THE EFFICACY, RESIDUE, AND FUTURE FOR TRIAZINE HERBICIDES IN CANOLA

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INTRODUCTION

Tolerance of weeds to triazine herbicides was reported in the early 1970's with common groundsel and lamb'squarters. This resistance was particularly evident in corn fields continuously treated with atrazine. As the use of atrazine in a corn monoculture was extended the tolerant species which were less vigorous than their susceptible cousins became more prevalent. In 1977, a weedy Brassica species (Bird rape) with tolerance to atrazine was noted in Quebec. In 1978, researchers at the University of Guelph successfully transferred the triazine tolerant factors to domestic canola. However, the same lack of vigor which was evident in the weedy species was transmitted to the domestic lines.

Early stage tolerance testing and weed control in 1980 and 1981 were conducted on Brassica campestris (Candle), triazine tolerant canola - TTC*. This early research identified atrazine, cyanazine, and metribuzin as having potential for control of cruciferae weeds in TTC. (Dekker 1981, Kirkland 1980, Kirkland 1982, Morrison 1980). In 1981 a TTC, Brassica napus (Tower) 6-line composite was made available for testing. In 1982 a single line (OAC-SRS-82-01) was selected from the 6-line composite and made available for seed increase and testing.

In 1984, the single line will be proposed for licensing and if licensed approximately 2500 hectares of pedigreed seed could be grown. By 1985, 400,000 to 800,00 hectares could be planted to TTC.

The objective of this paper is to present a summary of the research results on (a) triazine residue in soil; (b) tolerance of Brassica napus TTC to triazine herbicides; (c) control of cruciferae weeds with triazines and; (d) the yield potential of TTC.

MATERIALS AND METHODS

Soil residue

Separate experiments were conducted at Scott, Regina, and Lacombe in 1980 and 1981. Soil types were Scott clay-loam, 4.0 to 5% O.M., Regina clay, 2.0% O.M. and Lacombe loam 9.0 to 10% O.M. Atrazine, cyanazine and metribuzin were applied at a range of rates in May of each year. Soil was sampled to a depth of 0 to 7.5 cm. in October and transported to Scott for biological determination of possible residues. Oats, wheat and barley were used as the indicator species in a growthroom bioassay.

Crop tolerance and weed control

Tolerance of the 6-line Brassica napus TTC was conducted in separate experiments at Scott in 1982 and Scott, Beaverlodge, and Melfort in 1983. Toler-

*TTC = Triazine Tolerant Canola

ance of the single-line Brassica napus TTC was conducted at 4 locations in 1983. Scott, Melfort, Indian Head and Beaverlodge.

Weed control experiments on stinkweed and wild mustard were conducted at Scott, 1980-83 and 1982-83 respectively. Summary data are presented in Table 6.

Yield trials

Cooperative yield trials were conducted under weed free conditions in 1982 and 1983 at nine Saskatchewan locations: Scott, Lashburn, Glaslyn, Loon Lake, Saskatoon, Melfort, Regina, Indian Head and Watrous.

RESULTS AND DISCUSSION

Results of the oat (Var. Harmon) bioassay are presented in Table 1. No reduction in oat fresh weight occurred on soil previously treated with cyanazine. Fresh weight of oats growing in metribuzin treated soil was reduced on Regina clay at the highest application rate, 0.30 kg/ha. No reductions from metribuzin were evident on Scott clay-loam or Lacombe loam. Fresh weight of oats grown in atrazine treated soil was reduced in all three soil types, and at all rates tested except for the 0.75 kg/ha rate on Scott clay-loam. Growth reductions in cereals grown in the field 12 months following application were not as severe but followed a very similar trend. (Kirkland 1982).

Table 1 Fresh weight of oats grown in three soil types previously treated with metribuzin, cyanazine and atrazine (growthroom experiment).

Treatment	Rate kg/ha	Oats g/pot		
		Lacombe-loam	Scott-clay loam	Regina-clay
Untreated	-	2.18 a	3.32 a	0.85 a
Metribuzin	0.2	2.19 a	3.75 a	0.80 ab
Metribuzin	0.3	2.14 a	3.56 a	0.69 b
Cyanazine	1.0	2.61 a	3.57 a	0.91 a
Cyanazine	2.0	2.24 a	3.74 a	0.93 a
Cyanazine	3.0	2.29 a	3.30 a	0.91 a
Atrazine	0.75	1.30 b	3.43 a	0.08 c
Atrazine	1.0	1.44 b	2.69 b	0.05 c
Atrazine	1.5	0.01 c	1.65 c	0.02 c

a-c Means within columns followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

Tolerance of the TTC-6 line composite to cyanazine and metribuzin was excellent at Scott in 1982 (Table 2). Metribuzin caused some curl at the leaf margins but these symptoms disappeared as the season progressed. In 1983 tolerance of the 6-line and single-line were compared. Some cupping

at the leaf margins were observed from both cyanazine and metribuzin, however these symptoms disappeared as the season progressed and seed yields were not affected.

Table 2 Tolerance and yield of six and single line triazine tolerant canola to metribuzin and cyanazine (Scott).

Treatment	Rate kg/ha	Tolerance (0-9)* 1982 6-line	1983 6-line	1983 1-line	1983 yield g/m^2 6-line	1983 yield g/m^2 1-line
Untreated	-	9.0	9.0	9.0	194 a	210 a
Metribuzin	.20	9.0	8.2	8.0	203 a	207 a
Metribuzin	.25	8.6	8.3	8.0	189 a	205 a
Metribuzin	.30	8.1	7.9	7.8	191 a	195 a
Cyanazine	1.0	9.0	8.5	8.0	191 a	203 a
Cyanazine	2.0	9.0	8.3	8.0	192 a	228 a
Cyanazine	3.0	9.0	7.9	7.5	195 a	192 a

*0-9 9 = no injury 0 = complete kill

a = Means within columns followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

Tolerance tests were conducted on the six and single line material at Beaverlodge and Melfort and on the single line at Indian Head (Tables 3,4 and 5). At Beaverlodge and Indian Head there was no injury from either cyanazine or metribuzin at any of the rates tested. At Melfort, injury from the solution formulation of cyanazine was recorded at both rates tested. This initial damage was reflected in reduced seed yields. The WP (wettable powder) formulation of cyanazine did not cause injury or reduction in seed yield.

Table 3 Yield of six, and single line triazine tolerant canola treated with metribuzin and cyanazine (Beaverlodge 1983).

Treatment	Rate kg/ha	Yield g/m^2 6 - line	Yield g/m^2 1 - line
Untreated	-	137 a	154 a
Metribuzin	0.20	111 a	127 a
Metribuzin	0.25	124 a	112 a
Metribuzin	0.30	132 a	123 a
Cyanazine	1.0	143 a	134 a
Cyanazine	1.5	129 a	142 a
Cyanazine	3.0	129 a	141 a

a = Means within columns followed by the same letter are not significantly different at 5% level according to Duncan's multiple range test.

Table 4 Tolerance and yield of 6 and single line triazine tolerant canola to metribuzin and cyanazine (Melfort 1983).

Treatment	Rate kg/ha	Tolerance (0-9)**		Yield g/m^2	
		6 - line	1 - line	6 - line	1 - line
Untreated	-	9.0	9.0	165	125
Metribuzin	0.20	9.0	9.0	194	150
Metribuzin	0.25	9.0	9.0	186	138
Metribuzin	0.30	9.0	9.0	196*	114
Cyanazine SU	1.5	6.5	6.5	95*	82*
Cyanazine SU	3.0	7.0	7.0	127*	90*
Cyanazine WP	1.0	9.0	9.0	189	101
Cyanazine WP	1.5	9.0	9.0	197	156*
Cyanazine WP	3.0	9.0	9.0	196	122
LSD (0.05)				29	29

** Tolerance (0-9) 9 = no injury 0 = complete kill

Table 5 Tolerance and yield of single line triazine tolerant canola to metribuzin and cyanazine (Indian Head 1983).

Treatment	Rate kg/ha	1 - line	
		Tolerance (0-9)*	Yield g/m^2
Untreated	-	9.0	120 a
Metribuzin	.20	8.2	111 a
Metribuzin	.25	8.0	115 a
Metribuzin	.30	7.5	103 a
Cyanazine SU	1.0	8.2	112 a
Cyanazine SU	1.5	7.2	116 a
Cyanazine SU	3.0	7.2	128 a
Cyanazine WP	1.0	8.5	113 a
Cyanazine WP	1.5	8.5	112 a
Cyanazine WP	3.0	8.2	124 a

Tolerance (0-9) 9 = no injury 0 = complete kill
a = Means within columns followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

Control of stinkweed with post emergent metribuzin at rates of 0.20 kg/ha or greater has been excellent. A summary of the four year control data is presented in Table 6. The wettable powder formulation of cyanazine did not provide acceptable stinkweed control at rates less than 2.0 kg/ha. The addition of an oil adjuvant at 0.5% v/v greatly enhanced the post emergent activity of cyanazine. The 1.0 kg/ha rate plus oil provided control equal to or greater than the 2.0 kg/ha rate without oil.

When applied to the soil and incorporated both metribuzin and cyanazine failed to provide acceptable control of stinkweed or wild mustard. At the highest rate tested maximum control achieved with soil incorporated metribuzin was 60% for stinkweed and somewhat less on wild mustard. Soil incorporated cyanazine was ineffective on both weeds. The control achieved with soil incorporated metribuzin in the Scott experiments is less than that reported from larger scale field tests in the northeastern area of the province where rates of 0.4 to 0.5 kg/ha were used and weed densities were greater. The use of higher rates to compensate for some loss of activity through soil incorporation is cautioned as metribuzin at 0.4 kg/ha or greater can damage triazine tolerant canola. Injury is likely to be more pronounced on low organic matter or sandy soils but has also been reported on clay soils with 4-5% organic matter.

Table 6 Control of stinkweed and wild mustard with postemergent and soil incorporated metribuzin and cyanazine (Scott 1980-83).

		Control (0-9)*		
	Rate	Stinkweed		Wild Mustard
Treatment	kg/ha	Postemergent	Soil incorporated	Soil incorporated
Untreated	-	0.0	0.0	0.0
Metribuzin	.20	8.7	4.0	2.0
Metribuzin	.30	9.0	5.3	3.0
Cyanazine	1.0	3.8	2.0	0.0
Cyanazine + oil	1.0	8.5	-	-
Cyanazine	2.0	7.8	3.0	1.0
Cyanazine	3.0	9.0	4.5	1.9

* Control (0-9) 0 = no control 9 = complete kill

Yield of the single line TTC grown under weed free conditions at nine locations in Saskatchewan and five in Manitoba in 1982 is approximately 30% less than the yield of Westar (Tables 7 and 8). Similar results were reported from the same Saskatchewan locations in 1983. (Table 9). Oil content was approximately 3% less than the commonly grown Brassica napus varieties. These results suggest that triazine tolerant canola should only be grown in those areas or fields where cruciferae weed species such as wild mustard and stinkweed are present in sufficient numbers to cause yield and/or quality reductions in non-triazine canola.

Table 7 Performance of four Brassica napus lines under weed free conditions in regional and cooperative tests at nine Saskatchewan locations 1982.

	Yield % of Regent	Maturity in days	Oil content %
Regent	100	98	44.1
Altex	100	97	44.1
Westar	109	97	44.3
OAC-TR*	77	100	41.6

*OAC-TR - Triazine tolerant Brassica napus line

Table 8 Performance of four Brassica napus lines in regional and cooperative tests at five Manitoba locations 1982.

	Yield % of Regent	% Oil content
Regent	100	43.1
Altex	103	43.2
Westar	111	43.6
OAC-TR*	75	40.0

*OAC-TR - Triazine tolerant Brassica napus line

Table 9 Performance of four Brassica napus lines under weed free conditions in regional and cooperative tests at nine Saskatchewan locations 1983.

	Yield % of Regent	% Oil content
Regent	100	43.3
Altex	101	42.8
Westar	109	43.0
OAC-TR*	79	40.1

OAC-TR Triazine tolerant Brassica napus line

SUMMARY

The yield and oil content of the single line tolerant canola is much less than commonly grown Brassica napus varieties such as Westar. However, the need for such a variety is urgent on the large acreage of land which is heavily infested with cruiciferae species and presently unsuitable for canola production. Given this situation it is highly probable that the single line triazine tolerant canola will be licensed in time for the 1984 growing season. The information on crop tolerance and cruciferae weed control with metribuzin and cyanazine is extensive. Tolerance of the triazine tolerant canola material has been good over a wide range of soil and climatic conditions, and depending on method of application weed control with both herbicides has been acceptable over a similar range of environmental conditions.

Given the above information it is reasonable to expect that as soon as the licensing of a triazine tolerant canola is approved, the registration of both metribuzin and cyanazine for use on the crop will be granted in time for application in 1984.

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