Reducing Insecticide Inputs for Control of the Crucifer Flea Beetle in Different Canola Varieties, 2004

Janet Knodel, Lorilie Atkinson, Denise Olson, Bryan Hanson, and Bob Henson

Abstract

Phyllotreta cruciferae, Crucifer flea beetle, is an important insect pest of spring-planted canola, especially during the seedling stage. We studied the efficacy and agronomic performance of using reduced proportions of insecticide-treated seed on two different varieties, Hybrid '357' and open pollinated '225,' of canola, Brassica napus. Two commercially available seed treatments were compared at their low and high rates among varieties: Helix with active ingredient thiamethoxam from Syngenta, and Prosper with active ingredient clothianidin from Gustafson. Four different proportions were evaluated for each seed treatment: 0% treated seed; 33% treated seed : 67% untreated seed; 67% treated seed : 33% untreated seed; and 100% treated seed. During the spring of 2004, the cool wet weather caused a prolonged delay in flea beetle emergence and undesirable feeding conditions, which resulted in lower infestations in canola. Treatments, seed treatment products, or the proportion of treated seed did not significantly impact plant stand and shoot dry weight. However, plant stand count and shoot dry weight was influenced by variety selection with variety '357' having higher plant stand counts and shoot dry weights than variety '225.' Incidence (percent of plant injured) appeared to be mainly affected by whether a seed treatment was used and the proportion of treated seed, and whether early season flea beetles were present in plots. Incidence was not affected by variety selection. Damage ratings were inversely related to the proportion of treated seed and the rates of seed treatment (high or low) regardless of the insecticide, Helix or Prosper. Variety selection also impacted damage ratings with the hybrid '357' having lower damage ratings and higher percent coverage than the open-pollinated '225.' This indicates that the 100% treated seed provided the best protection against flea beetle on canola, and variety '357' tolerated flea beetle injury better than variety '225.' Crop phenology was primarily influenced by variety selection in comparison to treatments, proportion of treated seed and seed treatment products. However, insecticide-treated seed usually had a shorter period to the start of flowering and shorter period to maturity, regardless of proportion of treated seed. Early flowering and maturity would provide other benefits to the canola producers, such as avoiding periods of inclement weather for disease development and allowing earlier harvest. Crop height and test weights were generally not influenced by the treatment, proportion of treated seed or seed treatment product, but variety did appear to affect height and test weights. Although yield was generally higher for the 100% treated seed and yield decreased proportionally as the proportion of treated seed declined regardless of the insecticide, variety selection appeared to be the most important variable for high yields. Variety '357' was able to compensate for flea beetle feeding injury. Specific seed treatment products did have some impact on yield. The higher rates of insecticide seed treatment products generally had the higher yields than the lower rates. Variety selection and use of an insecticide seed treatment also impacted kernel weight. Kernel weight was higher for treated seed with either the high or low rates of Helix or Prosper. Variety '357' generally had a slightly higher kernel weight than variety '225.' The proportion of treated seed, the insecticide seed treatment product and variety selection affected percent oil. Seed with an insecticide seed treatment and higher proportions of treated seed (67% and 100%) generally had higher percent oil than the untreated check. Variety '225' generally had higher percent oil content than variety '357.' In summary, these data indicate that variety selection can impact flea beetle feeding injury and agronomic crop performance factors, like yield, kernel weight, and percent oil content. Additional research is necessary to facilitate the identification of other varieties with tolerance for flea beetle feeding injury and thus having the potential genetic background for developing resistant varieties and reducing insecticide inputs.

Introduction

Canola is an important rotation crop in the Northern Great Plains. Canola oil is expanding its market share due to its placement as one of the healthiest of vegetable oils. North Dakota produces 85% of U.S. canola and production was valued at $116M in 1998, $81M in 1999, $108M in 2000, $158M in 2001, $149M in 2002, $134M in 2003, and $110M in 2004. The high market demand for canola makes it an increasingly important crop for growers in North Dakota. Canola adds diversity to crop rotation systems and provides an important cash crop to central and northeastern North Dakota.

The crucifer flea beetle, Phyllotreta cruciferae Goeze, represents a major insect threat to canola production wherever it is grown in the Northern Great Plains. Flea beetles can invade and reduce newly emerged plant stands within a few days. Currently, the most effective management technique is the use of insecticides to control the overwintering generation of flea beetles that emerge early in the spring. The seedling stage is the most critical period and insecticides often need to be applied as a seed treatment or as a foliar application to protect the crop from flea beetle damage. Flea beetle populations have been at damaging levels since 1997 in north central North Dakota and appear to be increasing based on trapping records (Knodel, unpublished data). Although post-emergence foliar insecticides can be effective, they require timely applications within a relatively small window of opportunity. Therefore, seed treatments are obviously more convenient and commonly used.

Canola is expensive to produce due to high input costs (e.g., insecticides, seed, and fertilizer). Across different canola growing regions of North Dakota, canola has an estimated input cost of $58.53 per acre, compared to oil sunflowers at $35.55 per acre and hard red spring wheat at $32.70 per acre. In general, canola growers must plan for about $20 per acre higher expenses than other crops. Canola varieties have performed differently when injured by flea beetles. The larger hybrid seed has generally had higher plant stand counts, larger leaf surface area, and seedling weights than the smaller open-pollinated seed (Knodel et al., unpublished data,). Differences in hybrid versus open-pollinated varieties appear to be significantly affected by insecticide rates (Knodel et al., unpublished data). This may be due to the larger seed sizes being a hybrid type versus the smaller seed sizes being an open-pollinated type. The objective of this research is to determine if insecticide seed treatment costs ($7.00+ per acre) can be reduced in different Roundup Ready lines (open-pollinated and hybrid) of canola and still effectively control the crucifer flea beetle in areas with different pressures. This has never been tested before in North Dakota and would result in lowering input costs as well as lowering the risk of insecticide contamination in the soil.

Materials and Methods

The efficacy of using reduced ratios of insecticide-treated seed was evaluated using commercially available seed treatments. Trials assessing the different insecticide treatments were conducted in research plots located at the North Dakota State University research extension centers in Minot, Langdon, and Carrington. Two different varieties of canola (Brassica napus), '225' open-pollinated and '357' hybrid (Interstate Seed), was seeded on May 17, 2004, in Minot and Carrington, and May 7, 2004 in Langdon. The seeding rate was 14-17 pure live seeds per square foot. An RCB design with four replicates was used. Experimental units were 3.5-4.1 ft. (7 rows) x 20-25 ft. Two seed treatments, Helix (active ingredient thiamethoxam from Syngenta) and Prosper (active ingredient clothianidin from Gustafson) were evaluated at their commercially-available low and high rates. Four different ratios of untreated : treated seed were also evaluated for each seed treatment: 0% treated seed, 33% treated seed : 67% untreated seed; 67% treated seed : 33% untreated seed; and 100% treated seed. This included 13 treatments per variety (a total of 26 treatments):

1) Untreated check
33% treated seed : 67% untreated seed
2) Helix lite (200 g ai/100 kg seed)
3) Prosper 200 (200 g ai/100 kg seed)
4) Helix xtra (400 g ai/100 kg seed)

5) Prosper 400 (400 g ai/100 kg seed
67% treated seed : 33% untreated seed
6) Helix lite (200 g ai/100 kg seed)
7) Prosper 200 (200 g ai/100 kg seed)
8) Helix xtra (400 g ai/100 kg seed)
9) Prosper 400 (400 g ai/100 kg seed)
100% treated seed
10) Helix lite (200 g ai/100 kg seed)
11) Prosper 200 (200 g ai/100 kg seed)
12) Helix xtra (400 g ai/100 kg seed)
13) Prosper 400 (400 g ai/100 kg seed)

Flea beetle populations were monitored weekly using sticky yellow trap cards. To evaluate flea beetle damage, assessments were taken on approximately 18, 27, and 34 days after planting (DAP) using the following techniques:

Counting the total number of plants in a 16 ft. long section of row and then recounting the number of plants with flea beetle damage to determine the percent incidence. Any plant with pitting or other feeding punctures was considered damaged. This provided the plant stand count (# plants/sq. foot).

A total of ten plants per plot (40 per treatment) were randomly collected along this 16 ft. long section and rated for flea beetle damage. The following rating scheme was used:

1 = 0-3 pits per seedling
2 = 4-9 pits per seedling
3 = 10-15 pits per seedling
4= 16-25 pits per seedling
5 = >25 pits per seedling
6 = dead.

The shoot dry weights of 10 seedlings per plot were recorded to indicate the overall vigor of the plant on 18 and 27 DAP only. All roots were removed from the seedling using a razor.

During the field season, the following notes on crop development stages were taken:

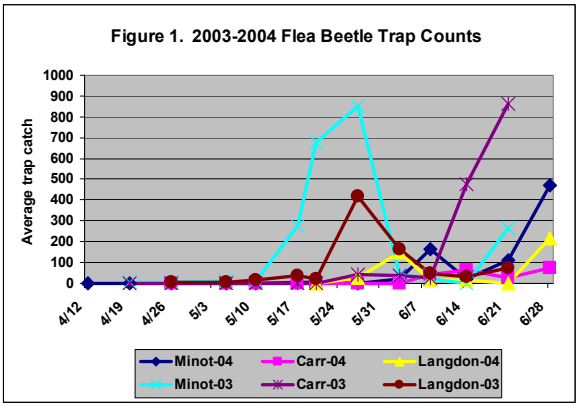
1st Flower: Days after planting when 10% of plants in plot have at least one open flower.
End Flower: Days after planting when 90% of plants in plot have completed flowering.
Flower Duration: Days from 1st flower – End flower
Days to Mature: Days after planting when seeds on lower third of main raceme are dark brown to black, seeds on middle third of main raceme are turning brown or black and seeds on top third of raceme are green but firm and pliable.
Plant Height: Height from soil surface to top of main raceme at the end of flowering.

Roundup (1 pt./A) + AMS was applied for weed control early in the season. Plots were harvested on August 20, 2004, in Minot, September 7, 2004, in Carrington, and September 17, 2004, in Langdon. Yield, test weight, kernel weight, and seed oil concentration were measured at the end of the season.

Data Analysis: Treatments were compared using Analysis Variance (ANOVA) (Zar 1984), and Fisher's Protected LSD (SAS institute 1991).

Results and Discussion

Flea Beetle Populations: During 2003 and 2004, the spring emergence of flea beetle was delayed due to the cool, wet early May weather (Fig. 1). In 2004, flea beetles were ready to emerge as the canola seedlings were emerging in late May and first week of June. This was the major peak of activity and spring emergence continued until late June. However, flea beetle populations were much lower in 2004 than 2003. There was no strong peak of



spring trap catches in 2004 compared to 2003. The average trap catch for 2004 and 2003, respectively, was 13 and 181 beetles per trap day in Minot, 4 and 181 beetles per trap day in Carrington, and 7 and 85 beetles per trap day in Langdon. Overall, flea beetle population decreased at trap sites. The cool wet weather caused a prolonged delay in flea beetle emergence and feeding and this may have demised their energy reserves. As a result, the overwintering mortality was probably higher than normal in 2004.

Plant Stand and Incidence (Tables 1-4):

Tables 1 & 2: At 18 and 27 DAP, there were significant interactions between treatment x variety for plant stand and percent incidence (number of plants attacked) at Minot only. For percent incidence there were also significant interactions between treatment x variety, regardless of the site. There were no consistent trends in plant stand counts among treatments. However, variety '357' had significantly higher plant stand counts than variety '225' at 18 and 27 DAP at all sites. For percent incidence at 18 DAP, all treatments had significantly lower percent incidence than the untreated check, except at Carrington where there were no significant differences between treatments. The 100% treated seed usually had lower percent incidence than treatments with the untreated check and treatments with 33% and 67% treated seed, regardless of site and variety. However, these differences were not always significant. Flea beetles moved into plots uniformly at 27 DAP at all sites, and there were no significant differences in percent incidence among treatments at 27 DAP regardless of site. There were no significant differences in percent incidences among varieties at 18 and 27 DAP; except for Langdon at 18 DAP where variety '357' had significantly higher percent incidence than variety' 225.'

Table 3: There were no significant differences in plant stand counts among proportions of treated seed at 18 or 27 DAP, regardless of site. At 18 DAP, 33, 67, and 100 percent treated seed had significantly lower percent incidence than the untreated check at Minot and Langdon. At Carrington on 18 DAP, there were no significant differences between proportions of treated seed; probably due to light pressures and flea beetles not moving into plots to feed due to the cool spring weather. Flea beetles moved into plots uniformly at 27 DAP at all sites, and there were no significant differences in percent incidence, regardless of site.

Table 4: There were significant differences in plant stand counts among different seed treatment products at Minot and Langdon at 19 DAP, and Carrington at 27 DAP. In general, the high rates of seed treatment products, Helix xtra and Prosper 400, had higher plant stand counts than the low rates of seed treatment products, Helix lite and Prosper 200, and the untreated check. At 18 DAP, seed treatment products had a significantly lower percent incidence than the untreated check at Minot and Langdon. At Carrington on 18 DAP, there were no significant differences between seed treatment products because flea beetles had not yet moved into plots to feed. Flea beetles moved into plots uniformly at 27 DAP at all sites. As a result, there were no significant differences in percent incidence.

In summary, these data indicate treatments, seed treatment products, or the proportion of treated seed did not affect that plant stand. However, plant stand count was influenced by variety selection with variety '357' having higher plant stand counts than variety '225.' Incidence appeared to be mainly affected by whether a seed treatment was used and the proportion of treated seed, and whether early season flea beetles were present in plots. Incidence was not affected by variety selection.

Table 1. Analysis of variance P-values in the response of two canola cultivars to flea beetle control treatments trial in Minot, Langdon and Carrington, 2004.

Source of Variation	df	18 DAP[1] ----------Plant Stand---------- Pl/ft^2			18 DAP[1] ----------% Inc ----------			27 DAP[1] ----------Plant Stand-------- Pl/ft^2			27 DAP[1] ----------% Inc ----------		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Rep	3	0.6902	0.2680	0.0071	0.4110	0.0535	0.0001	0.2123	0.0075	0.0320	--	--	0.4879
Treatment	12	0.0205	0.0599	0.3587	<.0001	0.0039	0.3221	0.2229	0.0654	0.0006	--	--	0.4766
Variety	1	0.0096	<.0001	0.0119	0.8295	0.0191	0.1444	0.0050	<.0001	0.0016	--	--	1.0000
Treatment x Variety	12	0.0029	0.5352	0.3798	0.0173	0.3854	0.2777	0.0074	0.1523	0.1642	--	--	0.6305

Table 2. Plant Stand and Incidence at Minot, Langdon and Carrington, 2004.

Seed Treatment	Variety	18 DAP[1] ----------Plant Stand---------- Pl/ft^2			18 DAP[1] ----------% Inc ----------			27 DAP[1] ----------Plant Stand-------- Pl/ft^2			27 DAP[1] ----------% Inc ----------		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	--	18.8 ab	9.2	14.4	17 a	10 a	6	9.8	8.8	10.4 cd	100	100	100
33% Helix lite	--	19.5 ab	9.0	15.3	7 b	7 bc	3	9.9	9.0	12.4 bc	100	100	100
33% Prosper 200	--	19.6 ab	11.2	13.9	4 bcd	6 bcd	4	9.9	8.3	9.1 d	100	100	100
33% Helix xtra	--	20.4 ab	11.5	12.4	6 bc	7 ab	6	11.6	8.9	10.3 cd	100	100	100
33% Prosper 400	--	19.4 ab	10.2	13.1	4 bcd	5 bcd	3	8.8	8.2	11.3 cd	100	100	100
67% Helix lite	--	18.0 bc	10.1	12.7	4 bcd	3 d	3	9.7	9.2	10.7 cd	100	100	99
67% Prosper 200	--	18.9 ab	11.2	14.6	4 bcd	5 bcd	4	10.5	9.9	12.4 bc	100	100	100
67% Helix xtra	--	20.5 ab	13.5	15.2	4 bcd	4 cd	2	11.5	10.0	15.0 a	100	100	100
67% Prosper 400	--	19.2 ab	10.5	15.0	3 cd	3 d	3	11.2	8.0	11.3 cd	100	100	100
100% Helix lite	--	15.9 c	10.5	13.7	3 bcd	6 bcd	4	10.4	7.3	10.7 cd	100	100	100
100% Prosper 200	--	20.9 a	11.4	16.3	3 cd	5 bcd	2	9.5	10.3	10.4 cd	100	100	100
100% Helix xtra	--	21.4 a	10.9	15.1	2 d	4 cd	3	10.9	11.1	13.8 ab	100	100	98
100% Prosper 400	--	20.4 ab	11.3	12.4	2 d	5 bcd	5	10.9	9.0	11.9 bc	100	100	100
LSD (P < 0.05)		***2.7***	***NS***	***NS***	***0.03***	***0.03***	***NS***	***NS***	***NS***	***2.5***	***--***	***--***	***NS***
CV		***14.0***	***22.3***	***23.6***	***66.5***	***61.9***	***89.2***	***20.4***	***24.2***	***21.4***	***--***	***--***	***1.5***
Mean		***19.5***	***10.8***	***14.2***	***5***	***5***	***4***	***10.4***	***9.1***	***11.5***	***100***	***100***	***100***
Variety													
225		18.7	9.5	13.3	5	5	3	9.7	7.9	10.7	100	100	100
357		20.2	12.1	15.0	5	6	4	10.9	10.3	12.3	100	100	100
t-test		**	**	*	***NS***	**	***NS***	**	**	**	***--***	***--***	***NS***

Means within a column followed by the same letter are not significantly different (P < 0.05); NS = not significant

[1] DAP=Days After Planting

Table 3. Effect of the proportion of treated seed on canola performance at Minot, Langdon and Carrington, 2004

Percent	n	18 DAP[1] ----------Plant Stand---------- Pl/ft[2]			18 DAP[1] ----------% Inc ----------			27 DAP[1] ----------Plant Stand-------- Pl/ft[2]			27 DAP[1] ----------% Inc ----------		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
0	8	18.8	9.2	14.4	17	10	6	9.7	8.8	10.0	100	100	100
33	32	19.7	10.5	13.7	5	6	4	10.0	8.6	11.0	100	100	100
67	32	19.2	11.3	14.4	4	4	3	10.7	9.3	12.0	100	100	100
100	32	19.6	11.0	14.4	3	5	3	10.4	9.4	12.0	100	100	99
LSD (P < 0.05)		***NS***	***NS***	***NS***	**	**	***NS***	***NS***	***NS***	***NS***	***--***	***--***	***NS***
C.V. (%)		***16.8***	***25.9***	***24.8***	***69.9***	***62.0***	***90.9***	***23.2***	***29.0***	***25.2***	***0.0***	***0.0***	***1.4***
Mean		***19.4***	***10.8***	***14.2***	***5***	***5***	***4***	***10.3***	***9.1***	***11.5***	***100***	***100***	***100***

Table 4. Effect of the seed treatment product on canola performance at Minot, Langdon and Carrington, 2004.

Product	n	18 DAP[1] ----------Plant Stand---------- Pl/ft[2]			18 DAP[1] ----------% Inc ----------			27 DAP[1] ----------Plant Stand-------- Pl/ft[2]			27 DAP[1] ----------% Inc ----------		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	8	18.8	9.2	14.4	17	10	6	9.7	8.8	10.4	100	100	100
Helix lite	24	17.8	9.8	13.9	5	5	3	10.0	8.5	11.3	100	100	100
Prosper 200	24	19.8	11.3	14.9	4	5	3	10.0	9.5	10.6	100	100	100
Helix xtra	24	20.7	12.0	14.2	4	5	4	11.4	10.0	13.0	100	100	99
Prosper 400	24	19.7	10.7	13.5	3	4	4	10.3	8.0	11.5	100	100	100
LSD (P < 0.05)		*	*	***NS***	**	*	***NS***	***NS***	***NS***	*	***--***	***--***	***NS***
C.V. (%)		***16.0***	***25.2***	***24.8***	***72.9***	***64.7***	***91.6***	***22.8***	***28.4***	***24.8***	***0.0***	***0.0***	***1.5***
Mean		***19.4***	***10.8***	***14.2***	***5***	***5***	***4***	***10.3***	***9.1***	***11.5***	***100***	***100***	***100***

Means within a column followed by the same letter are not significantly different (P < 0.05); NS = not significant

[1] DAP=Days After Planting

Shoot Dry Weight and Percent Cover (Tables 5-8): Tables 5 & 6: For shoot dry weight on 18 and 27 DAP, there was a significant interaction between treatment x variety, regardless of the site. Although there were small differences in treatments, no trends were found among treatments. Variety '357' had significantly higher shoot dry weight than variety '225' at all sites at 18 and 27 DAP. These data indicate that dry weights were not affected by specific seed treatments, but by variety selection.

At Minot, all treatments had significantly higher percent coverage than the untreated checks. Carrington had similar results with the following treatments having significantly higher percent coverage than the untreated checks: all 67% and 100% treatments and 33% Prosper 400 and 33% Helix xtra. Even though flea beetle pressures were severe in plots at Langdon, all treatments had significantly higher percent coverage than the untreated check, except 33% Helix lite and 33% Prosper 200. Variety '357' also had a higher percent coverage than variety '225' at all locations.

Table 7: There were no significant differences among proportions of treated seed for shoot dry weight at 18 and 27 DAP, regardless of site. However, Minot at 27 DAP had significantly higher shoot dry weights for 33%, 67%, and 100% treated seed than the untreated check. For percent coverage, all proportion of treated seed (33%, 67% and 100%) had a significantly higher value than the untreated check (0%). Sixty-seven percent and 100% treated seeds also had higher percent coverage than 33% treated seeds. This indicates that higher proportions of treated seed enhances plant vigor.

Table 8: Again, there were no significant differences among seed treatment products for shoot dry weight at 18 and 27 DAP, regardless of site. However, Minot at 27 DAP had significantly higher shoot dry weights for all seed treatment products than the untreated check. For percent coverage at 34 DAP, all seed treatment products had a higher value than the untreated check.

Different treatments, seed treatment products and proportions of treated seed generally did not impact shoot dry weights. Variety selection appeared to influence shoot dry weight with variety '357' having higher shoot dry weight than variety '225.' However, data were not consistent among sites. At Minot, results for shoot dry weights showed a response to the proportion of treated seeds and different seed treatment products at 27 DAP. The high rates of seed treatment products, like Helix xtra or Prosper 400, and the higher proportions (67% and 100%) of treated seed provided higher percent coverage and positively impacted plant vigor. Variety selection also impacted percent coverage with the hybrid '357' having higher percent coverage than the open-pollinated '225.'

Table 5. Analysis of variance P-values in the response of two canola cultivars to flea beetle control treatments trial in Minot, Langdon and Carrington, 2004.

Source of Variation	df	18 DAP[1] ----------Dry Shoot Wt---------- g/10 plant			27 DAP[1] ----------Dry Shoot Wt---------- g/10 plant			34 DAP[1] ----------% Coverage----------		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Rep	3	0.0113	<.0001	<.0001	0.4399	<.0001	0.2163	<.0001	0.0440	<.0001
Treatment	12	0.2326	0.0028	0.6193	<.0001	0.0063	0.0012	<.0001	<.0001	<.0001
Variety	1	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Treatment x Variety	12	0.0933	0.5748	0.0562	0.7751	0.3669	0.2417	0.0016	0.6568	0.1542

Table 6. Dry Shoot Weight and Percent Coverage at Minot, Langdon and Carrington, 2004

Seed Treatment	Variety	18 DAP[1] ----------Dry Shoot Wt---------- g/10 plant			27 DAP[1] ----------Dry Shoot Wt---------- g/10 plant			34 DAP[1] ----------% Coverage----------		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	--	0.130	0.075 d	0.078	1.312 f	0.610 d	0.177 cd	34.4 g	20.0 f	18.8 e
33% Helix lite	--	0.135	0.082 cd	0.088	1.993 b-e	0.631 cd	0.177 cd	43.8 f	27.5 ef	22.5 de
33% Prosper 200	--	0.132	0.086 cd	0.082	1.784 e	0.643 cd	0.154 cd	41.9 f	32.5 de	23.1 de
33% Helix xtra	--	0.139	0.090 bc	0.077	2.251 a-d	0.808 bcd	0.175 cd	48.8 cde	36.9 cd	33.8 c
33% Prosper 400	--	0.141	0.080 cd	0.074	1.917 cde	0.821 bcd	0.165 cd	46.3 def	26.3 ef	27.5 cd
67% Helix lite	--	0.168	0.102 ab	0.084	2.015 b-e	0.686 bcd	0.180 bcd	45.6 ef	31.9 de	41.3 b
67% Prosper 200	--	0.135	0.088 bcd	0.075	1.835 de	0.701 bcd	0.190 bcd	46.3 def	33.1 de	33.1 c
67% Helix xtra	--	0.147	0.088 bcd	0.086	2.194 a-e	0.925 ab	0.220 ab	55.6 ab	47.5 b	46.9 ab
67% Prosper 400	--	0.141	0.085 cd	0.077	2.076 a-e	0.838 bcd	0.154 d	51.3 bc	40.6 bcd	40.6 b
100% Helix lite	--	0.143	0.091 bc	0.070	2.322 abc	0.866 abc	0.184 bcd	48.8 cde	40.6 bcd	43.8 b
100% Prosper 200	--	0.149	0.086 cd	0.081	1.941 cde	0.632 cd	0.176 cd	50.6 cd	38.8 bcd	30.0 c
100% Helix xtra	--	0.162	0.109 a	0.086	2.418 ab	1.117 a	0.253 a	58.8 a	56.9 a	52.5 a
100% Prosper 400	--	0.147	0.092 bc	0.076	2.400 a	0.809 bcd	0.196 bc	56.3 a	43.8 bc	46.9 ab
LSD (P < 0.05)		***NS***	***0.01***	***NS***	***0.4***	***0.3***	***0.04***	***4.9***	***9.2***	***6.8***
CV		***19.1***	***16.5***	***21.1***	***20.9***	***33.0***	***23.2***	***10.3***	***25.1***	***19.3***
Mean		***0.144***	***0.089***	***0.080***	***2.044***	***0.776***	***0.184***	***48.3***	***36.6***	***35.4***
Variety										
225		0.106	0.066	0.064	1.663	0.477	0.148	43.9	25.2	29.4
357		0.182	0.112	0.095	2.424	1.075	0.221	52.7	48.1	41.4
t-test		**	**	**	**	**	**	**	**	**

Means within a column followed by the same letter are not significantly different (P < 0.05); NS = not significant

[1] DAP=Days After Planting

Table 7. Effect of the proportion of treated seed on canola performance at Minot, Langdon and Carrington, 2004

Percent	n	18 DAP[1] ----------Dry Shoot Wt--------- g/10 plant			27 DAP[1] ----------Dry Shoot Wt---------- g/10 plant			34 DAP[1] ----------% Coverage----------		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
0	8	0.130	0.075	0.078	1.311	0.610	0.177	34.4	20.0	18.8
33	32	0.137	0.084	0.080	1.986	0.726	0.168	45.2	30.8	26.7
67	32	0.148	0.091	0.080	2.035	0.788	0.186	49.7	38.3	40.5
100	32	0.150	0.094	0.078	2.293	0.856	0.202	53.6	45.0	43.3
LSD (P < 0.05)		***NS***	***NS***	***NS***	**	***NS***	***NS***	**	**	**
C.V. (%)		***33.7***	***32.0***	***29.8***	***28.7***	***53.6***	***32.8***	***16.5***	***43.2***	***31.0***
Mean		***0.144***	***0.089***	***0.080***	***2.000***	***0.776***	***0.184***	***48.3***	***36.6***	***35.4***

Table 8. Effect of the seed treatment product on canola performance at Minot, Langdon and Carrington, 2004.

Product	n	18 DAP[1] ----------Dry Shoot Wt--------- g/10 plant			27 DAP[1] ----------Dry Shoot Wt---------- g/10 plant			34 DAP[1] ----------% Coverage----------		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	8	0.130	0.075	0.078	1.312	0.610	0.177	34.4	20.0	18.8
Helix lite	24	0.148	0.092	0.081	2.110	0.728	0.180	46.0	33.3	35.8
Prosper 200	24	0.139	0.086	0.079	1.853	0.659	0.173	46.3	34.8	28.8
Helix xtra	24	0.149	0.095	0.083	2.288	0.950	0.216	54.4	47.1	44.4
Prosper 400	24	0.143	0.086	0.075	2.167	0.823	0.172	51.3	36.9	38.3
LSD (P < 0.05)		***NS***	***NS***	***NS***	**	***NS***	***NS***	**	**	**
C.V. (%)		***34.0***	***32.2***	***29.8***	***28.6***	***52.4***	***32.5***	***16.6***	***43.9***	***33.7***
Mean		***0.144***	***0.089***	***0.080***	***2.044***	***0.776***	***0.184***	***48.3***	***36.6***	***35.4***

Means within a column followed by the same letter are not significantly different (P < 0.05); NS = not significant

[1] DAP=Days After Planting

Flea Beetle Damage Ratings (Tables 9-12):
Tables 9 & 10: There were significant interactions between treatment x variety for flea beetle damage ratings on 18, 27, and 34 DAP, regardless of the site. As a result of flea beetle damage ratings being consistently low (a value of one) on 18 DAP regardless of the site, no statistical analyses were conducted. Flea beetles had not moved into plots to feed yet, due to the cool spring temperatures delaying emergence from their overwintering sites. Average flea beetle damage rating increased dramatically from 1 on 18 DAP to 4.4 on 27 DAP in untreated plots. At Minot on 27 and 34 DAP; all of the insecticide treatments had a significantly lower damage rating than the untreated check. The 100% treated seed usually had lower ratings than the 67% and 33% treated seed; however, these differences were not always statistically significant. At Langdon, the following treatments had significantly lower damage ratings than the untreated check on 27 DAP: 67% and 100% Helix xtra, 67% and 100% Prosper 400, 100% Helix lite, and 33% Helix xtra. Similar results were observed on 34 DAP at Langdon. At Carrington, 67% and 100% Helix xtra, 67% and 100% Prosper 400, and 100% Helix lite had significantly lower damage ratings than the untreated check on 27 DAP. The following treatments had significantly lower damage ratings than the untreated checks at Carrington on 34 DAP: all treatments with 67% and 100% treated seed and 33% Helix extra. Variety '357' had a significantly lower damage rating than variety '225' for damage ratings taken on 27 and 34 DAPs, regardless of site.

Table 11: For visual damage ratings on 18 DAP, no analyses could be conducted since all damage ratings had a value of 1 (0-3 pits per seedling). For damage ratings taken on 27 and 34 DAPs, 67%, and 100% treated seed had lower ratings than the untreated check, regardless of site. Thirty-three percent treated seed usually had damage ratings comparable to the untreated check.

Table 12: For visual damage ratings taken on 18 DAP, no analyses could be conducted since all damage ratings were a value of 1 (0-3 pits per seedling). For damage ratings taken on 27 and 34 DAPs, all seed treatment products had significantly lower damage ratings than the untreated check. The higher rates of seed treatment products (Helix xtra, Prosper 400) usually had lower damage ratings than the low rates of seed products (Helix lite, Prosper 200) and the untreated check, regardless of the site. The low rates of seed treatment products usually had damage ratings closer to the untreated check depending on flea beetle pressures. However, there were no significant differences among seed treatment products at Langdon at 34 DAP; probably due to severe flea beetle pressure.

In summary, damage ratings were inversely related to the proportion of treated seed and the rates of seed treatment (high or low) regardless of the insecticide, Helix or Prosper. Variety selection impacted damage ratings with the hybrid '357' having lower damage ratings than the open-pollinated '225.' Damage ratings averaged across treatments and sites by variety include: Variety '225' - 2.7 for 100% treated seed, 2.9 for 67% treated seed, 3.2 for 33% treated seed, and 3.7 for the untreated check; and Variety '357' - 2.7 for 100% treated seed, 2.9 for 67% treated seed, 3.2 for 33% treated seed, and 3.7 for the untreated check. This research indicates that the 100% treated seed provided the best protection against flea beetle on canola, and variety '357' tolerated flea beetle injury better than variety '225.'

Table 9. Analysis of variance P-values in the response of two canola cultivars to flea beetle control treatments trial in Minot, Langdon and Carrington, 2004.

		18 DAP[1] ----Visual Rating 1 --- 1-6*			27 DAP[1] ----------Visual Rating 2---------- 1-6*			34 DAP[1] ----------Visual Rating 3---------- 1-6*		
Source of Variation	df	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Rep	3	--	--	--	0.3085	0.4992	<.0001	0.7338	0.3066	<.0001
Treatment	12	--	--	--	<.0001	<.0001	0.0004	<.0001	<.0001	<.0001
Variety	1	--	--	--	0.0325	<.0001	0.0078	<.0001	<.0001	<.0001
Treatment x Variety	12	--	--	--	0.2504	0.4482	0.7635	0.2090	0.5526	0.1136

Table 10. Flea Beetle Damage Rating at Minot, Langdon and Carrington, 2004

		18 DAP[1] ----Visual Rating 1 --- 1-6*			27 DAP[1] ----------Visual Rating 2---------- 1-6*			34 DAP[1] ----------Visual Rating 3---------- 1-6*		
Seed Treatment	Variety	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	--	1.0	1.0	1.0	4.1 a	5.1 ab	3.8 abc	4.3 a	4.7 a	4.9 a
33% Helix lite	--	1.0	1.0	1.0	2.4 b	4.8 a-d	3.9 ab	3.1 bc	4.5 abc	4.4 abc
33% Prosper 200	--	1.0	1.0	1.0	2.2 bc	5.1 a	4.1 a	3.3 b	4.4 a-d	4.4 ab
33% Helix xtra	--	1.0	1.0	1.0	1.8 cde	4.5 cde	3.6 a-d	2.5 de	4.2 a-e	4.0 cde
33% Prosper 400	--	1.0	1.0	1.0	1.9 bcd	4.9 abc	3.8 a-d	2.6 cd	4.5 ab	4.1 bcd
67% Helix lite	--	1.0	1.0	1.0	1.4 efg	4.7 a-d	3.6 a-d	2.6 cd	4.3 a-e	3.6 efg
67% Prosper 200	--	1.0	1.0	1.0	2.0 bcd	4.7 a-e	3.8 a-d	2.6 cd	4.0 b-e	4.0 b-e
67% Helix xtra	--	1.0	1.0	1.0	1.1 g	4.2 e	3.5 b-e	1.8 fg	3.7 e	2.8 h
67% Prosper 400	--	1.0	1.0	1.0	1.1 fg	4.6 b-e	3.3 def	1.9 fg	3.9 b-e	3.3 fg
100% Helix lite	--	1.0	1.0	1.0	1.6 def	4.3 de	3.4 c-f	2.1 def	3.8 de	3.2 g
100% Prosper 200	--	1.0	1.0	1.0	1.3 fg	4.8 a-d	3.6 a-d	2.3 def	4.3 a-e	3.7 def
100% Helix xtra	--	1.0	1.0	1.0	1.1 fg	3.5 f	2.9 f	1.1 h	2.8 f	2.2 i
100% Prosper 400	--	1.0	1.0	1.0	1.0 g	4.5 cde	3.0 ef	1.7 g	3.8 cde	2.5 hi
LSD (P < 0.05)		*--*	*--*	*--*	***0.5***	***0.5***	***0.5***	***0.5***	***0.6***	***0.5***
CV		*--*	*--*	*--*	***25.6***	***11.3***	***14.9***	***19.5***	***15.7***	***12.9***
Mean		***1.0***	***1.0***	***1.0***	***1.8***	***4.6***	***3.5***	***2.5***	***4.1***	***3.6***
Variety										
225		1.0	1.0	1.0	1.9	5.3	3.7	2.7	4.7	3.9
357		1.0	1.0	1.0	1.7	3.9	3.4	2.1	3.5	3.3
t-test		*--*	*--*	*--*	*	**	**	**	**	**

Means within a column followed by the same letter are not significantly different (P < 0.05); NS = not significant

[1] DAP=Days After Planting

**** Damage Rating: 1 = 0-3 pits per seedling; 2 = 4-9 pits per seedlings; 3 = 10-15 pits per seedling; 4 = 16-25 pits per seedling; 5 = >25 pits per seedling; and 6 = dead seedling.***

Table 11. Effect of the proportion of treated seed on canola performance at Minot, Langdon and Carrington, 2004

Percent	n	18 DAP[1] ----Visual Rating 1 --- 1-6*			27 DAP[1] ----------Visual Rating 2---------- 1-6*			34 DAP[1] ----------Visual Rating 3---------- 1-6*		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
0	8	1.0	1.0	1.0	4.1	5.1	3.8	4.3	4.7	4.9
33	32	1.0	1.0	1.0	2.1	4.9	3.8	2.9	4.4	4.2
67	32	1.0	1.0	1.0	1.4	4.5	3.5	2.2	4.0	3.4
100	32	1.0	1.0	1.0	1.2	4.3	3.2	1.8	3.7	2.9
LSD (P < 0.05)		*--*	*--*	*--*	**	*	**	**	**	**
C.V. (%)		***1.0***	***0.0***	***0.0***	***31.4***	***19.5***	***15.6***	***27.7***	***22.6***	***19.9***
Mean		***1.0***	***1.0***	***1.0***	***1.8***	***4.6***	***3.5***	***2.4***	***4.1***	***3.6***

Table 12. Effect of the seed treatment product on canola performance at Minot, Langdon and Carrington, 2004.

Product	n	18 DAP[1] ----Visual Rating 1 --- 1-6*			27 DAP[1] ----------Visual Rating 2---------- 1-6*			34 DAP[1] ----------Visual Rating 3---------- 1-6*		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	8	1.0	1.0	1.0	4.1	5.1	3.8	4.3	4.7	4.9
Helix lite	24	1.0	1.0	1.0	1.8	4.6	3.6	2.6	4.2	3.8
Prosper 200	24	1.0	1.0	1.0	1.8	4.9	3.8	2.7	4.2	4.1
Helix xtra	24	1.0	1.0	1.0	1.3	4.1	3.3	1.8	3.6	3.0
Prosper 400	24	1.0	1.0	1.0	1.4	4.7	3.3	2.1	4.1	3.3
LSD (P < 0.05)		*--*	*--*	*--*	**	*	*	**	*NS*	**
C.V. (%)		***0.0***	***0.0***	***0.0***	***35.0***	***19.2***	***16.4***	***29.7***	***23.0***	***22.4***
Mean		***1.0***	***1.0***	***1.0***	***1.8***	***4.6***	***3.5***	***2.4***	***4.1***	***3.6***

Means within a column followed by the same letter are not significantly different (P < 0.05); NS = not significant

[1] ***DAP=Days After Planting***

[*] ***Damage Rating: 1 = 0-3 pits per seedling; 2 = 4-9 pits per seedlings; 3 = 10-15 pits per seedling; 4 = 16-25 pits per seedling; 5 = >25 pits per seedling; and 6 = dead seedling.***

Crop Phenology (Tables 13-16):

Tables 13 & 14: There were significant interactions between treatment x variety for 10% flower at Minot and Carrington, 90% flower at Minot and Langdon, flower duration at Langdon, and days to maturity at Minot and Langdon. There were significant interactions between treatment x variety for crop height. In general, the 67% and 100% treatments had a shorter period to 10% and 90% flower than the 33% treated seed treatments and the untreated check. There were no trends among treatments in flower duration, days to maturity, and crop height. However, the variety differences were consistent. Variety '357' had significantly shorter period to 10% and 90% flower compared to variety '225,' regardless of site. Flower duration was significantly shorter for variety '357' than variety '225' at Langdon and Carrington. No significant differences were observed in flower duration at Minot. Variety '357' also required significantly fewer days to reach maturity than variety '225' at Minot, Langdon, and Carrington. Variety '225' was significantly taller than variety '357' at Minot and Carrington. These results indicate that variety was a more dominant factor than insecticide seed treatments for crop phenology development.

Table 15: In general, there were no significant differences in flowering and maturity data across proportions of treated seed, regardless of site. However, Carrington had a significantly shorter period to 90% flower in 33%, 67%, and 100% treated seeds compared to the untreated check. Across proportion of treated seed, 33%, 67% and 100% treated seed were taller than the untreated check at Minot. There were no significant differences in height among proportions of treated seed at Langdon and Carrington.

Table 16: Regardless of the site across seed treatment products, seed treatment products had a shorter period to 10% flowering and days to maturity than the untreated check. For 90% flower, only Minot had a significantly shorter period in the seed treatment products than the untreated check. There were significant differences among the seed treatment products for 90% flowering at Langdon and Carrington. No significant differences were observed among the seed treatment products in flower duration at Minot, Langdon, and Carrington. At Minot and Carrington, the seed treatment products also had a shorter period to maturity than the untreated check. There were no significant differences in maturity at Carrington. At Minot, all of the seed treatment products were taller compared to the untreated check.

These data suggest that crop phenology was influenced more by variety selection than by proportion of treated seed and seed treatments. Insecticide-treated seed usually had a shorter period to the start of flowering. In some cases, the period to maturity was also shorter in seeds treated with an insecticide than the untreated check, regardless of proportion of treated seed. However, these differences were not consistent across sites. Early flowering would provide other benefits to the canola producers, such as avoiding periods of inclement weather for disease development and allowing earlier harvest. In addition, crop height was generally not influenced by the treatment, proportion of treated seed or seed treatment product, but variety did appear to affect height.

Table 13. Analysis of variance P-values in the response of two canola cultivars to flea beetle control treatments trial in Minot, Langdon and Carrington, 2004.

		10% Flower			90% Flower			Flower Duration			Maturity			Height		
Source of Variation	df	DAP[1]			DAP[1]			Days			Days			cm		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Rep	3	0.1584	0.2787	0.0001	0.1751	0.5432	<.0001	0.1834	0.9980	<.0001	<.0001	0.0213	0.0111	0.0121	0.0029	0.0744
Treatment	12	<.0001	<.0001	<.0001	<.0001	0.0004	0.0003	0.0298	0.1750	0.4946	0.0004	<.0001	0.0803	0.0225	0.2637	0.5198
Variety	1	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.1479	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.3216	<.0001
Treatment x Variety	12	<.0001	0.8817	0.0499	<.0001	0.0389	0.3534	0.1530	0.0063	0.4435	0.0010	0.6029	0.0447	0.1831	0.6848	0.0983

Table 14. Crop Phenology at Minot, Langdon and Carrington, 2004.

Seed Treatment	Variety	10% Flower DAP[1]			90% Flower DAP[1]			Flower Duration Days			Maturity Days			Height cm		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	--	50.6 bc	61.3 a	48.5 a	63.9 abc	84.8 a	70.8 a	13.3 b	23.5	22.3	81.4 bc	115.8 a	93.4	83.9 d	92.5	87.6
33% Helix lite	--	50.0 cd	60.3 ab	47.9 ab	63.8 abc	82.8 ab	70.4 ab	13.8 ab	22.5	22.5	80.9 bcd	114.6 ab	93.1	87.7 bcd	87.8	89.6
33% Prosper 200	--	49.9 cd	59.3 bcd	48.0 ab	63.0 c	81.0 bcd	70.8 a	13.1 bc	21.8	22.8	80.8 bcd	114.5 ab	94.1	86.3 cd	96.6	89.9
33% Helix xtra	--	49.4 d	58.0 cde	46.8 cde	62.9 c	80.8 bcd	69.5 a-d	13.5 ab	22.8	22.8	80.3 d	113.0 b	93.3	89.8 abc	96.8	86.1
33% Prosper 400	--	49.8 d	59.6 abc	48.0 ab	63.4 abc	81.6 bc	69.4 b-e	13.6 ab	22.0	21.4	80.6 cd	114.4 ab	92.6	88.1 bcd	88.6	90.1
67% Helix lite	--	51.0 b	58.9 b-e	46.8 cde	64.4 ab	82.5 abc	69.0 cde	13.4 b	23.6	22.5	81.6 ab	114.4 ab	93.0	90.0 abc	94.1	86.9
67% Prosper 200	--	49.8 d	59.5 bcd	47.4 bc	63.1 bc	81.5 bc	70.3 abc	13.4 b	22.0	22.9	80.9 bcd	113.6 b	93.8	85.8 cd	96.0	91.1
67% Helix xtra	--	49.3 d	57.3 ef	45.9 f	62.8 c	78.8 d	68.9 de	13.5 ab	21.5	23.0	80.5 cd	111.1 c	92.8	90.1 abc	97.1	90.4
67% Prosper 400	--	49.5 d	58.1 cde	46.9 cd	63.1 bc	80.1 cd	69.3 b-e	13.6 ab	22.0	22.4	80.3 d	113.4 b	92.5	88.4 bcd	94.5	88.6
100% Helix lite	--	52.3 a	58.5 cde	46.3 def	64.5 a	81.0 bcd	68.4 de	12.3 c	22.5	22.1	82.5 a	113.8 b	92.0	93.6 a	98.9	88.1
100% Prosper 200	--	49.9 cd	58.9 b-e	47.1 c	63.0 c	80.1 cd	69.4 b-e	13.1 bc	21.3	22.2	81.1 bcd	113.9 b	92.0	88.3 bcd	94.3	89.0
100% Helix xtra	--	49.3 d	56.1 f	45.9 f	63.6 abc	78.5 d	68.1 e	14.4 a	22.4	22.3	80.8 bcd	111.0 c	93.0	91.1 ab	97.5	90.0
100% Prosper 400	--	49.4 d	57.9 de	46.1 ef	63.0 c	80.3 bcd	68.1 e	13.6 ab	22.4	22.0	80.8 bcd	113.3 b	91.6	90.1 abc	94.0	90.1
LSD (P < 0.05)		*0.8*	*1.7*	*0.7*	*1.3*	*2.5*	*1.4*	*0.9*	*NS*	*NS*	*0.9*	*1.9*	*NS*	*4.8*	*NS*	*NS*
CV		*1.5*	*2.9*	*1.5*	*2.0*	*3.1*	*2.0*	*7.0*	*7.4*	*5.5*	*1.1*	*1.6*	*1.7*	*5.4*	*8.8*	*4.9*
Mean		*50.0*	*58.7*	*47.0*	*63.4*	*81.0*	*69.4*	*13.4*	*22.3*	*22.4*	*80.9*	*113.6*	*92.9*	*88.7*	*94.5*	*89.0*
Variety																
225		50.8	61.6	48.1	64.1	84.7	72.4	13.3	23.2	24.3	81.4	116.6	94.9	90.8	93.7	92.2
357		49.1	55.9	45.9	62.7	77.4	66.4	13.6	21.5	20.4	80.5	110.6	90.8	86.6	95.3	85.9
t-test		**	**	**	**	**	**	***NS***	**	**	**	**	**	**	***NS***	**

Means within a column followed by the same letter are not significantly different (P < 0.05); NS = not significant

[1] *DAP=Days After Planting*

Table 15. Effect of the proportion of treated seed on canola performance at Minot, Langdon and Carrington, 2004

Percent	df	10% Flower DAP[1]			90% Flower DAP[1]			Flower Duration Days			Maturity Days			Height cm		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
0	7	50.6	61.3	48.5	63.9	84.8	70.8	13.3	23.5	22.2	81.4	115.8	93.4	83.9	92.5	87.6
33	31	49.8	59.3	47.7	63.3	81.5	70.0	13.5	22.3	22.3	80.6	114.1	93.3	88.0	92.4	88.9
67	31	49.9	58.4	46.7	63.3	80.7	69.3	13.5	22.3	22.6	80.8	113.1	93.0	88.6	95.4	89.3
100	31	50.2	57.8	46.3	63.5	80.0	68.5	13.3	22.1	22.2	81.3	113.0	92.2	90.8	96.2	89.3
LSD (P < 0.05)		*NS*	*NS*	**	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*	*NS*	*NS*
C.V. (%)		*3.2*	*5.9*	*3.0*	*2.6*	*5.8*	*5.0*	*7.9*	*9.1*	*10.5*	*1.5*	*3.3*	*2.9*	*6.1*	*9.3*	*6.3*
Mean		*50.0*	*58.7*	*47.0*	*63.4*	*81.0*	*69.4*	*13.4*	*22.3*	*22.4*	*80.9*	*113.6*	*92.9*	*88.7*	*94.5*	*89.0*

Table 16. Effect of the seed treatment product on canola performance at Minot, Langdon and Carrington, 2004.

Product	df	10% Flower DAP[1]			90% Flower DAP[1]			Flower Duration Days			Maturity Days			Height cm		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	7	50.6	61.3	48.5	63.9	84.8	70.8	13.3	23.5	22.3	81.4	115.8	93.4	83.9	92.5	87.6
Helix lite	23	51.1	59.2	47.0	64.2	82.1	69.3	13.1	22.9	22.3	81.7	114.3	92.7	90.4	93.6	88.2
Prosper 200	23	49.8	59.2	47.5	63.0	80.9	70.1	13.2	21.7	22.6	80.9	114.0	93.3	86.8	95.6	90.0
Helix xtra	23	49.3	57.1	46.2	63.0	79.3	68.8	13.8	22.2	22.7	80.5	111.7	93.0	90.3	97.1	88.8
Prosper 400	23	49.5	58.5	47.0	63.2	80.7	68.9	13.6	22.1	21.9	80.5	113.7	92.3	88.9	92.4	89.6
LSD (P < 0.05)		**	*	**	*	*NS*	*NS*	*NS*	*NS*	*NS*	**	*	*NS*	*	*NS*	*NS*
C.V. (%)		*2.9*	*5.8*	*3.1*	*2.5*	*5.8*	*5.0*	*7.7*	*9.0*	*10.6*	*1.4*	*3.2*	*2.9*	*6.1*	*9.3*	*6.3*
Mean		*50.0*	*58.7*	*47.0*	*63.4*	*81.0*	*69.4*	*13.4*	*22.3*	*22.4*	*80.9*	*113.6*	*92.9*	*88.7*	*94.5*	*89.0*

Means within a column followed by the same letter are not significantly different (P < 0.05); NS = not significant

[1] *DAP=Days After Planting*

Agronomic Data (Tables 17-20):

Tables 17 & 18: There were significant interactions between treatment x variety for only percent oil at Carrington. For yield, only 100% Helix xtra had a significantly higher yield than the untreated check at Langdon. Although there were significant differences in yield at Carrington, these differences were not consistent with results from other locations. Variety '357' had higher yields than variety '225' at Langdon and Carrington. For test weights, there were no significant differences among treatments at Minot. No trends among treatments were observed in test weight at Carrington. No test weight data was recorded for Langdon. At Carrington, variety '225' had a significantly higher test weight than variety '357.' There was no significant difference in test weight among varieties at Minot. For kernel weights, there were no significant differences among treatments or varieties regardless of site. At Minot, variety '357' had a significantly higher kernel weight than variety '225.' For percent oil, there were no consistent trends among treatment at Minot. However, percent oil was significantly higher in all of the 67% and 100% treated seed treatments than the untreated check at Langdon and Carrington. At Minot and Carrington, variety '225' had significantly higher percent oil than variety '357.'

Table 19: Across proportion of treated seed (33%, 67% and 100% treated seed), yield was higher in seed that was treated at Langdon. In contrast, the untreated check had the highest yield at Carrington. There were no significant differences in yield among proportions of treated seed at Minot. In addition, no significant differences were found in test weight among proportions of treated seed. For kernel weight, 33%, 67% and 100% treated seed had higher weight than the untreated check at Langdon. For percent oil, Langdon and Carrington had significant differences with 33%, 67% and 100% treated seed having higher percent oil values than untreated seed. There were no significant differences in kernel weight and percent oil at Minot.

Table 20: Across seed treatment products, there were no significant differences in yield, test weight, and kernel weight at all sites. For Langdon and Carrington, the seed treatment products had significantly higher percent oil than the untreated check. Although there were significant differences in percent oil at Minot, these differences were not consistent with the results at Langdon and Carrington.

Table 17. Analysis of variance P-values in the response of two canola cultivars to flea beetle control treatments trial in Minot, Langdon and Carrington, 2004.

Source of Variation	df	Yield lb/A			Test Wt lb/bu			Kernel Wt g/1000			Oil Percent		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Rep	3	<.0001	0.0723	0.7057	0.1265		0.9474	0.142	0.1070	0.8923	0.3120	0.7753	0.0182
Treatment	12	0.8797	0.0183	0.0115	0.2552	No	0.0422	0.749	0.1987	0.1956	0.0152	0.0004	0.0002
Variety	1	0.9409	<.0001	0.0077	0.1032	Data	0.0187	<.0001	0.9514	0.5612	<.0001	0.5194	0.0079
Treatment x Variety	12	0.8158	0.6097	0.8049	0.6718	Available	0.5743	0.484	0.2680	0.4578	0.9080	0.0559	0.0361

Table 18. Agronomic data at Minot, Langdon and Carrington, 2004.

Seed Treatment	Variety	Yield lb/A						Test Wt lb/bu						Kernel Wt g/1000			Oil Percent					
		Minot	Lang		Carr			Minot	Lang		Carr			Minot	Lang	Carr	Minot		Lang		Carr	
Untreated	--	1570	1824	bcd	2521	a		52.1			50.2	a-d		3.03	2.78	3.20	44.9	abc	43.2	c	45.7	e
33% Helix lite	--	1496	1749	d	2130	bc		52.1			50.2	a-d		3.01	2.96	3.14	44.8	abc	44.9	b	46.6	abc
33% Prosper 200	--	1610	2049	bcd	2123	bc		52.1			50.4	abc		3.08	2.94	3.13	45.1	ab	45.0	b	46.0	de
33% Helix xtra	--	1617	1956	bcd	2215	abc		52.0			50.6	a		2.99	2.94	3.07	44.2	c	45.6	ab	46.6	a-d
33% Prosper 400	--	1633	1792	cd	2342	ab		51.7	No		50.1	bcd		3.04	2.94	5.13	45.4	a	45.3	b	46.3	cd
67% Helix lite	--	1530	1938	bcd	2451	ab		52.0	Data		49.8	d		3.00	2.94	3.21	44.2	c	45.4	b	46.8	abc
67% Prosper 200	--	1424	1892	bcd	1941	c		52.1	Available		50.1	bcd		3.01	2.88	3.09	45.3	a	45.5	b	46.5	a-d
67% Helix xtra	--	1603	2148	abc	2311	ab		52.1			50.3	abc		3.02	2.98	3.09	44.4	bc	46.6	a	46.8	abc
67% Prosper 400	--	1651	2054	bcd	2158	bc		52.2			50.0	bcd		3.06	3.05	3.07	44.7	abc	45.4	b	46.4	bcd
100% Helix lite	--	1770	2163	abc	1950	c		52.0			50.4	ab		2.98	2.91	3.04	44.1	c	45.4	b	46.9	ab
100% Prosper 200	--	1621	2188	ab	2113	bc		52.1			49.9	cd		3.09	2.94	3.11	44.8	abc	45.2	b	46.7	abc
100% Helix xtra	--	1364	2494	a	1896	c		51.7			50.5	ab		2.98	2.89	3.00	44.4	bc	45.6	ab	47.1	a
100% Prosper 400	--	1569	2201	ab	2129	bc		51.7			50.2	a-d		3.01	2.86	3.09	44.4	bc	45.7	ab	46.6	a-d
LSD (P < 0.05)		*NS*	*390*		*349*			*NS*			*0.5*			*NS*	*NS*	*NS*	*0.8*		*1.1*		*0.5*	
CV		*25.3*	*19.2*		*16.1*			*0.9*			*0.9*			*4.1*	*5.5*	*4.6*	*1.8*		*2.5*		*1.2*	
Mean		*1574*	*2034*		*2175*			*52.0*			*50.2*			*3.00*	*2.90*	*3.10*	*44.7*		*45.3*		*46.5*	
Variety																						
225		1577	1774		2082			51.9			50.3			2.89	2.92	3.10	45.2		45.2		46.7	
357		1571	2294		2269			52.1			50.1			3.15	2.92	3.11	44.1		45.4		46.4	
t-test		***NS***	**		**			***NS***			*			**	***NS***	***NS***	**		***NS***		**	

Means within a column followed by the same letter are not significantly different (P < 0.05); NS = not significant

Table 19. Effect of the proportion of treated seed on canola performance at Minot, Langdon and Carrington, 2004.

Percent	df	Yield (lb/A)			Test Wt (lb/bu)			Kernel Wt (g/1000)			Oil (Percent)		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
0	7	1570	1824	2521	52.1		50.2	3.03	2.78	3.20	44.9	43.2	45.7
33	31	1589	1886	2203	52.0	No	50.3	3.03	2.95	3.12	44.9	45.2	46.4
67	31	1552	2008	2216	52.1	Data	50.1	3.02	2.96	3.11	44.7	45.7	46.6
100	31	1581	2261	2022	51.9	Available	50.3	3.01	2.90	3.06	44.4	45.5	46.8
LSD (P < 0.05)		*NS*	**	**	*NS*		*NS*	*NS*	*	*NS*	*NS*	**	**
C.V. (%)		*24.3*	*23.1*	*16.7*	*0.9*		*1.0*	*6.0*	*5.4*	*4.6*	*2.3*	*2.7*	*1.3*
Mean		*1574*	*2034*	*2175*	*52.0*		*50.2*	*3.02*	*2.90*	*3.10*	*44.7*	*45.3*	*46.5*

Table 20. Effect of the seed treatment product on canola performance at Minot, Langdon and Carrington, 2004.

Product	df	Yield (lb/A)			Test Wt (lb/bu)			Kernel Wt (g/1000)			Oil (Percent)		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	7	1570	1824	2521	52.1		50.2	3.03	2.78	3.20	44.9	43.2	45.7
Helix lite	23	1598	1950	2177	52.0	No	50.2	2.99	2.94	3.13	44.3	45.2	46.8
Prosper 200	23	1552	2043	2059	52.1	Data	50.1	3.06	2.92	3.11	45.1	45.2	46.4
Helix xtra	23	1528	2199	2141	51.9	Available	50.5	3.00	2.94	3.05	44.3	45.9	46.8
Prosper 400	23	1618	2015	2210	51.9		50.1	3.04	2.95	3.10	44.8	45.5	46.4
LSD (P < 0.05)		*NS*	*NS*	*NS*	*NS*		*NS*	*NS*	*NS*	*NS*	*	**	**
C.V. (%)		*24.3*	*24.0*	*21.0*	*0.9*		*1.0*	*6.0*	*5.5*	*4.6*	*2.2*	*2.7*	*1.3*
Mean		*1574*	*2034*	*2175*	*52.0*		*50.2*	*3.02*	*2.92*	*3.10*	*44.7*	*45.3*	*46.5*

Means within a column followed by the same letter are not significantly different (P < 0.05); NS = not significant

Based on these data, test weights were generally not influenced by the treatment, proportion of treated seed or seed treatment product, but variety did appear to affect test weights. Although yield was generally higher for the 100% treated seed and yield decreased proportionally as the proportion of treated seed declined regardless of the insecticide. Yield was primarily influenced by variety selection and use of an insecticide seed treatment. Specific seed treatment products did not have a major impact on yield. However, the higher rates of insecticide seed treatment products generally had a higher yield than the lower rates. For example, the high rates of Helix/Prosper averaged 1952 lbs./a across varieties and sites, while the low rates of Helix/Prosper averaged 1897 lbs./a across varieties and sites. Variety selection impacted the kernel weight more than insecticide seed treatment or seed treatment product. Kernel weight was higher for treated seed with either the high or low rates of Helix/Prosper in variety '225', regardless of the insecticide seed treatment product. Variety '357' generally had a slightly higher kernel weight. For example, variety '225' had 3.01 g/1000 seeds for the high rate of Helix/Prosper, 3.02 g/1000 seed for the low rate of Helix/Prosper, and 2.88 g/1000 seeds for the untreated check; in contrast, variety '357' had 3.03 g/1000 seeds for the high rate of Helix/Prosper, 3.03 g/1000 seed for the low rate of Helix/Prosper, and 3.04 g/1000 seeds for the untreated check (no differences due to variety impact). The proportion of treated seed or the insecticide seed treatment product and variety selection affected percent oil. Seed with an insecticide seed treatment and higher proportions of treated seed (67% and 100%) generally had higher percent oil than the untreated check. Variety '225' generally had higher percent oil content than variety '357.'

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