2003 Reducing Insecticide Inputs for Control of the Crucifer Flea Beetle in Canola

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Abstract

Canola is an important crop of North Dakota agriculture. The crucifer flea beetle, *Phyllotreta cruciferae* Goeze, is the major insect pest of canola, and can significantly decrease plant stands, cause uneven growth and maturity, and decrease yields. Canola is becoming expensive to produce due to its high input costs including insecticides, seed, and fertilizer. The objective of this proposal was to determine if insecticide seed treatment costs ($7.00+ per acre) could be reduced and still effectively control the crucifer flea beetle in areas with different pressures. The high and low rates of Helix with active ingredient thiamethoxam from Syngenta, and Prosper with active ingredient clothianidin from Gustafson, were evaluated at 33 percent treated seed : 67 percent untreated seed; 67 percent treated seed : 33 percent untreated seed; and 100 percent treated seed. Results indicate that the 100 percent treated seed had higher plant stand counts, improved vigor (higher plant dry weight), and a lower incidence (percent of plants damaged) compared to the 67 percent and the 33 percent treated seed. Using 100 percent treated seed and the high rate of insecticide seed treatments was discovered to be crucial for protecting canola in moderate to heavy flea beetle pressure areas (Minot, Langdon, Carrington). These data demonstrate that as the ratio of insecticide treated seed was reduced, the damage ratings were subsequently increased. Sixty-seven percent and 33 percent treated seed were not as effective in reducing the overall damage rating compared to 100 percent treated seed. For example, 100 percent treated seed had an average damage rating across locations of 2.9, 67 percent treated seed had 3.1, 33 percent treated seed had 3.7 and the untreated check had 4.6. When averaged across locations, the high rate of insecticide seed treatments had a slightly lower damage rating of 3.1 compared to the damage rating of 3.4 for the low rate of insecticide seed treatments. Seed treated with 100 percent Helix xtra usually had the lowest damage ratings among the insecticide treatments. Canola seed treated with insecticides and 100 percent treated seed flowered earlier and were taller at the end of flowering than untreated seed, 67 percent and 33 percent treated seed. There were little differences in flower duration and maturity date, probably due to the hot July weather, which accelerated plant development. When yield was averaged across locations, 100 percent treated seed had the highest yield (1338 lbs./A), followed by 67 percent treated seed (1095 lbs./A), 33 percent treated seed (872 lbs./A), and the untreated check (568 lbs./A). The high and low rates of insecticide had a difference of 313 lbs./A (high rate averaged 1258 lbs./A versus low rate of 945 lbs./A). In addition, the high rate yielded 690 lbs./A more than the untreated check, compared to the low rate with a difference of 377 lbs./A from the untreated check. Yields were similar between insecticides when averaged across locations and percent treated seed: 1289 lbs./A for Helix xtra versus 1228 lbs./A for Prosper 400, and 996 lbs./A for Helix lite versus 893 lbs./A for Prosper 200. There was little difference in test weight, seed weight, and percent oil among percent treated seed, high and low rates of insecticides, and insecticide treatments.

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 percent of US canola and production was valued at $116M in 1998, $81M in 1999, $108M in 2000, $158M in 2001, $151M in 2002 and near $160M in 2003. The high market demand for canola makes it an increasingly important crop for growers in North Dakota. Canola will help add diversity and provide 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 measure is the use of insecticides for managing the over wintering 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). 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 becoming expensive to produce due to its high input costs including 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 of $35.55 per acre and hard red spring wheat of $32.70 per acre. In general, canola growers must plan for about $20 per acre higher expenses than other crops. The objective of this proposal is to determine if insecticide seed treatment costs ($7.00+ per acre) can be reduced and still effectively control the major insect pest of canola, crucifer flea beetle, in areas with different pressures. This has never been tested before in North Dakota and would result in lower input costs as well as lower 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 research extension centers in Minot, Langdon, and Carrington. *Brassica napus* cv. RaideRR (Integra Seed Ltd., open-pollinated) was seeded on May 2, 2003, in Minot, May 13, 2003, in Langdon and May 1, 2003, in Carrington. The seeding rate was approximately 14-17 pure live seeds per sq. foot. A RCB design with four replicates was used. Experimental units were 3.5-4.1 ft. (7 rows) x 20-22 ft. Two seed treatments, Helix with active ingredient thiamethoxam from Syngenta and Prosper with active ingredient clothianidin from Gustafson were evaluated at their low and high rates that are commercially available. Three different ratios were also evaluated for each seed treatment: 33 percent treated seed: 67 percent untreated seed; 67 percent treated seed: 33 percent untreated seed; and 100 percent treated seed. This included a total 13 treatments:

1) Untreated check

33% treated seed: 67% untreated seed

2) Helix lite (200 g ai/100 kg seed) seed treatment
3) Prosper 200 (200 g ai/100 kg seed) seed treatment
4) Helix xtra (400 g ai/100 kg seed) seed treatment
5) Prosper 400 (400 g ai/100 kg seed) seed treatment

67% treated seed : 33% untreated seed

6) Helix lite (200 g ai/100 kg seed) seed treatment
7) Prosper 200 (200 g ai/100 kg seed) seed treatment
8) Helix xtra (400 g ai/100 kg seed) seed treatment
9) Prosper 400 (400 g ai/100 kg seed) seed treatment

100% treated seed

10) Helix lite (200 g ai/100 kg seed) seed treatment
11) Prosper 200 (200 g ai/100 kg seed) seed treatment
12) Helix xtra (400 g ai/100 kg seed) seed treatment
13) Prosper 400 (400 g ai/100 kg seed) seed treatment

Flea beetle populations were monitored weekly using sticky yellow trap cards. To evaluate flea beetle damage, assessments were taken on approximately 25, 31, 38, and 45 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 (or 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.

Shoot dry weights of 10 seedlings per plot were recorded to indicate the overall vigor of the plants on 25 and 31 DAP only.

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 in inches at the end of flowering.

Roundup (1 pt./A) + AMS was applied for weed control early in the season. A Ronilan application was not necessary for disease control in 2003 due to the environmental conditions at Minot and Carrington. However, Ronilan (12 oz/A at 20-50% bloom) was sprayed in Langdon. Best management practices were used regarding fertility and harvest operations. Plots were harvested on August 12 in Minot, September 2 in Langdon, and August 18 in Carrington. Yield (lb/A), test weight (lb/bu), and seed weight (gm/1000 seeds) were obtained at the end of the season to facilitate agronomic comparisons.

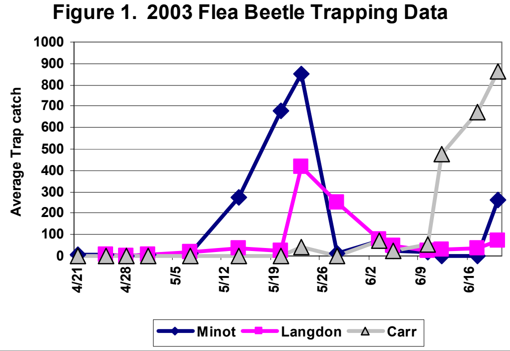
Data Analysis: Data were compared between treatments using Analysis Variance (ANOVA) (Zar 1984), and Fisher's Protected LSD (SAS institute 1991).

Results and Discussion

Flea Beetle Populations:

During 2003, the spring emergence of flea beetle was delayed due to the cool, wet early May. In late May, flea beetles were ready to emerge as the canola seedlings were emerging. This was the major peak of activity, and spring emergence continued until late June. Flea beetle populations were high in Minot and Langdon, and even moderate-high in Carrington during 2003 (Fig. 1). The total number of flea beetles

Figure 1. 2003 Flea Beetle Trapping Data



captured from May 1 to July 1 includes: 11,047 for Minot, 5,159 for Langdon, and 11,051 for Carrington. The average trap catch was 85 beetles per trap day in Langdon, 181 beetles per trap day in Minot and Carrington. Langdon had a lower than expected total number of flea beetles and average trap catch, because canola seedlings in the trapping area were almost completely defoliated by flea beetles making the trapping area less attractive. However, flea beetle pressures were very high in Langdon, killing most of the canola seedlings in the untreated plots. Trap data from Carrington recorded lower numbers of flea beetles in May due to the delayed planting and emergence of the untreated canola for the trapping area.

Plant Stand, Incidence, and Dry Weight (Table 1 & 2): For plant stands at Minot on 25 DAP, the 100% treated seed of Helix xtra and Prosper 400 had significantly higher plant stand, about 13 plants per square foot, compared to the untreated check, 8 plants per square foot. At Minot on 31 DAP, the following treatments had significantly higher plant stand counts than the untreated check: 100 percent Helix xtra; 100 percent, 67 percent, and 33 percent Prosper 400; 100 percent, 67 percent, and 33 percent Prosper 200. At Langdon and Carrington, no difference were observed in plants per square foot on 25 and 31 DAP, probably due to heavy flea beetle pressures in plots. Incidence measures the percent of plant damaged by flea beetles. At Minot, the following treatments had a significantly lower incidence at 25 DAP than the untreated check: 33 percent Helix xtra, 33 percent Prosper 400, and all treatments at 67 percent and 100 percent treated seed. Treatments with 100 percent and 67 percent Helix xtra, 100 percent Prosper 400, and 100 percent Prosper 200 also had lower incidences than 67 percent Prosper 200, and all treatments at 33 percent treated seed. At Langdon and Carrington, no differences were observed for incidences at 25 DAP, probably due to heavy flea beetle pressures and flea beetles moving into plots earlier than at Minot. At 31 DAP, there were no significant differences in incidence regardless of the location, which suggests heavy flea beetle infestations in the plots.

For dry weight at Minot on 25 DAP, 100 percent Prosper 200, 67 percent Helix xtra, and 67 percent Helix lite had significantly higher dry weight than the untreated check, but were not significantly different from the remaining seed treatments. There were no differences in dry weight at 25 DAP at Langdon and Carrington. At 31 DAP, dry weight of all seed treatment ratios was significantly higher than the untreated check at Minot. Seed treatments with 100 percent Helix xtra and 100 percent Prosper 400 had the highest dry weight. At Langdon and Carrington on 31 DAP, only 100 percent Helix xtra had significantly higher dry weight than the untreated check.

These data indicate that the 100 percent treated seed had higher plant stand counts, improved vigor (higher plant dry weight), and a lower incidence (percent of plants damaged) compared to the 67 percent and the 33 percent treated seed. In Table 2, these data are averaged across locations. In general, the insecticide treatments and treatments with 100 percent treated seed had higher plant stand counts. The high rate of seed treatment also had slightly higher plant stand counts, average of 9.6 for both Helix xtra and Prosper 400, compared to low rate of seed treatment, average of 9.2 for Helix lite and 9.4 for Prosper 200. At 25 DAP, the insecticide treatments and treatments with 100 percent treated seed also had lower incidences (or percent of plant damaged) than the untreated check. For example, 100 percent treated seed averaged 70 percent, 67 percent treated seed averaged 75 percent, and 33 percent treated seed averaged 91 percent compared to the untreated check of 100 percent damage. The high rate of insecticides also had a lower incidence of 74 percent compared to the low rate of insecticide of 83 percent. Differences between Helix xtra (73%) versus Prosper 400 (75%) and Helix lite (82%) versus Prosper 200 (83%) were small when averaged across locations. At 31 DAP, incidence of insecticide treatments was similar to the untreated check due to waning insecticide residuals and heavy flea beetle pressures. For dry weight, the differences were more observable at 31 DAP. Again, the insecticide treatments and treatments with 100 percent treated seed had higher plant dry weights. For example, 100 percent treated seed averaged 0.345 g/10 plants, 67 percent treated seed averaged 0.290 g/10 plants, and 33 percent treated seed averaged 0.234 g/10 plants compared to the untreated check of 0.083 g/10 plants. The high rate of insecticides also had a higher dry weight of 0.312 g/10 plants compared to the low rate of insecticide of 0.268 g/10 plants. Differences between Helix xtra (0.327 g/10 plants) versus Prosper 400 (0.298 g/10 plants) and Helix lite (0.281 g/10 plants) versus Prosper 200 (0.254 g/10 plants) were small when averaged across locations.

Table 1. Plant Stand and Incidence

Treatment	25 DAP ----------Plant Stand------- Pl/ft^2			25 DAP -------% Incidence-----			31 DAP --------Plant Stand------- Pl/ft^2			31 DAP -------% Incidence-------		
	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	8.0	11.4	8.6	100	100	100	5.9	9.3	8.7	100	100	100
33% Helix lite	9.5	11.7	8.8	83	100	100	7.5	9.7	7.7	100	100	100
33% Prosper 200	12.6	13.4	10.0	94	100	100	11.4	8.3	8.8	100	100	99
33% Helix xtra	11.4	11.8	9.0	62	100	99	9.6	8.9	8.3	96	100	100
33% Prosper 400	11.2	11.8	8.5	56	100	100	11.3	10.0	7.4	98	100	100
67% Helix lite	10.6	10.9	10.9	28	100	93	9.3	9.7	10.0	100	100	100
67% Prosper 200	11.3	10.4	8.2	56	100	100	11.8	8.8	7.4	99	100	99
67% Helix xtra	10.6	10.1	11.3	16	100	86	9.1	9.8	8.5	89	100	100
67% Prosper 400	11.9	10.7	10.1	24	100	95	11.1	8.1	9.4	76	100	100
100% Helix lite	10.8	11.1	7.8	37	100	99	9.2	10.7	9.0	75	100	100
100% Prosper 200	12.7	11.9	7.7	15	98	82	11.3	8.9	8.0	75	100	100
100% Helix xtra	13.2	11.5	9.9	18	99	82	11.6	10.9	9.6	89	95	100
100% Prosper 400	13.8	10.5	7.3	15	99	90	12.1	11.6	8.1	56	100	100
LSD (P=.05)	2.8	NS	NS	26	NS	NS	2.8	NS	NS	NS	NS	NS
CV	17.2	14.0	19.2	38.7	1.4	14.1	19.4	24.1	20.3	20.2	2.8	1.1
Grand Mean	11.4	11.3	9.1	46	100	94	10.1	9.6	8.5	89	100	100

DAP=Days After Planting

Table 1 Continued. Dry Weight

Treatment	25 DAP -------------Dry Wt---------g/10 plants Minot	Lang	Carr	31 DAP -----------Dry Wt----------- g/10 plants Minot	Lang	Carr
Untreated	0.133	0.009	0.008	0.203	0.023	0.024
33% Helix lite	0.185	0.014	0.009	0.741	0.019	0.017
33% Prosper 200	0.185	0.013	0.008	0.538	0.016	0.019
33% Helix xtra	0.235	0.016	0.008	0.658	0.016	0.022
33% Prosper 400	0.218	0.015	0.008	0.715	0.021	0.027
67% Helix lite	0.243	0.015	0.016	0.793	0.017	0.037
67% Prosper 200	0.195	0.014	0.008	0.800	0.014	0.026
67% Helix xtra	0.240	0.013	0.011	0.890	0.027	0.035
67% Prosper 400	0.200	0.017	0.011	0.800	0.019	0.034
100% Helix lite	0.205	0.016	0.008	0.858	0.021	0.027
100% Prosper 200	0.255	0.016	0.011	0.830	0.017	0.030
100% Helix xtra	0.210	0.015	0.010	1.213	0.034	0.046
100% Prosper 400	0.205	0.016	0.009	1.015	0.019	0.034
LSD (P=.05)	0.063	NS	NS	0.219	0.007	0.012
CV	21.1	28.6	31.2	19.8	23.9	28.6
Grand Mean	0.210	0.010	0.010	0.770	0.020	0.030

DAP=Days After Planting

Table 2. Average Plant Stand Count, Incidence, and Dry weight across Locations

Treatment	DAP 25 Average Plant Stand Pl/ft^2	DAP 31 Average Plant Stand Pl/ft^2	DAP 25 Average % Incidence	DAP 31 Average % Incidence	DAP 25 Average Dry Wt g/10 plants	DAP 31 Average Dry Wt g/10 plants
Untreated	9.3	7.9	100	100	0.050	0.083
33% Helix	10.0	8.3	94	100	0.069	0.259
33% Prosper low	12.0	9.5	98	100	0.069	0.191
33% Helix xtra	10.7	8.9	87	99	0.086	0.232
33% Prosper high	10.5	9.6	85	99	0.080	0.254
67% Helix	10.8	9.7	74	100	0.091	0.282
67% Prosper low	9.9	9.3	85	99	0.072	0.280
67% Helix xtra	10.7	9.1	67	96	0.088	0.317
67% Prosper high	10.9	9.5	73	92	0.076	0.284
100% Helix	9.9	9.7	79	92	0.076	0.302
100% Prosper low	10.8	9.4	65	92	0.094	0.292
100% Helix xtra	11.5	10.7	66	95	0.078	0.431
100% Prosper high	10.6	10.6	68	85	0.077	0.356

DAP=Days After Planting

<u>Damage Ratings</u> (Table 3 & 4):
At Minot, all of the treatments had significantly lower damage rating than the untreated check regardless of the DAP. In general, the 100 percent Helix xtra and 100 percent Prosper 400 also had significantly lower damage ratings than the other treatments with reduced ratios of treated seed. As the percent of treated seed decreased, the damage ratings increased. For example, on 38 DAP, 100 percent Helix xtra had a damage rating of 1.4, 2.8 for 67 percent Helix xtra, and 3.2 for 33 percent Helix xtra. Similarly, 100 percent Prosper 400 on 38 DAP had a damage rating of 1.6, 2.3 for 67 percent Prosper 400, and 3.2 for 33 percent Prosper 400.

At Langdon, there were no significant differences in damage ratings at 25 and 31 DAP due to the early and heavy pressures from flea beetles. At 38 and 45 DAP, only 100 percent and 67 percent Helix xtra had a significantly lower damage rating than the untreated check. On 45 DAP 100 percent Helix xtra also had a significantly lower damage rating than the other insecticide treatments.

At Carrington, only 100 percent Helix xtra, 100 percent Prosper 400, and 67 percent Helix lite had a significantly lower damage rating than the untreated check and 33 percent Helix lite at 25 DAP. At 31 and 38 DAP, none of the treatments were significantly different from the untreated check. However, 100 percent Helix xtra had a significantly lower damage rating than 33 percent Helix lite and 33 percent Prosper 400 at 31 DAP. At 38 DAP, 100 percent and 67 percent Helix xtra had a significantly lower damage rating than 33 percent Helix lite and 33 percent Prosper 400. At 45 DAP, there were no significant differences between treatments, which suggests that insecticide residuals were probably no longer active against flea beetles.

These data show that as the ratio of insecticide treated seed was reduced, the damage ratings increased. Compared to 100 percent treated seed, 67 percent and 33 percent treated seed were not as effective in reducing the overall damage rating. For example, 100 percent treated seed had an average damage rating of 2.9, 67 percent treated seed had 3.1, 33 percent treated seed had 3.7 and the untreated check had 4.6 (Table 4). Overall, the high rate of insecticide seed treatments had a lower damage rating of 3.1 compared to the damage rating of 3.4 for the low rate of insecticide seed treatments. In general 100 percent Helix xtra treated seed had the lowest damage ratings among the insecticide treatments. However, damage ratings were similar when averaged across sites and DAPs. For example, Helix xtra had an average damage rating of 2.9 versus 3.1 for Prosper 400, and 3.3 for Helix lite versus 3.5 for Prosper 200.

Table 3. Flea Beetle Damage Ratings

Treatment	25 DAP ------ Visual Rating 1--- 1-6*			31 DAP ----Visual Rating 2-- 1-6*			38 DAP ----Visual Rating 3---- 1-6*			45 DAP -------Visual Rating 4--- 1-6*		
	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	5.9	2.8	2.9	5.5	5.8	3.8	5.6	5.4	2.9	5.4	5.3	3.4
33% Helix lite	2.6	2.3	2.8	3.7	5.6	4.1	3.9	5.4	3.6	3.3	5.3	3.9
33% Prosper 200	2.4	2.8	2.3	3.7	5.9	3.9	3.6	5.5	3.1	2.8	5.5	3.9
33% Helix xtra	2.4	2.2	2.0	3.6	5.7	3.8	3.2	5.5	2.8	2.3	5.3	3.8
33% Prosper 400	2.4	1.9	2.6	3.3	5.9	4.1	3.2	5.4	3.8	2.1	5.4	3.8
67% Helix lite	1.8	2.0	1.4	2.8	5.8	3.1	2.9	5.5	2.0	2.4	5.4	2.4
67% Prosper 200	2.0	2.0	1.9	3.2	5.9	3.8	3.1	5.5	2.8	2.0	5.5	3.1
67% Helix xtra	1.5	1.9	1.8	2.8	5.5	2.9	2.8	4.7	2.3	1.9	4.6	2.4
67% Prosper 400	1.4	2.0	1.6	2.7	5.5	3.3	2.3	5.5	2.6	1.3	5.1	3.3
100% Helix lite	1.1	2.0	1.9	2.3	5.5	3.6	2.1	5.0	3.1	1.6	4.9	3.1
100% Prosper 200	1.6	2.0	1.7	3.2	5.8	3.7	2.6	5.4	3.2	1.8	5.4	3.1
100% Helix xtra	1.3	2.1	1.4	2.1	5.4	2.8	1.4	4.5	1.8	1.3	3.9	2.3
100% Prosper 400	1.0	1.8	1.4	2.0	5.5	3.3	1.6	5.1	2.4	1.4	4.9	3.5
LSD (P=.05)	0.6	NS	0.8	0.6	NS	0.7	0.8	0.4	0.9	0.8	0.4	NS
CV	21.0	19.1	27.5	13.8	3.6	14.0	18.0	4.6	22.7	25.5	5.4	23.0
Grand Mean	2.1	2.1	2.0	3.1	5.7	3.6	2.9	5.3	2.8	2.3	5.1	3.2

*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. DAP=Days After Planting

Table 4. Average Damage Ratings across Locations					
Treatment	25 DAP Average Visual Rating 1 1-6*	31 DAP Average Visual Rating 2 1-6*	38 DAP Average Visual Rating 3 1-6*	45 DAP Average Visual Rating 4 1-6*	Grand Average Rating
Untreated	3.9	5.0	4.6	4.7	4.6
33% Helix	2.5	4.5	4.3	4.2	3.9
33% Prosper low	2.5	4.5	4.1	4.0	3.8
33% Helix xtra	2.2	4.3	3.8	3.8	3.5
33% Prosper high	2.3	4.4	4.1	3.7	3.6
67% Helix	1.8	3.9	3.5	3.4	3.1
67% Prosper low	2.0	4.3	3.8	3.5	3.4
67% Helix xtra	1.7	3.7	3.3	3.0	2.9
67% Prosper high	1.7	3.8	3.4	3.2	3.0
100% Helix	1.7	3.8	3.4	3.2	3.0
100% Prosper low	1.8	4.2	3.7	3.4	3.3
100% Helix xtra	1.6	3.4	2.6	2.5	2.5
100% Prosper high	1.4	3.6	3.0	3.3	2.8

*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.
DAP=Days After Planting

Crop Phenology (Table 5 & 6):
At Minot, all of the insecticide treatments flowered significantly earlier than the untreated check for 10 percent and 90 percent flowering. However, there was no significant difference in flower duration or days to maturity, probably due to the hot July weather which accelerated plant development. For plant height at the end of flowering, 100% Helix xtra and 100% Prosper 400 had significantly taller plants (average of 104 cm) than the untreated check (average of 61 cm). However, there were no significant differences among insecticide treatments.

At Langdon, only 100 percent and 67 percent Helix xtra had a significantly earlier 10 percent flower date than the untreated check. For end of flowering date (90% flower), none of the insecticide treatments were significantly different from the untreated check. One hundred percent and 67 percent Helix xtra had significantly longer flower duration, an average of 29 days, compared to the untreated check of 23 days, treatments with 33 percent treated seed of 24 days, and treatments with 67 percent treated seed of 24 days (except 67% Helix xtra). For maturity, only 100 percent Helix xtra (102 days) had a shorter period to maturity than the untreated check (105 days). There were no significant differences for height at end of flowering.

At Carrington, only 100 percent Helix xtra flowered (10% flowering) significantly earlier than the untreated check. The remaining insecticide treatments were not significantly different. There were no significant differences among treatments for end of flower (90% flower) and flower duration and days to maturity. However, 100 percent Helix xtra had a significantly shorter maturity period than 33 percent Helix lite. There were also no significant differences among treatments for plant height at the end of flowering.

In Table 6, the crop phenology data is averaged across locations. The 100 percent treated seed had a shorter period, average of 55.1 DAP, to 10 percent flowering compared to the average of: 55.8 DAP for the 67 percent treated seed, 57.6 DAP for the 33 percent treated seed, and 61 DAP for the untreated check. The high insecticide rate also flowered earlier, 55.2 DAP, compared to the low insecticide rate, 57.1 DAP. There were few differences among insecticide treatments. The main difference was between insecticide treated seed and untreated seed: 56.1 DAP for the insecticide treated seed versus 61 DAP for the untreated check. Or, the insecticide treated seed flowered five days earlier than the untreated seed. The period to the end of flowering (90% flowering) was similar for the different percents of seed treated, insecticide rates, and insecticide treatments. Again, the main difference was between the treated seed and untreated seed: 78 DAP for the treated seed and 82 DAP for the untreated seed. Or, the insecticide treated seed ended flowering four days earlier than the untreated seed. The flower duration and maturity days were similar to the untreated check among the different percentages of seed treated, insecticide rates, and insecticide treatments. This may have been due to the hot summer temperatures in July pushing the plant's development. For average height at end of flowering, the 100 percent treated seed averaged taller plants (103.7 cm) than the average for 67 percent treated seed (101.3 cm), 33 percent treated seed (99.7 cm), and untreated check (90.1 cm). The high rate of insecticide was taller, 103.6 cm, compared to the low rate of insecticide, 99.6 cm. There were few differences among insecticide treatments when averaged across locations: Helix xtra at 103.6 cm versus Prosper 400 at 103.6 cm, and Helix lite at 100.6 cm versus Prosper 200 at 98.5 cm. The main difference in height was between treated seed being taller, 101.6 cm, and untreated seed being shorter, 90.1 cm. In summary, the canola seed treated with insecticides and with 100 percent treated seed flowered earlier and was taller at the end of flowering than untreated seed.

Table 5. Crop Phenology Data

	---------10% Flower------- DAP			-------90% Flower------ DAP			-----Flower Duration---- Days			----------Maturity--------- Days			-----------Height--------- cm		
Treatment	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	56.5	65.5	61.0	73.3	88.5	84.3	16.8	23.0	23.3	80.0	104.5	99.8	60.9	114.3	95.3
33% Helix lite	48.3	64.5	61.8	66.5	88.0	85.3	18.3	23.5	23.5	80.0	104.0	101.2	78.0	116.5	100.0
33% Prosper 200	46.0	67.0	61.5	61.5	89.3	84.8	15.5	22.3	23.3	78.5	104.0	99.5	85.1	116.3	95.5
33% Helix xtra	44.8	64.5	60.3	60.8	88.5	84.0	16.0	24.0	23.8	78.5	103.3	98.0	84.0	117.3	99.0
33% Prosper 400	45.3	65.8	61.3	61.0	90.5	85.3	15.8	24.8	24.0	80.0	103.8	99.8	96.4	114.0	94.5
67% Helix lite	44.8	66.0	58.5	61.0	90.3	83.0	16.3	24.3	24.5	78.5	103.3	96.5	88.9	115.8	97.3
67% Prosper 200	44.5	67.0	60.5	60.8	90.0	84.0	16.3	23.0	23.5	78.0	103.8	99.3	86.4	113.3	97.3
67% Helix xtra	44.0	57.3	58.5	61.3	86.0	83.3	17.3	28.8	24.8	78.5	102.3	96.3	90.1	118.0	95.8
67% Prosper 400	44.8	63.0	60.5	61.8	87.0	84.5	17.0	24.0	24.0	80.0	102.8	98.5	95.8	19.0	97.5
100% Helix lite	44.8	62.3	60.0	61.3	88.3	84.5	16.5	26.0	24.5	78.5	103.5	100.0	94.6	116.5	97.8
100% Prosper 200	44.8	65.0	61.3	60.5	88.5	85.3	15.8	23.5	24.0	78.5	103.3	99.3	80.3	115.8	98.3
100% Helix xtra	44.3	54.8	57.3	61.8	84.3	82.3	17.5	29.5	25.0	79.5	101.5	95.0	105.1	119.8	101.8
100% Prosper 400	44.5	61.8	60.5	61.5	88.0	84.3	17.0	26.3	23.8	80.0	103.3	98.8	103.0	117.0	94.8
LSD (P=.05)	2.4	2.9	2.0	2.4	2.7	NS	NS	2.3	NS	NS	1.5	3.5	23.1	NS	NS
CV	3.7	3.2	2.4	2.7	2.1	1.4	9.2	6.4	4.0	1.8	1.0	2.4	18.3	2.9	5.7
Grand Mean	45.9	63.4	60.2	62.5	88.2	84.2	16.6	24.8	24.0	79.1	103.3	98.6	88.4	116.4	97.3

DAP=Days After Planting

Table 6. Average Crop Phenology Data across Locations.

Treatment	Average 10% Flower DAP	Average 90% Flower DAP	Average Flower Duration Days	Average Maturity Days	Average Height cm
Untreated	61.0	82.0	21.0	94.8	90.1
33% Helix	58.2	79.9	21.8	95.1	98.2
33% Prosper low	58.2	78.5	20.4	94.0	99.0
33% Helix xtra	56.5	77.8	21.3	93.3	100.1
33% Prosper high	57.5	78.9	21.5	94.5	101.6
67% Helix	56.4	78.1	21.7	92.8	100.6
67% Prosper low	57.3	78.3	20.9	93.7	98.5
67% Helix xtra	53.3	76.9	23.6	92.4	101.9
67% Prosper high	56.1	77.8	21.7	93.8	104.2
100% Helix	55.7	78.0	22.3	94.0	103.0
100% Prosper low	57.0	78.1	21.1	93.7	98.1
100% Helix xtra	52.1	76.1	24.0	92.0	108.9
100% Prosper high	55.6	77.9	22.4	94.0	104.9

DAP=Days After Planting

Agronomic Data (Table 7 & 8):

At Minot, all of the insecticide seed treatments had a significantly higher yield than the untreated check, except 33 percent Helix lite, 33 percent Prosper 200, and 67 percent Prosper 200. It is interesting to note that all of the treatments with the highest yield were the high rate (400 a.i. per 100 kg of seed) of insecticide seed treatments and usually the treatments with 100 percent treated seed plots. For test weight, seed weight, and percent oil, there were also no differences among insecticide treatments. The untreated check was not included in the analysis due to missing values.

At Langdon, only 100 percent and 67 percent Helix xtra and 100 percent Prosper 400 had significantly higher yield than the untreated check. Again, the high rate (400 a.i. per 100 kg of seed) of the insecticide seed treatments and usually the 100 percent treated seed had the highest yields. There were no significant differences among treatments for test weight, seed weight, and percent oil.

At Carrington, only 100% Helix xtra had significantly higher yields than the untreated check. Again, the high rate (400 a.i. per 100 kg of seed) of insecticide seed treatment and usually the 100 percent treated seed had the highest yields. There were no significant differences among treatments for test weight, seed weight, and percent oil.

These data indicate that 100 percent treated seed and the high rate of insecticide seed treatments is crucial for protecting canola in moderate to heavy flea beetle pressures areas. In Table 8, agronomic data are averaged across locations: 100 percent treated seed averaged 1338 lbs./A, 67 percent treated seed averaged 1095 lbs./A, 33 percent treated seed averaged 872 lbs./A, and the untreated check averaged 568 lbs./A. The high and lower rate of insecticide had a difference of 313 lbs./A (average of 1258 lbs./A for high rate versus average of 945 lbs./A for low rate). The high rate had twice the increase (690 lbs./A) over the untreated check compared to the low rate (377 lbs./A). Yields were similar among insecticides averaged across locations and percent treated seed: 1289 lbs./A for Helix xtra versus 1228 lbs./A for Prosper 400, and 996 lbs./A for Helix lite versus 893 lbs./A for Prosper 200. There were few differences in test weight and seed weight among percent treated seed, high and low rates of insecticides, and insecticide treatments.

Table 7. Agronomic Data

Treatment	----Yield---- lb/A			----Test Wt---- lb/bu			----Seed Wt---- g/1000 seeds			----Oil---- %		
	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	163	908	634	-	2.48	2.63	-	53.25	52.40 -	-	42.33	46.99
33% Helix lite	663	1047	633	2.76	2.64	2.46	48.03	52.88	52.69	43.47	43.90	46.32
33% Prosper 200	904	901	666	2.81	2.50	2.55	51.47	53.13	52.13	43.18	41.99	47.10
33% Helix xtra	1107	1147	716	2.89	2.48	2.48	53.32	52.88	52.45	42.69	43.48	46.91
33% Prosper 400	1342	795	542	2.88	2.40	2.54	53.17	53.00	52.13	43.40	40.68	45.65
67% Helix lite	1114	938	878	2.81	2.71	2.63	53.35	52.63	52.33	42.94	41.37	47.76
67% Prosper 200	920	761	792	2.76	2.44	2.74	53.03	53.13	52.33	41.66	41.68	47.23
67% Helix xtra	1468	1530	867	3.06	2.84	2.66	52.83	52.38	52.10	42.28	45.12	46.29
67% Prosper 400	1808	1270	788	2.84	2.55	2.74	53.01	52.88	52.28	43.70	44.47	46.69
100% Helix lite	1593	1267	833	2.84	2.76	2.55	53.07	52.75	52.68	42.94	43.36	46.03
100% Prosper 200	1194	1048	849	2.91	2.45	2.63	53.08	53.00	52.28	43.02	42.16	46.08
100% Helix xtra	1777	1786	1200	2.89	2.85	2.70	52.70	52.38	52.40	42.44	44.98	47.58
100% Prosper 400	2195	1397	913	2.96	2.70	2.63	52.51	52.63	52.70	43.21	44.02	46.91
LSD (P=.05)	588	317	302	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV	32.6	19.5	26.7	15.6	7.5	6.1	14.2	1.0	0.9	16.0	5.0	3.1
Grand Mean	1250	1138	793	2.70	2.60	2.61	49.32	52.84	52.37	40.45	43.04	46.73

Table 8. Average Agronomic Data across Locations

Treatment	Average Yield lb/A	Average Test Wt lb/bu	Average Seed Wt g/1000 seeds
Untreated	568	52.8	2.6
33% Helix	781	51.2	2.6
33% Prosper low	824	52.2	2.6
33% Helix xtra	990	52.9	2.6
33% Prosper high	893	52.8	2.6
67% Helix	977	52.8	2.7
67% Prosper low	824	52.8	2.6
67% Helix xtra	1288	52.4	2.9
67% Prosper high	1289	52.7	2.7
100% Helix	1231	52.8	2.7
100% Prosper low	1030	52.8	2.7
100% Helix xtra	1588	52.5	2.8
100% Prosper high	1502	52.6	2.8

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