CULTURAL PRACTICES TO MAXIMIZE SEED YIELD OF TRIAZINE TOLERANT WINTER RAPESEED

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INTRODUCTION

Triazine tolerant rapeseed cultivars have been developed to allow production of rapeseed in soils with residual levels of triazine and to allow selective weed control with broad spectrum, low cost herbicides (Marshall, 1987). However, incorporation of the triazine tolerance caused significant reductions in several agronomic traits. OAC Triton, a triazine resistant spring Canola, has poor seedling vigor, lower seed yield, lower oil content and delayed maturity (Marshall, 1987). Triazine tolerance also reduces the comparative fitness of near isonuclear lines of triazine susceptible genotypes (Gressel and Ben-Sinai, 1985). OAC Triton has been shown to yield approximately 80% of Regent, a triazine susceptible Canola (Beversdorf and Hume 1984) Seed yield of reciprocal hybrids of winter oilseed rape using Lirabon x ATR-BC3 (triazine resistant cytoplasm) yielded an average of 87% of the susceptible lines (Robbelen 1987). In Canada, repeated backcrossing of spring rapeseed failed to generate a line with yields equivalent to the triazine susceptible recurrent parent (Austin et al. 1986). The reduced productivity of triazine tolerant plants may be the result of reduced photosynthetic capacity (Stowe and Holt 1988).

The purpose of these studies was to determine if increasing the plant population could minimize the yield reductions in triazine tolerant Canola cultivars. During the 1989 and 1990 growing season, row spacings and seeding rates were evaluated in four near isonuclear populations of winter rapeseed at Moscow, Idaho. The indices of seed yield, total dry matter, harvest index and oil content were measured in two separate studies.

MATERIALS AND METHODS

Row Spacing Study

Near isonuclear populations of winter rapeseed were planted in field studies at Moscow in the fall of both 1988 and 1989. Cascade, Bridger, LEI-I, LEI-II and their respective near isonuclear analogs were planted in 9 and 18 cm rows in plots 1 m wide and 5 m in length. Plots were established on 1.5 m centers using a cone seeder with double disk openers and packing wheels to ensure good soil to seed contact.

The 1988-89 study was seeded on Aug 24, 1988, on a summer fallow field. Prior to planting, 90 kg/ha of nitrogen fertilizer was applied as 16-20-0. The study was topdressed with 157 kg/ha of nitrogen applied by aerial application on Mar 8, 1989, as 46-0-0. Cabbage seedpod weevil were controlled with an aerial application of 0.25 kg/ha Parathion on May 25.

The 1989-90 study was seeded on August 17, 1989, on a summer fallow field. Prior to planting, 157 kg/ha of nitrogen was applied as 16-20-0. The study was topdressed with 224 kg/ha of nitrogen, applied by aerial application on Mar 24, 1990, as 40-0-0-6. Cabbage seedpod weevil were controlled with an aerial application of 0.25 kg/ha of parathion on June 15.

Fall and spring stand counts were made to determine winter survival. Plots were harvested with a Hege plot combine and subsamples were taken to determine moisture and percent oil. Above ground plant material was collected and weighed during the harvest to allow an estimate of harvest index. A subsample of the biomass was dried to determine moisture content. The total dry seed weight and above ground plant material dry matter were used to calculate the harvest index.

Percent oil was determined by using a Newport MKIIIA Nuclear Magnetic Resonance (NMR) instrument on 12 g of oven-dried, open-pollinated seed obtained from each plot. The NMR was calibrated using the cultivar, Bridger, as the standard.

This study had four replications and used a randomized, complete block, split-split plot design. Cultivars were used as main plots, near isonuclear lines were utilized as subplots and row spacings as sub-subplots.

Seeding Rate Study

A seeding rate study was conducted in the 1988-89 and 1989-90 growing seasons at Moscow, Idaho, using the procedure described above. The cultivar Cascade and its near isonuclear line, TriCascade, were planted in 9 cm and 18 cm row spacings at seeding rates of 13, 26, 39, 52, 65 and 78 seeds per m of row. This study was conducted as a randomized, complete block, split-split plot design with four replications. The near isonuclear isolines were utilized as main plots, row spacings as subplots and seeding rates as sub-subplots.

Data from both experiments were subject to analyses of variance and means indices with significant F Test values were separated with Fisher's Protected Least Significant Difference at the 0.05 level of probability. Those factors with only two treatments (row spacing and isonuclear lines) were separated by F Tests.

RESULTS AND DISCUSSIONS

Row Spacing Study

Average seed yield of the triazine tolerant near isonuclear lines in 1988-89 was 2802 kg/ha compared to 3780 kg/ha for the susceptible near isonuclear lines (Table 1). In the 1989-90 study, the average yield of the triazine tolerant near isonuclear lines was 2086 kg/ha compared to 2760 kg/ha for the susceptible near isonuclear lines. In 1988-89 and 1989-90 the average yield of the tolerant near isonuclear lines were 74% and 75% of the susceptible near isonuclear lines, respectively.

Total dry matter yields for triazine tolerant near isonuclear lines in 1988-89 and 1989-90 averaged 11.9 Mg/ha and 13.4 Mg/ha compared to 14.3 Mg/ha and 16.6 Mg/ha for the susceptible near isonuclear lines, respectively (Table 1). This represents a reduction in total dry matter production for the tolerant near isonuclear lines of 17% and 19% in the two years of the study.

Average harvest index for the triazine tolerant near isonuclear lines (19.3%) in the 1988-89 study was lower than the susceptible near isonuclear lines (21.3%) (Table 1). Harvest index for tolerant near isonuclear lines (13.7%) in the 1989-90 study was not significantly different than the susceptible near isonuclear lines (14.8%). The wide variation in harvest index between the two growing seasons of this study was probably due to differential environmental conditions. Average oil content in the triazine tolerant near isonuclear lines was 2.0% and 2.2% lower than the susceptible near isonuclear lines for the 1988-89 and 1989-90 growing seasons, respectively.

Seed yields, total dry matter, harvest index, and oil content were not affected by row spacings in either growing season (Table 1). The 9 cm row spacings produced slightly higher seed yields in both years than 18 cm rows but these differences were not statistically different.

Seeding Rate Study

Seeding rates ranging from 13 to 78 seeds per meter of row were evaluated for effects on seed yield, total dry matter, harvest index and oil content (Table 2). In the 1988-89, study seeding rates of 26 to 65 seeds per meter of row did not differ in seed yield. Seeding rates of 39 to 65 seeds per meter of row did not differ in seed yields in the 1989-90 crop year. In both years, seeding rates of 13 and 78 seeds per meter of row had significantly lower seed yields than the intermediate seeding rates. Total dry matter production in 1988-89 showed no significant difference for seeding rates of 13 to 65 seeds per meter of row, but seeding at a rate of 78 seeds per meter of row significantly decreased total dry matter production. In 1989-90, seeding rates of 39 to 78 seeds per meter of row did not differ in dry matter production, but seeding rates of 13 and 26 seeds per meter of row significantly decreased dry matter yield. Harvest index values for the 1988-89 production year were higher than the values in 1989-90 due to the different environments observed in both years. Seeding rate did not appear to influence harvest index. Oil content in both years of this study was not influenced by seeding rate.

CONCLUSIONS

The factors with the greatest impact on the performance of winter rapeseed in this study appeared to be the near isonuclear lines with differential levels of tolerance to the triazine herbicides and the cultivars in which this cytoplasmic factor had been incorporated. Significant differences in seed yield, total dry matter, harvest index and oil content were found between both the near isonuclear lines and the four cultivars. Triazine tolerance reduced performance for all indices measured.

Increased seeding rates from 13 to 78 seeds per meter of row at both 9 cm and 18 cm row spacings did not compensate for the yield reductions associated with triazine tolerance in rapeseed. Yield reduction in triazine tolerant winter rapeseed near isonuclear lines was shown to follow trends similar to those of other tolerant spring and winter rapeseed (Beversdorf et al. 1980; Gressel and Ben-Sinai 1985; Robbelen 1987; Stowe 1988). Increasing plant population by using narrower row spacings or increasing seeding rates within the row did not compensate for the reduction in seed yield caused by the incorporation of triazine tolerance in winter rapeseed.

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Table 1. Comparison of seed yield, total dry matter production, harvest index and oil content of four triazine tolerant near isonuclear populations of winter rapeseed planted in 9 and 18 cm row spacings at Moscow, Idaho (USA) in the 1988-89 and 1989-90 growing season.

	Seed Yield		Total Dry Matter		Harvest Index		Oil Content	
	1988-89	1989-90	1988-89	1989-90	1988-89	1989-90	1988-89	1989-90
	kg/ha		Mg/ha		%		%	
Isonuclear:								
Tolerant	2802 a[1/]	2086 a[1/]	11.9 a[1/]	13.4 a[1/]	19.3 a[1/]	13.7 a[1/]	38.1 a[1/]	36.3 a[1/]
Susceptible	3781 b	2760 b	14.3	16.6 b	21.3 b	14.8 b	40.1 b	38.5 b
Cultivar:								
Bridger	3609	2515	14.5	16.3	20.1	13.6	40.3	38.7
TriBridger	2587	1851	12.8	14.8	16.8	11.3	37.8	36.2
Cascade	4017	3075	11.9	12.6	25.3	20.1	39.3	38.2
TriCascade	3095	2155	10.8	12.1	22.2	15.4	36.9	35.8
LEI-I	3865	2788	14.4	17.4	21.1	13.8	40.3	38.9
Tri-LEI-I	2705	2036	11.7	12.5	19.0	14.1	38.5	36.8
LEI-II	3635	2662	16.6	19.9	18.5	11.9	40.6	38.2
Tri-LEI-II	2822	2302	12.1	14.1	19.1	14.1	38.7	36.6
$LSD_{(p=0.05)}$	196	196	2.0	1.5	1.4	1.7	0.3	0.4
Row Spacing:								
9 cm	3305 a[1/]	2427 a[1/]	13.1 a[1/]	14.7 a[1/]	20.2 a[1/]	14.6 a[1/]	37.4 a[1/]	39.1 a[1/]
18 cm	3278 a	2417 a	13.1 a	15.3 a	20.4 a	14.0 a	37.4 a	39.1 a

1/ Differences in triazine tolerant vs. susceptible near isonuclear lines and 9 and 18 cm row spacing separated by F-Test at the 0.05 level of probability.

Table 2. Comparison of seed yield, total dry matter production, harvest index and oil content of a triazine near isonuclear populations of winter rapeseed planted in 9 and 18 cm row spacings at Moscow, Idaho (USA) in the 1988-89 and 1989-90 growing seasons.

	Seed Yield		Total Dry Matter		Harvest Index		Oil Content	
	1988-89	1989-90	1988-89	1989-90	1988-89	1989-90	1988-89	1989-90
	-----kg/ha------		------Mg/ha------		--------%--------		--------%--------	
Isonuclear:								
susceptible	3097 a1/	4213 a1/	14.3 a1/	10.5 a1/	17.9 a1/	28.6 a1/	38.4 a1/	39.3 a1/
tolerant	2278 b	3443 b	14.0 a	9.8 b	14.1 b	26.1 b	36.0 b	36.9 b
Seeds/m/row:								
13	2404	3616	12.6	10.0	16.0	26.7	37.2	38.1
26	2618	3958	13.3	10.2	16.4	27.9	37.4	38.2
39	2758	3871	14.5	10.6	16.0	26.7	37.4	38.2
52	2951	3885	14.7	10.4	16.7	27.0	37.2	38.0
65	2778	3933	15.0	10.0	15.9	28.2	37.2	38.0
78	2615	3705	14.2	9.7	15.5	27.6	37.0	38.1
$LSD_{(p=0.05)}$	286	197	1.4	0.6	1.8	1.0	.34	.23
Row Spacings:								
9 cm	3883 a1/	2706 a1/	10.3 a1/	14.3 a1/	27.5 a1/	16.1 a1/	38.1 a1/	37.3 a1/
18 cm	3773 a	2769 a	9.9 b	14.0 a	27.3 a	15.8 a	38.0 a	37.2 a

1/ Differences in triazine tolerant vs. susceptible near isonuclear lines and 9 and 18 cm row spacing separated by F-Test at the 0.05 level of probability.