CONTROL OF ATRAZINE—RESISTANT FATHEN IN MAIZE

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SUMMARY

Resistance to atrazine, developed by some fathen (*Chenopodium album*) plants, has been reported in some parts of the world in the last decade and now appears to have evolved in many maize (*Zea mays*) fields of the Waikato. Results of two field trials reported here confirmed the presence of atrazine-resistant fathen and showed some differences in the effectiveness of various pre-plant and pre-emergence herbicides on this weed in maize. Replacing atrazine by chlorbromuron and metribuzin when used with metolachlor and alachlor respectively improved the control of fathen. As post-emergence treatments dicamba, bentazone/atrazine and bromophenoxim gave promising control of fathen in both trials.

INTRODUCTION

Variations within weed species in response to herbicides have been reported with many chemicals, but only a few examples of the development of resistance due to repeated herbicide treatments have been noted. The examples described include resistance to MCPA, atrazine and simazine. This subject has recently been reviewed by LeBaron and Gressel (1982) and Rahman (1982).

Evidence suggests that the strong selective pressure of repeated treatments with atrazine in continuous maize production has proliferated biotypes with remarkable tolerance to this chemical. To date biotypes belonging to such unrelated species as fathen, redroot (*Amaranthus powellii*) and annual ragweed (*Ambrosia artemisiifolia*) appear to have developed similar mechanisms of resistance (Gressel 1979). Tolerance of one selection of fathen to rates of 40 kg/ha of atrazine (Souza Machado *et al* 1977), increased growth after post-emergence treatments (Warwick and Marriage 1982), and extended resistance to other triazine and uracil herbicides have also been reported (Jensen *et al* 1977).

The only case of weed resistance to triazine herbicides noted in New Zealand so far has been that of fathen where atrazine has been applied for several years in succession to maize crops. The first instance was noted in the 1979-80 season and limited work suggested that the fathen plants could tolerate between 35 to 60 kg/ha of atrazine (T.M. Patterson, pers comm). This problem is now of increasing concern in many maize fields. The pre-plant and pre-emergence herbicides used specifically for control of grass weeds in maize provide some control of fathen but their relative effectiveness is not well known. The field trials reported here compared the effect of these herbicides as well as some selective post-emergence chemicals for the control of atrazine-resistant fathen.

MATERIALS AND METHODS

Two field trials were conducted in the Waikato on maize fields where fathen was a serious problem in the previous season. Both sites had been cropped with maize for several years and treated each year with atrazine in combination with a grass herbicide. The soil for Trial 1 was an Otorohanga sandy loam with an organic carbon content of 8.3% and a pH of 5.6. Trial 2 was on an Ohaupo silt loam soil with an organic carbon content of 6.9% and a pH of 5.9. Plot size in both trials was 4 x 10 m and maize was planted in rows 75 cm apart on 15.10.82 and 4.11.82 in Trials 1 and 2 respectively. Treatments were arranged in a randomised block design with four replications.

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All chemicals were applied in 350 litres/ha at 210 kPa. The thiocarbamate herbicides, viz. EPTC + R-25788* (Eradicane super) and vernolate + R-25788* (Surpass) were applied before planting and rotary hoed to a depth of 7.5 cm. All other herbicides listed in Table 1 including atrazine (Gesaprim 500 FW), were applied as pre-emergence treatments within a week after planting. Rainfall in the 2 weeks following spraying was 82 and 41 mm for the pre-plant treatments and 41 and 21 mm for the pre-emergence treatments in Trials 1 and 2 respectively. The post-emergence treatments of dicamba (ICI dicamba), bromophenoxim (Faneron), and the bentazone/atrazine combination (Laddock) were sprayed about 7 weeks after sowing when the crop was 30-40 cm high and fathen plants were 5-15 cm tall.

The numbers of surviving fathen plants in the whole plot were counted 7 weeks after planting for the pre-plant and pre-emergence treatments and at regular intervals for the post-emergence treatments. The original number of fathen plants in each plot before application of post-emergence herbicides was also recorded. Visual assessments of grass weed control and maize vigour were also made in both trials.

RESULTS AND DISCUSSION

The number of fathen plants in plots treated with atrazine alone show that both trial sites were heavily infested with atrazine-resistant fathen (Table 1). Of the two pre-plant herbicides, vernolate⁺ reduced the fathen population significantly more than EPTC⁺ in Trial 1 but in Trial 2 the level of control from the two chemicals was similar.

TABLE 1: Comparison of pre-plant and pre-emergence herbicides for control of fathen 7 weeks after planting.

Herbicides and rates (kg/ha)	No. of fathen plants/30 m ²	
	Trial 1	Trial 2
atrazine 1.6	483	1085
EPTC ⁺ 6.0 + atrazine 1.6	76	588
vernolate ⁺ 6.0 + atrazine 1.6	13	393
pendimethalin 2.0 + atrazine 1.6	1	228
alachlor 3.5 + atrazine 1.6	81	695
alachlor 3.5 + metribuzin 0.6	6	288
metolachlor 3.2 + atrazine 1.8	63	610
metolachlor 3.0 + chlorbromuron 2.0	4	115
SED*	25	ns

* Approximate values, as the analysis was done using the square root transformation.

Among the pre-emergence herbicide combinations, pendimethalin (Stomp) with atrazine provided better control of fathen than either alachlor (Lasso) with atrazine or the metolachlor/atrazine mixture (Primextra), although the differences were significant only in Trial 1 (Table 1). Several dinitroaniline herbicides including pendimethalin have been shown to give effective control of atrazine-resistant fathen by workers in Canada (Bandein and McLaren 1976). Compared to the atrazine mixtures, the combinations of alachlor with metribuzin (Sencor) and that of metolachlor with chlorbromuron (Maloran) were more effective on the fathen. The fathen plants which survived the pre-plant or pre-emergence treatments appeared to be healthy and their growth was similar to those in the plots treated only with atrazine.

All the pre-plant and pre-emergence herbicide treatments provided good control of grass weeds and other broad leaf weeds in both trials. None of the treatments had any apparent effect on the maize crop.

* Hereinafter referred to as EPTC⁺ and vernolate⁺

TABLE 2: Number of fathen plants/30 m² before and after the post-emergence herbicide treatments.

Treatment	Rate (kg/ha)	Trial 1			Trial 2		
		Original	Final	% of original	Original	Final	% of original
		No. 7.12.82	No. 11.1.83		No. 22.12.82	No. 17.2.83	
dicamba	0.4	116	1	0.9	1066	8	0.8
dicamba	0.6	—	—	—	496	0	0
bromophenoxim	0.5	156	21*	13.5*	1010	58	5.7
bromophenoxim	0.75	146	1	0.7	396	20	5.0
bentazone + atrazine	0.8 + 0.8	214	3	1.4	745	5	0.7
bentazone + atrazine	1.2 + 1.2	—	—	—	558	13	2.3

* Significantly different from other treatments at the 5% level according to t test (analysis carried out using logistic transformation).

— not included.

Data on the effects of three post-emergence herbicides are presented in Table 2. As the weed population was not uniform between the plots at the time of spraying, the plant numbers have also been converted to the percentage of the original population. Results show that most treatments were effective in controlling the fathen on both sites, although the low rate of bromophenoxim provided significantly lower level of control than other treatments in Trial 1. The 13.5% of the population surviving from the low rate of bromophenoxim (Table 2) is not large, but as the plants were apparently healthy, they could still produce sufficient seeds for a large population the following year. Although individual plants were not tagged, observations at regular intervals suggested that most of the surviving fathen plants were larger than 10 cm at the time of spraying.

The high rate of bromophenoxim caused occasional slight scorching of maize leaves, but the damage disappeared within a short time. None of the other treatments caused any apparent damage to the crop.

Results from these field trials confirm the presence of atrazine-resistant fathen and it could be postulated that much of the fathen population surviving after atrazine treatments in the maize fields of Waikato has developed resistance to this herbicide. This atrazine-resistant fathen may become a problem weed in most maize fields of New Zealand and it may limit the usefulness of s-triazine herbicides. There is some difference among the herbicides used for grass weed control in maize with regard to their effectiveness for controlling this fathen. Where the weed becomes a problem in maize, it is possible to control it with the aid of a post-emergence herbicide. The extra spraying operation though would inevitably add to the cost of growing the maize crop.

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