Effect of rates and times of application of diuron, linuron and methabenzthiazuron on wheat yields and soursob control

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SUMMARY

The herbicides diuron, linuron, and methabenzthiazuron were applied at three rates, 1, 2 and 3 kg product per hectare, to a wheat crop at three different growth stages, 1.5 to 2.5 leaf, 5 leaf, and early tillering, heavily infested with soursob. Grain yields indicated that the time of application of diuron was most critical because crop phytotoxicity increased markedly after the 2.5 leaf stage. Although grain yields decreased with later applications of linuron and methabenzthiazuron they were not as marked as for diuron. The 2 and 3 kg/ha of diuron significantly reduced cereal yields. Diuron applications at all three stages of cereal growth reduced soursob density the year following applications. Control of soursob using linuron and methabenzthiazuron was highest at the latest time of application. Diuron applied at the 1.5 to 2.5 leaf stage of growth was the most effective treatment.

INTRODUCTION

Soursob (*Oxalis pes-caprae* L.), a native of South Africa, is a widespread weed in many cereal districts of Victoria, South Australia and Western Australia (Catt, 1972; Parsons, 1973; and Peirce, 1973). It competes with pastures and cereals (Meadly, 1965) and its high oxalate content is reported to have cause stock losses in Western Australia (Gardner and Bennetts, 1956). Estimation of losses associated with soursob in cereal crops in South Australia have been made by Catt and Baldwin (1973) who used the chemical diuron to control the weed. Increased yields associated with the use of diuron in wheat in Western Australia have been reported by Peirce (1975).

A major problem associated with the use of herbicides in cereal crops is to determine the correct stage of application so that maximum weed control and cereal yield is obtained. Often at the growth stage when a cereal is resistant to a herbicide the weed may also be resistant or have passed the stage when most damage due to competition has been done. The malformations in wheat plants due to the application of 2,4-D outside the resistant growth stage limits have been given by Meadly (1964).

To examine the timing of herbicide application an experiment was carried out to test the effect of three herbicides, diuron, linuron, and methabenzthiazuron, applied at three stages of cereal growth, on the cereal yield and control of soursob. The experiment was conducted on the common pentaploid soursob described by Michael (1964) and Peirce (1973).

MATERIALS AND METHODS

The experiment was a randomized complete block design. Three herbicides, diuron, linuron and methabenzthiazuron were each applied at three rates, 1, 2 and 3 kg of product per ha to a wheat crop at three different growth stages (i.e. 1.5 to 2.5 leaf, 5.0 leaf, and early tiller stages).

The site was selected in a crop of wheat cv. Gamenya which was sown by a farmer. Eighty-one plots 20 m x 3 m in three blocks of 27 were pegged with the 20 m length at right angles to the drill runs. Buffers 3 m wide were left at the ends of each block.

The chemical treatments were applied through a boom spray delivering a volume of 110 ℓ/ha at a pressure of 200 kPa.

Wheat yields (kg/plot) were taken at maturity, from a 1.20 m strip down the middle of each plot. The middle 1.20 m of each untreated buffer strip was also harvested. The following year after the break of the season, soursob plant counts were taken, twenty counts 25 cm x 20 cm from each plot. Soursob plant counts were also taken from the buffer strips. Before analysis a square root transformation was made on the counts.

Because untreated controls were not included in the experimental design no direct comparison can be made between the treatments and the untreated buffer plots. However they do indicate the mean grain yields and soursob density where no treatments were applied.

RESULTS

Yields of cereal grain

Mean yield from the six buffers was 1750 kg/ha and spray treatments varied from 3300 to 400 kg/ha depending on the degree of weed control and the amount of phytotoxicity. All main factors, herbicides, rates and timing of application were highly significant ($P<0.001$). Delaying the application of each herbicide caused a reduction in grain yields (Table 1). At the 1.5 to 2.5 leaf stage there was no significant difference in yield between the three herbicides. Spraying diuron at the 2.5 to 5.0 leaf stage reduced grain yields to about 34% of the yields obtained from linuron and methabenzthiazuron. At the third time of application (tillering stage of the cereal) all chemicals were significantly different, methabenzthiazuron reducing yields by the least amount, linuron reducing yields by 50% and diuron by 80% compared to untreated areas in the buffers.

Diuron was the only herbicide to significantly depress wheat yields at the 3 kg/ha rate of application (Table 2), when compared to yields at the 1 kg/ha rate of diuron. At the 2 kg rate diuron significantly reduced grain yields when compared to methabenzthiazuron. Linuron, although not significantly reducing yields ($P<0.001$) substantially reduced the grain yield. At the 3 kg rate diuron significantly reduced yields more than linuron, which in turn significantly decreased yields more than methabenzthiazuron.

Table 1. Effect of three herbicides applied at three growth stages on yield of wheat infested with soursob

	Wheat yield(kg/ha)			
	Stages of growth of cereal and date of application (in brackets)			
Herbicide	1* (9/7)	2 (25/7)	3 (8/8)	
Diuron	2758	683	379	Untreated 1750 kg/ha
Linuron	3320	1967	871	
Methabenzthiazuron	3258	2258	1795	
	L.S.D. P = 0.001 691 kg			

1* = 1.5 to 2.5 leaf, 2 = 5.0 leaf, 3 = early tillering

Table 2. Effect of three rates of diuron, linuron, methabenzthiazuron on yield of wheat infested with soursob

	Wheat yield(kg/ha)		
	Rate herbicide(kg product per ha)		
Herbicide	1	2	3
Diuron	1825	1383	617
Linuron	2217	2096	1842
Methabenzthiazuron	2217	2629	2467
	L.S.D. P = 0.001 691 kg		

Counts of soursob plants

The timing of herbicide application significantly affected the soursob density the year following application. Diuron and linuron were significantly superior to methabenzthiazuron in reducing the density of soursob at the first and second times of application (Table 3). Soursob reduction by these two herbicides was about 35% greater.

There was no difference in soursob reduction between the three times of application of diuron, however linuron improved reduction by 25% and methabenzthiazuron by 40% between the first and third time of spraying. At the third time of spraying there was no difference between the herbicides for reducing the density of soursob.

DISCUSSION

The rate and timing of application of the three herbicides for optimum cereal yields and soursob control are clearly indicated from the results in this experiment. Linuron and methabenzthiazuron are used in cereal crops and applied between the 2.5 to 5 leaf stage of the cereal for linuron and 2.5 to tillering for methabenzthiazuron (Swarbrick, 1974). Diuron has not been widely used for weed control in cereals, South Australia being the only state where it is

Table 3. Effect of three herbicides applied at three different stages of cereal growth on reduction of soursob the year following application

	No. plants/m^2 *			
	Time of application			
Herbicide	1 (9/7)	2 (25/7)	3 (8/8)	
Diuron	6.35	6.57	6.08	Untreated 14.80
Linuron	7.42	7.65	5.59	
Methabenzthiazuron	10.73	10.24	6.80	
L.S.D. P = 0.05	1.30			

* Transformation $y - \sqrt{x + 0.5}$

extensively used for soursob control in cereals. The probable reason for lack of confidence in using the chemical has been the problems associated with crop phytotoxicity. The extreme phytotoxicity of diuron used outside the 1.5 to 2.5 leaf stage of the cereal growth is clearly shown in this experiment by the grain yield losses.

The herbicides linuron and methabenzthiazuron also depress wheat yields when applied later than the 2.5 leaf stage, but not to the same degree as diuron. It is possible that some of the differences between yields at the first and later applications is due to phytotoxicity and competition from the soursob. Because methabenzthiazuron is relatively safe to apply to cereal crops up until the tillering stage, most yield losses at the three times of application could be attributed to competition.

No statistical comparison between untreated and treated means can be made due to the design of the experiment, however, the untreated plot yield mean was 1750 kg/ha compared to 1795 kg/ha for methabenzthiazuron at the third time of spraying which suggests that the grain yield losses between the first and third times of spraying were probably due to competition and not phytotoxicity.

The margin of crop safety with diuron applications, up to 3 kg/ha, is lower than with the other two herbicides, which further confines the limits of its use. Linuron and methabenzthiazuron were safe to use up to 3 kg/ha without depressing grain yields.

Over the three stages of growth of wheat, diuron was more efficient in reducing the density of soursob the year following application. Linuron and methabenzthiazuron only reduced the density of soursob to levels similar to that obtained for diuron when applied later in the season. The greater activity of the herbicides at this time may be partly due to the growth stage of the soursob. The latest application of the herbicides was in early August which would coincide with the stage of development of soursob outlined by Clarke (1936) when new bulbs would be developing.

With any control program in cereals it is necessary to consider the time of herbicide application so a balance between cereal tolerance and maximum weed reduction is obtained. With linuron and methabenzthiazuron for a soursob control program there is a time gap of some 4 weeks between optimum spraying time for maximum cereal yields and greatest reduction of soursob. That is, highest yields are obtained when the herbicides are applied at the 1.5 to 2.5 leaf stage of cereal growth, and maximum soursob reduction obtained some 1 month later when the crop is at the tillering stage.

However, with diuron applications greatest cereal yield and reduction of soursob can be obtained at one growth stage of the cereal crop, i.e. 1.5 to 2.5 leaf stage.

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