2004 Reduced Input Flea Beetle Insecticide Trial

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Abstract

Phyllotreta cruciferae, Crucifer flea beetle, is an important insect pest of spring-planted canola, especially during the seedling stage. The efficacy and agronomic performance of using reduced proportions of insecticide-treated seed on canola, Brassica napus cv. RaideRR (Integra Seed Ltd., open pollinated), was compared using commercially available seed treatments at their low and high rates: 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 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. Results indicate that plant stand was not affected by seed treatments or the proportion of treated seed. Incidence or percent of plants attacked 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. Data was not consistent for shoot dry weights among sites. However, dry weights were higher with the increased proportions of treated seeds and with insecticide seed treatments at Minot. In general, damage ratings were inversely related to the proportion of treated seed and the rates of seed treatment (high or low) regardless of the insecticide treatment. This indicates that the 100% treated seed provided the best protection against flea beetle on canola. Times to flowering and maturity were influenced by proportion of treated seed and seed treatments. Insecticide-treated seed usually had a shorter period to beginning bloom and maturity period, regardless of proportion of treated seed. Early flowering would provide other benefits to the canola producers, such as, avoiding periods of inclement weather for disease development and allowing earlier harvest. Crop heights and test weights were generally not influenced by the proportion of treated seed or insecticide seed treatment. Yield and kernel weight were generally higher for the 100% treated seed and yield decreased proportionally as the proportion of treated seed declined regardless of the insecticide. Use of an insecticide seed treatment appeared to affect yield and kernel weight more than which product was used for the insecticide seed treatment. Higher rates of insecticide seed treatments generally had a higher yield than the low rates of insecticide seed treatments. Whether or not an insecticide seed treatment was used or not influenced percent oil, rather than the proportion of treated seed or the specific insecticide seed treatment. In summary, this research indicates that the proportion of treated seed, high or low rate of insecticide seed treatment, and insecticide seed treatments can influence flea beetle control and agronomic crop performance.

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 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, 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. 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 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. Brassica napus cv. RaideRR (Integra Seed Ltd., open pollinated) 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 sq. 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 a total 13 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

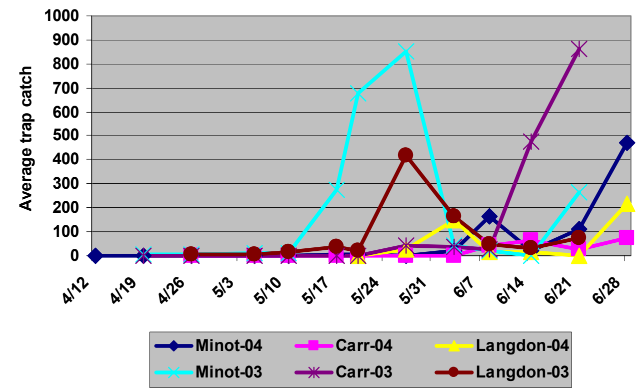
Days to Mature: Days after planting when seeds on lower third of main raceme are dark brown to black, seeds on middle third of main raceme are turning brown or black and seeds on top third of raceme are green but firm and pliable.

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).

Figure 1. 2003-2004 Flea Beetle Trap Counts



Results and Discussion

Flea Beetle Populations:

During 2004, the spring emergence of flea beetle was delayed as in 2003 due to the cool, wet early May weather (Fig. 1). However, flea beetle populations were much lower in 2004 than 2003. In 2004, the flea beetles emerged as the canola seedlings were emerging in late May and the first week of June, and beetle emergence continued until late June. There was no strong peak of spring trap catches in 2004 as there was in 2003 (Fig. 1). The average trap catch for 2004 and 2003, respectively, 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. The cool wet weather caused a prolonged delay in flea beetle emergence and feeding and this may have diminished their energy reserves. Consequently, the very low spring population during 2004 may have been a result of high mortalities in the overwintering sites.

Plant Stand and Incidence (Tables 1-3):

Table 1: At 18 DAP, there were no significant differences in plant stand, regardless of the site. Overall, percent incidence (percent of damaged plant) at 18 DAP was low (average of 5%), due to light flea beetle pressure. For percent incidence at 18 DAP, all of the insecticide treatments had a significantly lower percentage of plants attacked than the untreated check at Minot. At Carrington, some treatments, like 100% Helix xtra and 100% Prosper 400, had lower percent incidences than the untreated check; however, these difference were not always significant. There were no significant differences among treatments for percent incidence at Langdon at 18 DAP. For 27 DAP, there were also no significant differences among treatments for plant stand or percent incidence, regardless of site.

Table 2: 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 Carrington. At Langdon on 18 DAP, there were no significant differences between proportions of treated seed; probably due to flea beetles not moving into plots to feed due to the cool spring weather. At

27 DAP, flea beetles moved into plots uniformly at all sites, but there were no significant differences in percent incidence.

Table 3: There were no significant differences in plant stand counts among different seed treatment products at 18 or 27 DAP, regardless of site. At 18 DAP, seed treatment products had a significantly lower percent incidence than the untreated check at Minot and Carrington. At Langdon on 18 DAP, there were no significant differences between seed treatment products because flea beetles had not yet moved into plots to feed. At 27 DAP, flea beetles moved into plots uniformly at all sites, but there was no significant difference in percent incidence.

Table 1. Plant Stand and Incidence at Minot, Langdon and Carrington, 2004.

Seed Treatment	18 DAP Plant Stand Pl/ft^2			18 DAP % Inc			27 DAP Plant Stand Pl/ft^2			27 DAP % Inc		
	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	13.6	7.2	7.4	14 a	8	13 a	7.2	5.3	5.7	98	100	100
33% Helix lite	12.5	4.6	9.8	6 b	7	3 b	8.1	6.0	5.6	100	100	100
33% Prosper 200	14.2	5.1	6.1	6 b	4	7 ab	8.3	2.9	5.9	100	100	100
33% Helix xtra	13.3	7.0	5.8	6 b	4	7 ab	7.9	4.4	5.0	100	100	100
33% Prosper 400	11.6	6.4	6.5	4 b	5	3 b	8.3	5.0	7.1	100	100	100
67% Helix lite	12.4	5.7	7.2	3 b	5	6 ab	8.4	5.4	5.2	100	100	100
67% Prosper 200	12.0	6.2	4.3	6 b	8	9 ab	7.5	5.1	6.0	100	99	100
67% Helix xtra	13.0	6.6	6.7	5 b	5	5 b	8.3	5.9	5.4	100	100	100
67% Prosper 400	11.2	5.7	5.0	4 b	2	6 ab	7.1	5.8	4.8	99	100	100
100% Helix lite	12.1	6.9	7.1	3 b	5	4 b	8.5	4.9	6.6	100	100	100
100% Prosper 200	10.9	4.6	7.0	5 b	4	6 ab	6.0	3.4	8.1	100	100	99
100% Helix xtra	11.3	5.2	6.2	4 b	4	3 b	8.0	5.5	6.4	100	100	100
100% Prosper 400	12.8	7.9	6.7	4 b	4	2 b	6.4	4.6	6.8	100	100	100
Mean	***12.4***	***6.1***	***6.6***	***5***	***5***	***6***	***7.7***	***4.9***	***6.1***	***100***	***100***	***100***
CV	***20.2***	***31.4***	***32.0***	***40.4***	***64.0***	***63.8***	***24.5***	***38.6***	***48.6***	***1.2***	***0.4***	***0.6***
LSD (P=0.05)	***NS***	***NS***	***NS***	***0.03***	***NS***	***0.05***	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***

DAP=Days After Planting

Table 2. Effect of the proportion of treated seed on canola performance at Minot, Langdon and Carrington, 2004

Percent	df	18 DAP Plant Stand Pl/ft^2			18 DAP % Inc			27 DAP Plant Stand Pl/ft^2			27 DAP % Inc		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
0	4	13.6	7.2	7.4	13.5	8.3	13.3	7.2	5.3	5.7	98.0	100.0	100.0
33	16	12.9	5.8	7.0	5.6	4.7	4.8	8.1	4.6	5.9	100.0	100.0	100.0
67	16	12.1	6.0	5.8	4.4	5.0	6.1	7.8	5.6	5.6	99.8	99.8	100.0
100	16	11.8	6.2	6.8	3.7	4.1	3.7	7.2	4.6	7.0	100.0	100.0	99.8
Mean		***12.4***	***6.1***	***6.6***	***5.3***	***4.9***	***0.06***	***7.7***	***4.9***	***6.1***	***99.8***	***99.9***	***99.9***
C.V. (%)		***19.2***	***32.5***	***33.9***	***40.2***	***65.2***	***64.2***	***23.7***	***38.5***	***44.5***	***1.1***	***0.4***	***0.6***
LSD (P=0.05)		***NS***	***NS***	***NS***	********	***NS***	********	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***

DAP=Days After Planting

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

Product	df	18 DAP Plant Stand Pl/ft^2			18 DAP % Inc			27 DAP Plant Stand Pl/ft^2			27 DAP % Inc		
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	4	13.6	7.2	7.4	13.5	8.3	13.3	7.2	5.3	5.7	98.0	100.0	100.0
Helix lite	12	12.3	5.7	8.0	4.0	5.5	4.3	8.3	5.4	5.8	100.0	100.0	100.0
Prosper 200	12	12.3	5.3	5.8	5.7	5.2	7.1	7.2	3.8	7.0	100.0	99.8	99.7
Helix xtra	12	12.5	6.3	6.3	4.8	4.3	4.6	8.0	5.3	5.6	100.0	100.0	100.0
Prosper 400	12	11.9	6.7	6.1	3.9	3.5	3.6	7.2	5.1	6.2	99.8	100.0	100.0
Mean		***12.4***	***6.1***	***6.6***	***5.3***	***4.9***	***5.5***	***7.7***	***4.9***	***6.1***	***99.8***	***99.9***	***99.9***
C.V. (%)		***19.7***	***31.8***	***32.4***	***41.3***	***64.2***	***63.1***	***23.7***	***37.7***	***45.1***	***1.1***	***0.4***	***0.6***
LSD (P=0.05)		***NS***	***NS***	***NS***	********	***NS***	********	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***

DAP=Days After Planting

In summary, these data indicate that plant stand was not affected by seed treatments or the proportion of treated seed. 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.

Shoot Dry Weight and Flea Beetle Damage Ratings (Tables 4-6):

Table 4: For shoot dry weight on 18 and 27 DAP, there were no significant differences among treatments, regardless of the site. These data indicate that shoot dry weights were not affected by specific seed treatments.

There were no significant differences among treatments for flea beetle damage ratings on 18 DAP, regardless of the site. 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 5 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. There were no significant differences in damage ratings on 27 DAP at Langdon and Carrington. At Langdon, all of the100% treated seed treatments; 67% Helix extra, 67% Prosper 400, 33% Helix lite and 33% Prosper 400 had significantly lower damage ratings than the untreated check on 34 DAP. At Carrington, all of the100% treated seed treatments (except 100% Prosper 200), 67% Helix extra and 67% Prosper 400 had significantly lower damage ratings than the untreated check on 34 DAP.

Table 5: For shoot dry weights, there were no significant differences among proportion of treated seed at 18 and 27 DAP for Langdon and Carrington. At Minot, there were no differences in shoot dry weights at 18 DAP; however, 33%, 67%, and 100% treated seed had significantly higher shoot dry weights than the untreated check at 27 DAP. 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 on 27 DAP, only Minot had significant differences, with 33%, 67%, and 100% treated seed lower than the untreated check. For damage ratings on 34 DAP, 67% and 100% treated seed usually had lower damage ratings compared to the untreated check regardless of the site. However, 33% treated seed usually had damage ratings comparable to the untreated check. For percent coverage at 34 DAP, the larger proportion of treated seed (67% and 100%) usually had a higher value than 33% treated and the untreated check.

Table 6: For shoot dry weights, there were no significant differences among seed treatment products at 18 and 27 DAP for Langdon and Carrington. At Minot, there were no differences in shoot dry weights at 18 DAP; however, low and high rates of seed treatments (Prosper and Helix) had significantly higher shoot dry weights than the untreated check at 27 DAP. For visual damage ratings 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 on 27 DAP, only Minot had significantly lower damage ratings among seed treatment products than the untreated check. For damage rating on 34 DAP, the higher rates of seed treatment products usually had lower damage ratings compared to the untreated check regardless of the site. However, the low rates of seed treatment products usually had damage ratings closer to the untreated check. For percent coverage at 34 DAP, the high rate of seed treatment products usually had a higher value than the low rates of seed treatment products and the untreated check.

Table 4. Dry Weight and Flea Beetle Damage Rating at Minot, Langdon and Carrington, 2004

	18 DAP			27 DAP			18 DAP			27 DAP			34 DAP			34 DAP		
Seed Treatment	-------------Dry Wt------------			-----------Dry Wt-----------			-----Visual Rating 1-----			------Visual Rating 2-----			-------Visual Rating 3------			------% Coverage----		
	g/10 plant			g/10 plant			1-6*			1-6*			1-6*					
	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	0.071	0.049	0.065	0.787	0.244	0.152	1.0	1.0	1.0	5.1 a	5.5	4.1	5.1 a	5.8 a	5.0 a	7.5 c	5.0 d	7.5 c
33% Helix lite	0.079	0.051	0.058	1.419	0.287	0.130	1.0	1.0	1.0	3.4 bc	5.5	3.9	3.6 b	4.8 bcd	5.0 a	32.5 ab	12.5 bcd	10.0 bc
33% Prosper 200	0.093	0.049	0.051	1.132	0.289	0.121	1.0	1.0	1.0	3.5 b	5.5	4.1	3.5 b	5.3 ab	5.0 a	26.3 b	7.5 cd	10.0 bc
33% Helix xtra	0.090	0.052	0.069	1.083	0.289	0.139	1.0	1.0	1.0	3.0 bcd	5.5	4.0	3.0 bc	5.0 abc	4.9 a	28.8 b	13.8 bcd	12.5 bc
33% Prosper 400	0.086	0.053	0.064	1.234	0.264	0.154	1.0	1.0	1.0	2.6 b-e	5.5	3.6	2.8 cd	4.3 cd	5.0 a	40.0 ab	16.3 bcd	10.0 bc
67% Helix lite	0.082	0.049	0.059	1.571	0.247	0.121	1.0	1.0	1.0	2.5 cde	5.5	3.8	2.5 cd	4.9 abc	5.0 a	38.8 ab	13.8 bcd	13.8 bc
67% Prosper 200	0.076	0.044	0.049	1.135	0.286	0.129	1.0	1.0	1.0	2.5 cde	5.5	3.5	2.5 cd	5.0 abc	4.9 a	45.0 ab	13.8 bcd	12.5 bc
67% Helix xtra	0.075	0.037	0.071	1.425	0.343	0.137	1.0	1.0	1.0	1.9 e	5.5	4.3	1.9 d	4.1 cd	4.0 cd	48.8 a	20.0 b	17.5 b
67% Prosper 400	0.087	0.044	0.050	1.146	0.266	0.144	1.0	1.0	1.0	2.3 de	5.4	3.8	2.3 cd	4.4 bcd	4.3 bc	43.8 ab	13.8 bcd	15.0 bc
100% Helix lite	0.097	0.043	0.066	1.429	0.315	0.124	1.0	1.0	1.0	2.3 de	5.4	3.5	2.3 cd	4.1 cd	4.2 bc	45.0 ab	23.8 b	16.3 b
100% Prosper 200	0.086	0.043	0.060	1.288	0.251	0.148	1.0	1.0	1.0	2.8 b-e	5.5	4.0	2.6 cd	4.5 bcd	4.6 ab	41.3 ab	17.5 bc	13.8 bc
100% Helix xtra	0.078	0.056	0.067	1.581	0.392	0.139	1.0	1.0	1.0	2.0 de	5.3	3.3	1.9 d	3.2 e	3.2 e	50.0 a	31.3 a	27.5 a
100% Prosper 400	0.083	0.046	0.052	1.414	0.332	0.120	1.0	1.0	1.0	2.0 de	5.5	3.8	2.0 d	4.0 d	3.8 d	45.0 ab	21.3 b	23.8 a
Mean	***0.083***	***0.047***	***0.060***	***1.280***	***0.293***	***0.135***	***1.0***	***1.0***	***1.0***	***2.8***	***5.5***	***3.8***	***2.8***	***4.6***	***4.5***	***37.9***	***16.2***	***14.6***
CV	***17.9***	***19.0***	***25.5***	***29.7***	***22.3***	***21.3***	***0***	***0***	***0***	***15.8***	***2.2***	***17.7***	***14.9***	***8.9***	***5.4***	***21.0***	***31.2***	***25.1***
LSD (P=0.05)	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***	***0.6***	***NS***	***NS***	***0.6***	***0.6***	***0.3***	***11.4***	***7.2***	***5.2***

***Damage Rating: 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; and 6= dead seedling.**

Table 5. Effect of the proportion of treated seed on canola performance at Minot, Langdon and Carrington, 2004

		18 DAP			27 DAP			18 DAP			27 DAP			34 DAP			34 DAP		
Percent	df	-------------Dry Wt------------			-----------Dry Wt-----------			-----Visual Rating 1-----			------Visual Rating 2-----			-------Visual Rating 3------			------% Coverage----		
		g/10 plant			g/10 plant			1-6*			1-6*			1-6*					
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
0	4	0.071	0.049	0.065	0.787	0.244	0.152	1.0	1.0	1.0	5.1	5.5	4.1	5.1	5.8	5.0	7.5	5.0	7.5
33	16	0.087	0.051	0.060	1.217	0.282	0.136	1.0	1.0	1.0	3.1	5.5	3.9	3.2	4.8	5.0	31.9	12.5	10.6
67	16	0.080	0.043	0.057	1.319	0.285	0.133	1.0	1.0	1.0	2.3	5.5	3.8	2.3	4.6	4.5	44.1	15.3	14.7
100	16	0.086	0.047	0.061	1.428	0.323	0.133	1.0	1.0	1.0	2.3	5.4	3.6	2.2	4.0	3.9	45.3	23.4	20.3
Mean		***0.083***	***0.047***	***0.060***	***1.28***	***0.293***	***0.135***	***1.0***	***1.0***	***1.0***	***2.8***	***5.5***	***3.8***	***2.8***	***4.6***	***4.5***	***37.9***	***16.2***	***14.6***
C.V. (%)		***17.5***	***19.1***	***26.1***	***28.9***	***23.7***	***20.8***	***0.0***	***0.0***	***0.0***	***18.1***	***2.3***	***17.2***	***17.5***	***12.2***	***10.0***	***21.8***	***36.9***	***33.1***
LSD (P=0.05)		***NS***	***NS***	***NS***	*******	***NS***	***NS***	***--***	***--***	***--***	********	***NS***	***NS***	********	********	********	********	********	********

DAP=Days After Planting

Table 6. Effect of the seed treatment product on canola performance at Minot, Langdon and Carrington, 2004.

		18 DAP			27 DAP			18 DAP			27 DAP			34 DAP			34 DAP		
Product	df	-------------Dry Wt------------			-----------Dry Wt-----------			-----Visual Rating 1-----			------Visual Rating 2-----			-------Visual Rating 3------			------% Coverage----		
		g/10 plant			g/10 plant			1-6*			1-6*			1-6*					
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	4	0.071	0.049	0.065	0.787	0.244	0.152	1.0	1.0	1.0	5.1	5.5	4.1	5.1	5.8	5.0	7.5	5.0	7.5
Helix lite	12	0.086	0.047	0.061	1.473	0.283	0.125	1.0	1.0	1.0	2.7	5.5	3.7	2.8	4.6	4.7	38.8	16.7	13.3
Prosper 200	12	0.085	0.045	0.053	1.185	0.275	0.133	1.0	1.0	1.0	2.9	5.5	3.9	2.9	4.9	4.8	37.5	12.9	12.1
Helix xtra	12	0.081	0.048	0.069	1.363	0.341	0.138	1.0	1.0	1.0	2.3	5.4	3.8	2.3	4.1	4.0	42.5	21.7	19.2
Prosper 400	12	0.085	0.047	0.055	1.265	0.287	0.139	1.0	1.0	1.0	2.3	5.5	3.7	2.3	4.2	4.3	42.9	17.1	16.3
Mean		***0.083***	***0.075***	***0.060***	***1.280***	***0.293***	***0.135***	***1.0***	***1.0***	***1.0***	***2.8***	***5.5***	***3.8***	***2.8***	***4.6***	***4.5***	***37.9***	***16.2***	***14.6***
C.V. (%)		***18.0***	***20.4***	***24.3***	***28.8***	***23.0***	***20.6***	***0.0***	***0.0***	***0.0***	***21.6***	***2.4***	***17.6***	***22.7***	***13.0***	***12.1***	***26.9***	***43.5***	***39.2***
LSD (P=0.05)		***NS***	***NS***	***NS***	*******	***NS***	***NS***	***--***	***--***	***--***	********	***NS***	***NS***	********	********	********	********	********	********

DAP=Days After Planting

Although shoot dry weights were generally not impacted by the different seed treatments, 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 treatments. In general, damage ratings were inversely related to the proportion of treated seed and the rates of seed treatment (high or low) regardless of the insecticide treatment. Damage ratings averaged across treatments and sites include: 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.

Crop Phenology (Tables 7-9): Table 7: Regardless of the site, all of the insecticide treatments had a shorter period to 10% flowering than the untreated check, except for 33% Prosper 200 at Langdon and Carrington. For 90% flowering, only 100% Helix xtra had a shorter period than the untreated check at Carrington. However, there were no significant differences in flower duration at Carrington. There were no significant differences in days to 90% flowering or in flower duration at Minot either. There were no data recorded for 90% flowering or flower duration at Langdon. For days to maturity, all of the insecticide treatments had a shorter period than the untreated check at Minot. At Langdon where flea beetle pressures were heavier, only 100% Helix xtra had a shorter period to maturity than the untreated check. No maturity data were collected at Carrington. For height at maturity, there were no significant differences at Minot or Carrington. At Langdon, none of the insecticide treatments were significantly different from untreated check, but 67% Helix xtra and 67% Helix lite were significantly taller than 33% Prosper 200.

Table 8: Regardless of the site, 33%, 67%, and 100% treated seed had a shorter period to 10% and 90% flowering and days to maturity than the untreated check. There were no data recorded for 90% flowering or flower duration at Langdon, and maturity data at Carrington. However, there was usually no difference in flower duration and crop height at maturity among proportions of treated seed.

Table 9: Regardless of the site, seed treatment products had a shorter period to 10% and 90% flowering and days to maturity than the untreated check. There were no data recorded for 90% flowering or flower duration at Langdon, and maturity data at Carrington. However, there was usually no difference in flower duration and crop height at maturity between the seed treatment products. At Langdon, Prosper 200 had a significantly lower height than the other products and the untreated check.

These data suggest that crop phenology was influenced 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. No trends were found in crop height. Early flowering would provide other benefits to the canola producers, such as avoiding periods of inclement weather for disease development and allowing earlier harvest.

Table 7. Crop Phenology at Minot, Langdon and Carrington, 2004.

Seed Treatment	10% Flower DAP Minot	10% Flower DAP Lang	10% Flower DAP Carr	90% Flower DAP Minot	90% Flower DAP Lang	90% Flower DAP Carr	Flower Duration Days Minot	Flower Duration Days Lang	Flower Duration Days Carr	Maturity Days Minot	Maturity Days Lang	Maturity Days Carr	Height cm Minot	Height cm Lang	Height cm Carr
Untreated	60.0 a	68.0 ab	55.3 a	71.0	--	78.0 a	11.0	--	22.8	84.0 a	121.0 a	--	93.6	110.0 ab	115.8
33% Helix lite	57.0 b	67.3 bcd	54.8 ab	68.0	--	78.0 a	11.0	--	23.3	81.0 b	120.3 ab	--	91.3	104.8 ab	113.5
33% Prosper 200	56.5 bc	68. 5 a	55.3 a	69.0	--	78.0 a	12.5	--	22.8	81.0 b	121.0 a	--	94.5	100.5 b	115.0
33% Helix xtra	56.5 bc	65.5 efg	54.0 bcd	68.8	--	78.0 a	12.3	--	24.0	81.8 b	119.5 ab	--	98.5	110.5 ab	113.8
33% Prosper 400	56.3 bc	66.3 def	54.8 ab	68.3	--	77.5 a	12.0	--	22.8	81.0 b	120.3 ab	--	93.3	111.5 ab	113.5
67% Helix lite	55.3 cd	65.8 efg	54.3 bc	69.0	--	77.5 a	13.8	--	23.3	81.0 b	119.8 ab	--	99.5	113.3 a	113.8
67% Prosper 200	55.8 bcd	67.5 abc	54.8 ab	68.8	--	78.0 a	13.0	--	23.3	81.0 b	120.5 ab	--	102.0	104.3 ab	117.0
67% Helix xtra	55.5 bcd	65.3 fg	53.5 cde	67.3	--	77.0 ab	11.8	--	23.5	81.8 b	118.5 ab	--	95.9	114.0 a	117.5
67% Prosper 400	55.5 bcd	65.8 efg	54.3 bc	67.3	--	78.0 a	11.8	--	23.8	81.0 b	119.3 ab	--	86.3	109.8 ab	113.5
100% Helix lite	55.8 bcd	65.3 fg	53.5 cde	68.3	--	76.5 ab	12.5	--	23.0	81.0 b	118.8 ab	--	92.4	110.5 ab	114.3
100% Prosper 200	56.0 bcd	66.8 cde	53.8 cd	67.8	--	77.0 ab	11.8	--	23.3	81.0 b	120.5 ab	--	92.3	109.8 ab	114.5
100% Helix xtra	54.5 d	64.5 g	52.8 e	67.0	--	76.0 b	12.5	--	23.3	79.5 c	117.8 b	--	93.5	109.5 ab	115.3
100% Prosper 400	55.0 cd	65.8 efg	53.3 de	68.0	--	76.5 ab	13.0	--	23.3	79.0 c	119.5 ab	--	98.0	110.3 ab	112.5
Mean	***56.1***	***66.3***	***54.2***	***68.3***	***--***	***77.4***	***12.2***	***--***	***23.2***	***81.1***	***119.7***	***--***	***94.8***	***109.1***	***114.6***
CV	***1.2***	***1.0***	***0.8***	***2.2***	***--***	***0.9***	***13.1***	***--***	***3.3***	***0.8***	***1.0***	***--***	***9.2***	***4.6***	***2.9***
LSD (P=0.05)	***1***	***0.9***	***0.6***	***NS***	***--***	***0.9***	***NS***	***--***	***NS***	***0.9***	***1.7***	***--***	***NS***	***7.1***	***NS***

DAP=Days After Planting

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

Percent	df	10% Flower DAP Minot	10% Flower DAP Lang	10% Flower DAP Carr	90% Flower DAP Minot	90% Flower DAP Lang	90% Flower DAP Carr	Flower Duration Days Minot	Flower Duration Days Lang	Flower Duration Days Carr	Maturity Days Minot	Maturity Days Lang	Maturity Days Carr	Height cm Minot	Height cm Lang	Height cm Carr
0	4	60.0	68.0	55.3	71.0		78.0	11.0		22.8	84.0	121.0		93.6	110.0	115.8
33	16	56.6	66.9	54.2	68.5	No	77.9	11.9	No	23.2	81.2	120.3	No	94.4	106.8	113.9
67	16	55.5	66.1	54.7	68.1	Data	77.6	12.6	Data	23.4	81.2	119.5	Data	95.9	110.3	115.4
100	16	55.3	65.6	53.3	67.8		76.5	12.4		23.2	80.1	119.1		94.3	110.0	114.1
Mean		***56.1***	***66.3***	***54.2***	***68.3***		***77.4***	***12.2***		***23.2***	***81.1***	***119.7***		***94.8***	***109.1***	***114.6***
C.V. (%)		***1.3***	***1.7***	***1.1***	***2.1***		***0.9***	***13.0***		***3.3***	***1.0***	***1.1***		***9.3***	***5.2***	***2.9***
LSD (P=0.05)		**	**	**	**		**	***NS***		***NS***	**	*		***NS***	***NS***	***NS***

DAP=Days After Planting

Table 9. Effect of the seed treatment product on canola performance at Minot, Langdon and Carrington, 2004.

Product	df	10% Flower DAP Minot	10% Flower DAP Lang	10% Flower DAP Carr	90% Flower DAP Minot	90% Flower DAP Lang	90% Flower DAP Carr	Flower Duration Days Minot	Flower Duration Days Lang	Flower Duration Days Carr	Maturity Days Minot	Maturity Days Lang	Maturity Days Carr	Height cm Minot	Height cm Lang	Height cm Carr
Untreated	4	60.0	68.0	55.3	71.0		78.0	11.0		22.8	84.0	121.0		93.6	110.0	115.8
Helix lite	12	56.0	66.1	54.2	68.4	No	77.3	12.4	No	23.2	81.0	119.6	No	94.4	109.5	113.8
Prosper 200	12	56.1	67.6	54.6	68.5	Data	77.7	12.4	Data	23.1	81.0	120.7	Data	96.6	104.8	115.5
Helix xtra	12	55.5	65.1	53.4	67.7		77.0	12.2		23.6	81.0	118.6		96.0	111.3	115.5
Prosper 400	12	55.6	65.9	54.1	67.8		77.3	12.3		23.3	80.3	119.7		92.5	110.5	113.2
Mean		***56.1***	***66.3***	***54.2***	***68.3***		***77.4***	***12.2***		***23.2***	***81.1***	***119.7***		***94.8***	***109.1***	***114.6***
C.V. (%)		***1.6***	***1.3***	***1.3***	***2.1***		***1.2***	***13.3***		***3.3***	***1.2***	***1.0***		***9.3***	***4.9***	***2.8***
LSD (P=0.05)		**	**	**	**		***NS***	***NS***		***NS***	**	**		***NS***	*	***NS***

DAP=Days After Planting

Agronomic Data (Tables 10-12):

Table 10: For yield, there were no significant differences at Minot. At Langdon, the following treatments had a significantly higher yield than the untreated check (ranked from highest to lowest): 100% Helix lite, 100% Helix xtra, 33% Prosper 400, 67% Helix xtra, 33% Helix xtra, and 67% Helix lite. At Carrington, only 100% Helix xtra had a significantly higher yield than the untreated check. For test weights at Minot, all of the insecticide treatments had a significantly higher test weight than the untreated check. However, at Langdon and Carrington, none of the insecticide treatments were significantly different in test weight from the untreated check. For kernel weight, 67% Prosper 400 and 100% Prosper 200 had a significantly higher kernel weight than the untreated check at Minot. At Langdon and Carrington, none of the insecticide treatments were different from the untreated check.

Table 11: Across proportion of treated seed, 67% and 100% treated seed had a higher yield than 33% treated seed and the untreated check. Although Carrington had significant differences in test weight among proportions of treated seed, these differences were small and not consistent across sites. For kernel weight, 67% and 100% treated seed had higher weight than 33% treated seed and the untreated check. There were no significant differences in percent oil among proportions of treated seed at Minot. However, Langdon and Carrington had significant differences and generally the 67% and 100% treated seed had higher percent oil values.

Table 12: There were no significant differences in yield among seed treatment products at Minot and Carrington. At Langdon, Helix xtra and Helix lite had higher yields compared to Prosper 200 and 400, and the untreated check. Although Langdon had significant differences in test weight among seed treatment products, these differences were small and not consistent across sites. For kernel weight, the high rate of seed treatment products (Helix xtra or Prosper 400) had higher weights than low rates of seed treatment products (Helix lite and Prosper 200) and the untreated check. There were no significant differences in percent oil among seed treatment products at Minot and Carrington. For Langdon, seed treatment products had higher percent oil than the untreated check.

Table 10. Agronomic data at Minot, Langdon and Carrington, 2004

Seed Treatment	----------------Yield-----------------			----------------Test Wt----------------			--------------Kernel Wt---------------			---------------Oil---------------		
		lb/A			lb/bu			g/1000			Percent	
	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	507	1315 b	1741 b	50.3 b	50.3 ab	50.6 abc	2.3 b	3.4 ab	3.1 ab	45.3	42.7 cd	46.2
33% Helix lite	594	1454 ab	1859 b	52.0 a	50.1 ab	50.8 a	2.5 ab	3.3 ab	3.1 ab	46.1	43.2 bcd	45.8
33% Prosper 200	589	1251 b	1930 b	51.8 a	50.6 ab	50.7 ab	2.6 ab	3.2 b	3.1 b	46.0	41.5 d	46.0
33% Helix xtra	668	1768 a	1846 b	52.1 a	50.0 ab	50.3 abc	2.5 ab	3.4 ab	3.3 ab	45.9	44.0 abc	46.3
33% Prosper 400	788	1817 a	2145 ab	51.9 a	50.4 ab	50.5 abc	2.5 ab	3.2 b	3.3 ab	46.1	43.0 bcd	46.3
67% Helix lite	876	1767 a	1984 ab	52.3 a	50.4 ab	50.2 bc	2.6 ab	3.4 ab	3.3 ab	45.8	44.4 abc	46.7
67% Prosper 200	1013	1453 ab	1902 b	52.0 a	50.8 a	50.7 ab	2.5 ab	3.3 ab	3.2 ab	46.5	43.1 bcd	46.4
67% Helix xtra	854	1777 a	2252 ab	52.2 a	49.9 ab	50.4 abc	2.6 ab	3.4 ab	3.3 ab	45.2	45.3 ab	46.8
67% Prosper 400	673	1615 ab	1902 b	52.3 a	50.4 ab	50.3 abc	2.7 a	3.5 ab	3.2 ab	45.7	44.0 abc	46.5
100% Helix lite	870	1894 a	2239 ab	51.8 a	49.9 ab	50.1 c	2.5 ab	3.5 a	3.3 ab	46.0	44.8 abc	46.7
100% Prosper 200	732	1613 ab	1963 ab	52.2 a	50.1 ab	50.2 abc	2.7 a	3.4 ab	3.2 ab	46.0	43.8 abc	46.4
100% Helix xtra	894	1865 a	2506 a	51.9 a	49.6 b	50.0 c	2.6 ab	3.5 a	3.4 a	45.5	45.5 a	46.9
100% Prosper 400	772	1624 ab	2153 ab	51.9 a	50.1 ab	50.1 c	2.5 ab	3.5 ab	3.3 ab	44.9	44.8 abc	46.5
Mean	***756***	***1632***	***2032***	***51.9***	***50.2***	***50.4***	***2.6***	***3.4***	***3.2***	***45.8***	***43.8***	***46.4***
CV	***32.5***	***11.9***	***12.3***	***1.3***	***0.8***	***0.5***	***4.5***	***3.5***	***3.0***	***1.7***	***2.3***	***0.9***
LSD (P=0.05)	***NS***	***278***	***357***	***1.0***	***0.6***	***0.3***	***0.2***	***0.2***	***0.1***	***NS***	***1.5***	***NS***

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

Percent	df	----------------Yield-----------------			----------------Test Wt----------------			--------------Kernel Wt---------------			----------------Oil---------------		
			lb/A			lb/bu			g/1000			Percent	
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
0	4	507	1315	1741		50.4	50.6	2.34	3.40	3.14	45.3	42.7	46.2
33	16	660	1573	1945		50.3	50.6	2.53	3.30	3.18	46.0	43.0	46.1
67	16	854	1653	2010	No	50.3	50.4	2.59	3.40	3.22	45.8	44.2	46.6
100	16	817	1749	2215	Data	49.9	50.1	2.59	3.50	3.29	45.6	44.7	46.2
Mean		***756***	***1632***	***2033***		***50.2***	***50.4***	***2.55***	***3.38***	***3.22***	***45.8***	***43.8***	***46.4***
C.V. (%)		***31.7***	***15.2***	***13.5***		***0.9***	***0.5***	***4.5***	***3.8***	***3.3***	***1.7***	***2.7***	***0.9***
LSD (P=0.05)		*	*	**		***NS***	**	**	**	*	***NS***	**	**

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

Product	df	----------------Yield-----------------			----------------Test Wt----------------			--------------Kernel Wt---------------			----------------Oil---------------		
			lb/A			lb/bu			g/1000			Percent	
		Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr	Minot	Lang	Carr
Untreated	4	507	1315	1741		50.4	50.6	2.34	3.40	3.14	45.3	42.7	46.2
Helix lite	12	780	1705	2027	No	50.1	50.4	2.55	3.39	3.22	46.0	44.1	46.4
Prosper 200	12	778	1439	1932	Data	50.5	50.5	2.59	3.29	3.15	46.1	42.8	46.2
Helix xtra	12	806	1803	2201		49.8	50.2	2.56	3.43	3.29	45.5	44.9	46.7
Prosper 400	12	744	1685	2067		50.3	50.3	2.58	3.39	3.26	45.6	43.9	46.4
Mean		***756***	***1632***	***2032***		***50.2***	***50.4***	***2.55***	***3.38***	***3.22***	***45.8***	***43.8***	***46.4***
C.V. (%)		***34.0***	***13.6***	***14.1***		***0.8***	***0.6***	***4.7***	***4.2***	***3.2***	***1.7***	***2.8***	***1.0***
LSD (P=0.05)		***NS***	**	***NS***		**	***NS***	*	***NS***	*	***NS***	**	***NS***

Based on these data, test weights were generally not influenced by the proportion of treated seed or seed treatment product. Yield was generally higher for the 100% treated seed and yield decreased proportionally as the proportion of treated seed declined regardless of the insecticide. For example, averaging the proportion of treated seed across treatments and site, the 100% treated seed averaged 1594 lbs./a (406 lbs./a more than untreated check); 67% treated seed averaged 1506 lbs./a (318 lbs./a more than untreated check); and 33% treated seed averaged 1392 lbs./a (204 lbs./a more than untreated check); and the untreated check averaged 1188 lbs./a. Use of an insecticide seed treatment appears to have affected yield more than which product was used. 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 and Prosper average 1444 lbs./a compared to the low rates of Helix and Prosper at 1144 lbs./a, and the untreated check at 1188 lbs./a. Kernel weight was generally higher for the 100% treated seed and declined as the proportion of treated seed declined, regardless of the insecticide seed treatment product. For example, 100% treated seed had the highest kernel weight of 3.13 g/1000 seeds, 3.07 g/1000 seeds for 67% treated seed, 3.00 g/1000 seeds for 33% treated seed, and 2.96 g/1000 seeds for the untreated check. The insecticide seed treatment product did not appear to impact the kernel weight. For example, the high rate of Helix/Prosper had 3.09 g/1000 seeds, 3.03 g/1000 seed for the low rate of Helix/Prosper, and 2.96 g/1000 seeds for the untreated check. The proportion of treated seed or the insecticide seed treatment product did not appear to influence percent oil. Seed oil was affected by whether or not an insecticide seed treatment was used. For example, the high and low rates of Helix/Prosper combined had 45.5% and 45.3% oil respectively, whereas the untreated check had 44.7% oil.

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