

WEED CONTROL AND SOIL PERSISTENCE STUDIES WITH DIMETHENAMID IN MAIZE

A. RAHMAN and T. K. JAMES

Ruakura Agricultural Centre, Private Bag, Hamilton

SUMMARY

Five field trials were conducted in maize (*Zea mays*) on two soil types over three growing seasons to evaluate the efficacy, crop tolerance and the residual activity of the new chloroacetamide herbicide dimethenamid. Dimethenamid applied pre-emergence at 1.4 or 2.0 kg/ha followed by a post-emergence application of atrazine or dicamba provided excellent control of annual summer grasses and all the broadleaf weed species present, except thorn apple (*Datura stramonium*). The crop sustained no visual damage at any stage and grain yields were not affected by the highest rate tested (i.e. 7.2 kg/ha). At probable field use rates, dimethenamid persisted in both soils at phytotoxic levels for 8 to 12 weeks.

Keywords: dimethenamid, SAN 582 H, weed control, crop tolerance, persistence

INTRODUCTION

Dimethenamid is a new pre-emergence herbicide for use in maize, soya bean (*Glycine max*) and several other crops. Developed under the code number SAN 582H (trade name Frontier) by Sandoz Agro Ltd, it belongs to the chemical class of chloroacetamides. Dimethenamid has provided good control of many annual grasses and broadleaf weeds and an effective suppression of yellow nut sedge (*Cyperus esculentus*), a major weed in many countries (Harr *et al* 1991).

Site of uptake studies have shown that entry of dimethenamid into plants is primarily through developing coleoptiles and the emerging shoot zone (Chollet and Harr 1992). It kills weeds by reducing cell division and growth, and although the mode of action is not yet fully understood, alkylation of sulfhydryl groups of certain enzymes seems to be one of the major mechanisms (Anonymous 1991). Glutathione and homogluthathione conjugation play a significant role in its detoxification within the plants (Harr *et al* 1991). Degradation of dimethenamid in the soil is mainly through microbial action and is dependant on soil type and weather conditions. Its half life in the soil has varied between 6 and 43 days (Harr *et al* 1991). This paper describes results from field trials in maize on crop tolerance, weed control efficacy and the soil residual activity of dimethenamid over three growing seasons.

MATERIALS AND METHODS

Weed control/crop tolerance

Five trials were conducted between 1988 and 1992 on two sites, one a Horotiu sandy loam soil (61% sand, 16% clay, 7.3% organic C and a pH of 6.0) and the other a Hamilton clay loam soil (37% sand, 27% clay, 2.4% organic C and a pH of 6.5). Dates of planting and spraying and other relevant details for each trial are given in Table 1. Maize was planted with a Nodet Gougis precision seeder at 76000 seeds/ha and 75 cm row spacing. Individual plots were 10 m x 3 m and treatments were replicated four times in a randomised block design.

All herbicides were applied with a CO₂ powered precision sprayer in 300 litres/ha water at 200 kPa. The dimethenamid and alachlor (Lasso) treatments were applied pre-emergence, except in Trial 2 where maize had emerged and was 3 to 4 cm high. Rainfall of between 20 and 42 mm was recorded within the first week after treatment in all trials. Atrazine (Gesaprim) or dicamba (Shell Dicamba) was applied post-

Proc. 45th N.Z. Plant Protection Conf. 1992: 84-88

emergence on the dates shown in Table 1.

Assessments of weed control and crop damage were made at regular intervals after application of the treatments. Weed dry matter was determined in late December to mid January by harvesting weeds from duplicate 0.1 m² quadrats from each plot. Crop yield was determined by harvesting cobs from the two centre rows (5 m of each row) of each plot. The maize was then shelled, and the weight and moisture content of the grain measured.

TABLE 1: Trial timetable and related details.

Trial No.	Planting	Pre-emerg. spray	Post-emerg. spray	Weed control assessment	Weed DM	Maize yield	Maize variety	Soil type*
1	26.10.88	27.10.88	16.11.88	14.11.88	21.12.88	6.6.89	PX74	H.S.L.
2	31.10.89	9.11.89	5.12.89	4.12.89	17.1.90	31.5.90	Pioneer 3709	H.S.L.
3	2.11.89	9.11.89	5.12.89	4.12.89	17.1.90	31.5.90	Pioneer 3709	H.C.L.
4	21.10.91	24.10.91	10.12.91	26.11.91	6.1.92	5.5.92	Pioneer 3475	H.S.L.
5	1.11.91	5.11.91	24.12.91	26.11.91	7.1.92	-	Pioneer 3585	H.C.L.

* H.S.L.-Horotiu sandy loam; H.C.L. - Hamilton clay loam.

Soil persistence study

Two field trials were conducted on sites adjacent to Trials 2 and 3 in 1989. Treatments included 0, 0.9, 1.4, 2.0 and 2.7 kg/ha of dimethenamid and were applied on 9.11.89. Soil samples for bioassay of herbicide residues were collected from the top 10 cm of each plot at 2 week intervals. These were brought to the glasshouse where they were thoroughly mixed and used to plant one pot of each of the three bioassay species, viz. annual ryegrass (*Lolium multiflorum*), German millet (*Setaria italica*) and oats (*Avena sativa*). The glasshouse was maintained between 16°C and 30°C, with no additional lighting and pots were surface watered as required. After 4 to 5 weeks' growth biological activity of the herbicide was assessed visually and dry matter yields of the bioassay species were determined. Additional experiments were conducted simultaneously to establish standard curves of the activity of dimethenamid in the two soils by employing a range of concentrations between 0.01 and 2.0 parts per million by weight of dry soil (ppmw). Details of the bioassay technique have been published previously (Rahman and Holland 1985).

RESULTS AND DISCUSSION

Weed control

The weed spectrum of the trial sites varied between the two soil types and to a lesser extent between the three growing seasons. The main broadleaf weeds present included willow weed (*Polygonum persicaria*), redroot (*Amaranthus powellii*), fathen (*Chenopodium album*) and black nightshade (*Solanum nigrum*). Additionally Trial 4 had broad-leaved dock (*Rumex obtusifolius*), thorn apple and atrazine-resistant fathen, while Trials 3 and 5 included significant numbers of thorn apple, fumitory (*Fumaria officinalis*), stagger weed (*Stachys arvensis*) and spurrey (*Spergula arvensis*). The major grass weeds on all sites were summer grass (*Digitaria sanguinalis*) and smooth witchgrass (*Panicum dichotomiflorum*), with large populations of barnyard grass (*Echinochloa crus-galli*) also in Trials 3 and 5.

In the first season's evaluation (Trial 1) only two very high rates of dimethenamid were used in combination with an early post-emergence treatment of atrazine. All treatments provided excellent weed control for the duration of the crop (Table 2), although a small number of weeds emerged late in the season; mainly annual grasses in alachlor treated plots and fathen in plots treated with the lower rate of dimethenamid.

TABLE 2: Effect of herbicide treatments on weeds and maize yield in the 1988-89 and 1989-90 trials.

Treatment*	Rate (kg ai/ha)	Weed control (%)†			Weed DM (kg/ha)†			Maize yield (t/ha)		
		Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
dimethenamid	0.9	-	71	63	-	9	27	-	10.4	8.4
dimethenamid	1.4	-	79	79	-	0	10	-	9.9	8.7
dimethenamid	2.0	-	86	83	-	0	0	-	10.8	8.5
dimethenamid	2.7	-	86	92	-	0	0	-	11.0	9.5
dimethenamid	3.6	100	-	-	0	-	-	7.7	-	-
dimethenamid	7.2	100	-	-	0	-	-	8.1	-	-
alachlor	3.5	100	65	87	0	0	0	7.7	10.2	9.0
untreated	-	0	0	0	2150	530	1650	2.3	9.5	5.8
LSD (P <0.05)		10	16	14	-	-	-	1.6	1.1	1.6

* All plots (except the untreated) also received a post-emergence application of atrazine 1.5 kg ai/ha.

† Weed control before atrazine was applied; weed DM after atrazine application (for dates see Table 1).

During the second season, several low rates of dimethenamid were tested in combination with atrazine on two soil types. In Trial 2 some grass weeds had emerged by the time of treatment, but all rates of dimethenamid prevented any of them from becoming established. Broadleaf weeds were not so well controlled by dimethenamid, however, with significant numbers becoming established, especially at the two lowest rates. This is demonstrated by the weed control assessment of 4.12.89 (Table 2), made the day before atrazine was applied. However, all rates of dimethenamid gave levels of broadleaf weed control similar to or better than the standard alachlor treatment. At the time of weed dry matter assessments in January, all rates of dimethenamid (in combination with atrazine) were giving excellent weed control. Results of Trial 3 were similar to those of Trial 2 conducted on a different soil type, except that the low rate of dimethenamid in Trial 3 did not provide as good weed control as the standard alachlor treatment (Table 2). Also the thorn apple present was not controlled by any of the herbicides and was separately controlled with dicamba in December.

In the 1991-92 growing season the 1.4 kg/ha rate of dimethenamid was tested alone and in combination with atrazine and dicamba in Trials 4 and 5. A high rate of dimethenamid (2.7 kg/ha) was also included mainly for crop tolerance evaluation. Once again weed control assessments made before application of post-emergence treatments show that broadleaf weeds were not completely controlled by dimethenamid, especially by the low rate of 1.4 kg/ha (Table 3). The weed dry matter data collected in early January showed that the combination of dimethenamid with either atrazine or dicamba provided very good weed control, similar to the standard treatment of alachlor + atrazine. In Trial 4, the atrazine combination had more weeds than the dicamba combination, which was mainly due to the presence of atrazine-resistant fathen plants. The high rate of dimethenamid alone also provided good weed control, but the low rate of 1.4 kg/ha on its own was significantly worse than the standard alachlor treatment in both trials.

Crop tolerance

In 1988-89 the very high rates of dimethenamid tested in Trial 1 were well tolerated by the maize crop. The two dimethenamid treatments resulted in yields similar to the standard alachlor treatment (Table 2). Subsequent trials confirmed these results with no sign of injury to the maize crop at any stage and no significant differences in grain yield between dimethenamid and alachlor treatments, except in Trial 4 where yields for the low rate of dimethenamid alone were significantly lower as a result of competition from weeds throughout the growing season (Table 3). All herbicide treatments outyielded the untreated controls which suffered serious weed competition,

except in Trial 2 where weed density was very low.

TABLE 3: Effect of herbicide treatments on weeds and maize yield in the 1991-92 trials on two soil types.

Treatment	Rate kg ai/ha	Weed control (%)*		Weed DM (kg/ha)*		Maize yield (t/ha)**
		Trial 4	Trial 5	Trial 4	Trial 5	Trial 4
dimethenamid	1.4	90	93	1950	286	10.1
dimethenamid	2.7	97	97	349	64	10.9
dimethenamid + atrazine*	1.4 1.5	95	95	152	35	12.1
dimethenamid + dicamba*	1.4 0.4	92	96	62	45	10.7
alachlor + atrazine	3.5 1.5	99	99	247	19	12.1
untreated	-	0	0	5810	2100	5.9
LSD (P <0.05)		5.3	2.3	916	237	1.4

* Weed control before post-emergence atrazine or dicamba; weed DM after post-emergence treatment (for dates see Table 1).

** No yield data collected from Trial 5.

Soil persistence

Dry shoot weight data from experiments conducted with known rates of dimethenamid showed that annual ryegrass and German millet were the most sensitive species, showing growth reductions from 0.1 ppmw in both the Horotiu sandy loam and Hamilton clay loam soils. Oats were not as susceptible, with 0.4 to 0.5 ppmw being the lowest concentration to have any effect on the dry matter production in the two soils. The first noticeable effect of the herbicide on German millet was to produce a twist in the first leaf of the emerged plant. This distortion occurred even at very low concentrations and was not necessarily accompanied by reductions in the dry matter production. With ryegrass and oats the herbicide damage took the form of reduced growth and smaller leaves. In both soils dimethenamid showed greater activity than alachlor, with the latter showing phytotoxicity only at concentrations greater than 0.5 ppmw for ryegrass and German millet.

The German millet bioassay of soil samples collected from the field trials showed that the persistence of dimethenamid was similar in the two soil types (Table 4). Phytotoxic residues from the 0.9 and 1.4 kg/ha rates disappeared within 8 weeks after application in both soils, while the higher rates of 2.0 and 2.7 kg/ha persisted for nearly 12 weeks in both soils. Similar results were obtained also with annual ryegrass as the test species, but with oats phytotoxic residues could be detected for only 2 weeks at the lower rates and for 4 weeks at the two highest rates. At an equivalent rate of 2 kg/ha, the length of persistence of dimethenamid was slightly longer than that of alachlor but much shorter than that of metolachlor reported earlier for the same two soil types (Rahman *et al* 1976, 1978).

Results of the field trials presented here show that dimethenamid in combination with atrazine provided excellent control of all the weed species present, except thorn apple, present in both soil types. There were no signs of visual damage to the crop at any stage and grain yields were as good as in the standard treatment of alachlor + atrazine. Based on the results over three growing seasons, a rate of dimethenamid between 1.4 and 2.0 kg/ha would be required for adequate weed control and addition of a broadleaf herbicide such as atrazine or dicamba would be necessary. At the expected field use rates, dimethenamid would not leave any phytotoxic residues in the soil for the susceptible species at the end of the maize growing season.

TABLE 4: Residual activity of dimethenamid in soil samples collected from the field.

Rate kg ai/ha	Dry shoot weight of German millet as % of untreated control*				
	Weeks after application (9.11.89)				
	0†	2	4	8	12
	Horotiu sandy loam soil				
0.9	7	19	60	<i>104</i>	<i>103</i>
1.4	3	8	39	<i>106</i>	<i>97</i>
2.0	1	3	22	74	<i>105</i>
2.7	0	0	16	52	<i>103</i>
	Hamilton clay loam soil				
0.9	22	37	85	<i>103</i>	<i>96</i>
1.4	6	8	59	<i>111</i>	<i>94</i>
2.0	0	12	38	89	<i>104</i>
2.7	0	0	28	85	<i>112</i>

* Figures in this table, except those in italics, are all significantly lower than untreated controls (=100), P <0.05; pooled SED 5.1.

† Sampled the day after spraying.

REFERENCES

- Anonymous, 1991. SAN 582 H Experimental herbicide, Technical bulletin. Sandoz Agro Ltd, Switzerland. 6 pp.
- Chollet, R. and Harr, J., 1992. SAN 582 H: Site of uptake. *Weed Sci. Soc. America Abstracts* 32: 95.
- Harr, J., Seckinger, K., Ummel, E. and Hargett, L. T., 1991. SAN 582 H - A new herbicide for weed control in corn and soy beans. *Proc. Brighton Crop Protection Conf. - Weeds - 1991*: 87-92.
- Rahman, A., Burney, B. and Manson, B. E., 1976. Pattern of dissipation of some soil-applied herbicides. *Proc. 29th N.Z. Weed and Pest Control Conf.*: 115-119.
- Rahman, A., Burney, B. and Manson, B. E., 1978. Persistence of some herbicides used for weed control in maize. *Proc. 31st N.Z. Weed and Pest Control Conf.*: 25-29.
- Rahman, A. and Holland, P. T., 1985. Persistence and mobility of simazine in some New Zealand soils. *N.Z. J. Expt. Agric.* 13: 59-65.