
Crop growth stage	Jointing	Jointing	L.tillering	Jointing	
Weed growth stage	15-30 cm rosettes	E.flowering	20-25 cm rosettes	12-20 cm rosettes	

Table 2. The effect of various herbicides on wild radish density and grain yield in cereal crops near Rutherglen in 1976 and 1977

Treatments[1] g a.i./ha (g product/ha)	Fishers' 1976		Fishers' 1977		Briggs' 1977		Chambers' A 1977		Chambers' B 1977	
	W.radish (No/m^2) 28 Sept.	Wheat (t/ha)	W.radish (No/m^2) 21 Oct.	Wheat (t/ha)	W.radish (No/m^2) 29 Sept.	Barley (t/ha)	W.radish (No/m^2) 1 Aug.	Wheat (t/ha)	W.radish (No/m^2) 25 Aug.	Wheat (t/ha)
Early spraying										
Treatment 1a (850)	4.2a[2]	1.68a			3.6b	1.33bcd	2.1bc	1.91a		
1b (1000)					6.0b	1.60abc	3.9bcd	1.61a	1.2b	1.54a
Treatment 2a (500)	12.6a	1.61a			2.3b	1.54abc	1.5bc	1.96a		
2b (750)	7.6a	1.80a			0	1.51abc	1.2c	1.78a		
Treatment 3 280 + 280					4.6b	1.76a	0	1.51a	7.3b	1.50a
Treatment 4a 31			109.9a	0.61a						
4b 62			11.4b	0.75a						
4c 125			0	0.83a	0	1.70ab	0.8c	1.86a		
4d 250					0	1.59abc	0	1.49a		
Late spraying										
Treatment 5 850	12.7a	1.41a	277.3a	0.16b	55.4a	0.93d	0[3]	1.48a		
Treatment 6a 380	5.7a	1.24b								
6b 500			169.1a	0.21b	80.1a	1.15d	2.3[3]bc	1.68a		
Unsprayed control	31.5a	1.40a	173.3a	0.22b	107.6a	1.00d	39.5a	1.58a	98.2a	1.24a

[1] Treatment 1 = methabenzthiazuron (45.6%) + 2,4-D sodium salt (17.5%)
Treatment 2 = methabenzthiazuron (44.0%) + 2,4-D sodium salt (14.0%) + metribuzin (14%)
Treatment 3 = bromoxynil (20.0%) + MCPA (20.0%)
Treatment 4 = RH5205
Treatment 5 = 2,4-D amine
Treatment 6 = MCPA

[2] Values followed by different letters are significantly different ($P<0.05$) as determined by Duncan's Multiple Range Test (comparisons within columns only).

[3] Wild radish densities after late spraying were recorded on 13 October.

(Fishers', 1977; Briggs', 1977; Chambers' A and B, 1977) and increased crop yield (Fishers', 1977; Briggs', 1977). Late spraying generally gave no reduction in wild radish and no increase in crop yield, although it did suppress seed production of wild radish.

The most effective herbicide was the experimental compound RH5205, which gave zero or near zero counts of wild radish at the two higher rates, and significant increases in crop yield at all rates of application. There was, however, slight scorching of the crop at 125 g/ha, and severe scorching at 250 g/ha, and, although the crop recovered, this may explain the consistently (but not significantly) lower yields at the high rate.

The mixtures methabenzthiazuron + 2,4-D sodium salt + metribuzon; bromoxynil + MCPA; and methabenzthiazuron + 2,4-D sodium salt also gave good control of wild radish, but yield increases were significant at only one site (Briggs, 1977).

There was considerable germination of wild radish for 2 weeks after spraying at the Briggs site in 1977. The only herbicides to give zero counts of wild radish at this site were RH5205 at 125 and 250 g/ha and the methabenzthiazuron + 2,4-D sodium salt and metribuzon mixture at 750 g/ha. It appeared that these herbicides had some residual activity in the soil and were killing late-emerging seedlings of wild radish. At the Chambers' site, only a few seedlings ($<2/m^2$) emerged post-spraying, and these came up 5 to 6 weeks after spraying; even after this time, these seedlings appeared to be killed by the highest rate of RH5205. These herbicides will be tested further for pre-emergence activity, and residual control of late-emerging seedlings.

It is rather difficult to select optimum rates for these herbicides, because of the lack of significant differences in the yield and, to a lesser extent, density data. This lack of significance can probably be attributed to variations in wild radish density at spraying. At present, wild radish is usually found in crops in heavy but isolated patches, and it is difficult to locate large randomized block design trials so there is a thick and even density of radish on all plots. Future trials may be improved by locating each replicate on a separate patch of wild radish within a paddock. However, the trials do suggest that optimum rates of herbicides for control of wild radish in crops are methabenzthiazuron + 2,4-D sodium salt at 1000 g product/ha, methabenzthiazuron + 2,4-D sodium salt + metribuzon at 750 g product/ha or RH5205 at 125 g a.i./ha.

The "end of tillering" treatments gave no yield responses, but usually gave complete or nearly complete suppression of wild radish seed production. In practice, they would be useful to reduce contamination of harvested grain in situations where early control measures have not been used and wild radish is growing thickly in the crop, or where some wild radish has emerged after early spraying operations.

Several herbicides not listed in Table 2 were also used in these trials. These were bromoxynil (280 g a.i./ha), methabenzthiazuron (595 and 700 g a.i./ha), bromoxynil + methabenzthiazuron (70 + 385 g a.i./ha), bromoxynil + terbutryne (140 + 100 g a.i./ha), methabenzthiazuron + dicamba (385 + 100 g a.i./ha), dicamba + 2,4-D amine

(70-280 +150-175 g a.i./ha), dicamba + MCPA (70-280 + 300-600 g a.i./ha), terbutryne + 2,4-D amine (275 + 150-175 g a.i./ha), and dinoseb (800 g a.i./ha). All were less effective and/ or more variable than the other early applied herbicides listed in Table 2. However, the mixtures of dicamba and 2,4-D or MCPA could be useful because of their low cost, and will be tested further. They generally gave good suppression of seeding in wild radish, although control was slow and incomplete and thus yield responses were generally low.

Wild radish densities and crop yields from a time of spraying experiment using methabenzthiazuron + 2,4-D sodium salt at 1000 g product/ha are presented in Table 3. At the last time of spraying (22 August), the effects of 2,4-D amine (850 g a.i./ha) and methabenzthiazuron were compared.

Spraying with methabenzthiazuron + 2,4-D significantly reduced wild radish density and increased grain yield, and generally wild radish control and yield response were reduced and grain contamination was increased as spraying was delayed. This again highlights the importance of early spraying for maximum wild radish control and yield response, even though some wild radish may emerge after spraying. Late spraying with 2,4-D was much less effective in controlling wild radish and increasing grain yield, but it did reduce contamination of the harvested grain.

CONCLUSIONS

These results show that wild radish must be controlled at an early stage in crops or grain yields will be reduced. Of the herbicides currently registered for wild radish control, methabenzthiazuron + 2,4-D at 1000 g product/ha or bromoxynil + MCPA at 280 + 280 g a.i./ha, applied at 4 to 5 weeks from sowing when the crop was in the 3-leaf to early tillering stage and the wild radish was in the cotyledon to 4-leaf stage, resulted in the best control of wild radish and increase in grain yield. RH5205 and the mixture of methabenzthiazuron + 2,4-D sodium salt + metribuzin are also very promising herbicides, particularly in view of their apparent residual activity, but are not registered at present.

Late-applied herbicides (2,4-D and MCPA) give no yield response, and are not suitable where wild radish density is high (>*c*. 10 plants/m^2). They are useful to reduce seed production of wild radish and grain contamination where wild radish density is low.

ACKNOWLEDGEMENTS

The authors are grateful to Mrs. S. Alexander, Mr. D. Baker and Mr. W. Dempsey for technical assistance, and Mr. R. Briggs, Mr. P. Chambers, Mr. B. Fisher and Mr. G. Fisher for permission to conduct the trials on their properties.

REFERENCES

Blackman, G.E. and Templeman, W.G. (1938).- The nature of the competition between cereal crops and annual weeds. *J. Agric. Sci.* 28 : 247-71.

Meadly, G.R.W. and Pearce, G.A. (1954).- The chemical control of wild radish. *J. Dept. Agric. W. Aust.* (3rd Series) 3 : 309-15.

Piggin, C.M., Reeves, T.G., Brooke, H.D. and Code, G.R. (1978).- Germination of wild radish (*Raphanus raphinistrum* L.). *Proceedings First Conf. Coun. Aust. Weed Sci. Soc.* (Melbourne, 1978).

Table 3. The effect of time of spraying with methabenzthiazuron + 2,4-D sodium salt (1000 g product/ha), or late spraying of 2,4-D amine (850 g a.i./ha), on wild radish density, grain yield, and contamination of harvested grain in a barley crop (Briggs) near Rutherglen in 1977

Treatments and application dates	Crop growth stage	Weed growth stage	W.radish (no/m^2 30 Sept.)	Barley (t/ha)	% contamination of of wild radish seed in harvested sample[1]
methabenzthiazuron + 2,4-D sodium salt					
17 June	2 leaf	Cot. - 2 leaf	17.4c[2]	1.75a	1.8
20 June	2¼ leaf	Cot. - 2 leaf	23.2c	1.58bc	0.3
27 June	3-3¼ leaf	Cot. - 4 leaf	89.6b	1.33d	9.1
4 July	3 leaf - E.tillering	Cot. - 4 leaf	20.8c	1.70ab	3.0
12 July	E.tillering	Cot. - 4 leaf	79.6b	1.44cd	6.3
18 July	E.tillering	Cot. - 7 leaf	64.6b	1.42cd	7.9
6 Aug.	Mid tillering	2 - 7 leaf	57.6c	1.50c	2.9
22 Aug.	Mid-late tillering	2 leaf - bolting	87.0b	0.97e	7.5
2,4-D 22 Aug.	Mid-late tillering	2 leaf - bolting	117.4ab	1.03e	1.4
Unsprayed control			215.5a	0.80f	16.8

1 On an air-dry weight basis.

2 Values followed by different letters are significantly different ($P<0.05$) as determined by Duncan's Multiple Range Test (comparisons within columns only).