PROJECT DETAILS

- **Title**: Strategies for managing flea beetle populations in canola
- **Funders:** Manitoba Canola Growers and SaskCanola
- **Research program:** Canola Agronomic Research Program (CARP)
- **Principal investigator:** Juliana (Julie) Soroka and Byron Irvine
- **Collaborators/additional investigators:** Hector Carcamo
- **Year completed:** 2005

Final report

Strategies for Managing Flea Beetle Populations in Canola
Canola Council of Canada Project AG#2002-11
Final Report submitted May, 2005
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Executive Summary:

The project consisted of activities to control flea beetles in canola while reducing insecticide levels in the process. The main investigation, conducted at Brandon and Saskatoon, examined the effects of decreased proportions of seed treated with insecticide on control of flea beetle damage to canola seedlings. Two reduced proportions of treated seed, consisting of 2/3 and 1/3 of the seed treated with insecticide, were compared to all seeds treated, and with fungicide alone and bare seed controls. The insecticide acetamiprid (Premium Plus®, Assail®) was evaluated at both locations from 2002 to 2004, and at Melita, MB, in 2003. The insecticide clothianidin (Prosper 200®) was evaluated in 2003 and 2004 at Brandon and Saskatoon. There were 32 feeding damage ratings and 11 site years of seed yield data. The insecticides were examined in separate trials, as the main purpose of the experiment was to examine differences among levels of treated seed, not differences between seed treatments.

Flea beetle feeding pressure was especially high in 2002 and 2003, when drought was a factor in beetle feeding and canola growth. Flea beetle feeding damage to seedlings in the 0.66X treatment was similar to that of 1X treatment seedlings in 20 of the 32 damage evaluations. The 1X treatment had significantly lower feeding damage than did the other treatments on only two evaluation dates, and in 10 evaluations, mostly the last evaluation of the year, when insecticide effects were wearing off, all damage ratings were similar among all treatments. Plant stand and seedling growth rates were generally similar between 1X and 0.66 X treatments. The 0.33X treatment tended to have flea beetle feeding levels between those of the two high and the two no insecticide treatments.

Seed yield differences were not as great as they may have been because feeding levels often were greater than economic thresholds in all treatments. In five of the 11 site years, the 0.66X treatment had seed yields similar to the 1X treatment, both of whose yields were greater than the insecticide-free treatments. In five instances, there were no differences in seed yields among treatments. And in only one site year the 1X seed treatment had significantly greater seed yields than any other treatment.

In practical terms, whether the decrease in monetary and environmental costs of utilizing decreased proportions of insecticide-coated seed offsets the increased time and handling necessary to mix untreated and treated seed lots is a decision best left to the individual producer. In more and more instances untreated seed is no longer available to the producer, and the question of proportions is irrelevant. However, when flea beetle feeding levels are not severe, utilizing a partial rather than full proportion of insecticide-coated seed may prove monetarily and environmentally advantageous. In cases of severe flea beetle feeding, as was seen in 2003, supplemental application of foliar insecticides is likely necessary no matter what proportion of coated to uncoated seed is used.

In secondary investigations, five commercial canola fields, three in Manitoba and two in Alberta, were utilized in investigations testing the feasibility of using border rows only of insecticide to control flea beetle damage to the entire crop. While some interesting results were found, no uniform trends could be discerned in optimum distance of insecticide border, or even in efficacy of the border at all. In an investigation in 2004 at Brandon and Saskatoon, herbicide-intolerant seed was mixed with herbicide-tolerant seed in an effort to diffuse flea beetle feeding by increasing seeding rates of canola, and so minimize damage to individual seedlings. Results were not definitive, and the idea was not disproved.

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This report will present results from 2004, and will summarize the results of the trial over the three years 2002-2004 at each location and at locations combined.

General Activities 2004

Field plot trials were established for the third year of investigation at the Brandon and Saskatoon Research Centres in May of 2004, using canola seeded in four different ratios of insecticide plus fungicide-treated seed and seed treated with fungicide alone, and with a bare seed control. Two insecticides, acetamiprid (Premium Plus®/Assail®) and clothianidin (Prosper 200®), were evaluated in separate trials. Flea beetle feeding levels and plant growth attributes were monitored on two to three occasions throughout the spring. The generally cool spring conditions resulted in lower flea beetle feeding pressure than in 2003, but beetle populations were high enough at Saskatoon that, during the infrequent warm, sunny spells, feeding was intense, and in all four trials flea beetle economic thresholds were surpassed. At Brandon, flea beetle feeding at the first evaluation period was low with no difference in damage among treatments. Later, at the second and third evaluations, feeding damage increased among all treatments indiscriminately. Plots were maintained and harvested at maturity. Cool summer temperatures delayed crop maturity so that harvest at both locations occurred in late September.

Growing Conditions

The 2004 growing season (May 1 – August 31) was much cooler and generally wetter than normal (Appendix 1), in marked contrast to the weather of the two previous years. At Saskatoon the growing season was 2.5 °C below normal, with total May 1- August 31 rain 134% of normal. Killing frosts occurred in the third week of August at both locations, with July being the only frost- free month of the growing season. Further, Saskatoon received heavy hail that pummelled crops on August 28th. Wet weather in September delayed maturity further.

Methodology

Trial 1: Impact of the amount of insecticide- treated seed on flea beetle damage:
Differing proportions of acetamiprid seed dressing and the fungicide Foundation Lite® (ipridion and thiram), and Prosper 200® (clothianidin) seed treatment with or without fungicide, were evaluated in separate trials at two locations, Brandon and Saskatoon. Insecticide-coated Roundup Ready® B. napus SW Arrow canola was planted on May 18, 2004, at Brandon (acetamiprid and Prosper 200®) and Saskatoon on May 17 (acetamiprid) and May 20 (Prosper 200) at a rate of approximately 4.5 kg/ha. At Brandon, nitrogen was surface broadcast as urea at 110 kg/ha N just prior to a heavy rain, with sulphur applied at 16 kg/ha as ammonium sulphate. The following treatments were seeded in 12 x 8m plots using disc drills at 30 cm row spacings:
1) Full acetamiprid seed treatment - acetamiprid 50 FS seed treatment, consisting of acetamiprid insecticide plus Foundation Lite® fungicide (1X, 4.5 kg/ha) to all seeds
2) 2/3 acetamiprid plus Foundation Lite® fungicide-treated seed treatment (0.66 X, 3.0 kg/ha), 1/3 Foundation Lite® fungicide-treated seed only (1.5 kg/ha),

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3) 1/3 acetamiprid plus Foundation Lite® fungicide-treated seed treatment (0.33 X, 1.5 kg/ha), 2/3 Foundation Lite® fungicide- treated seed only (3.0 kg/ha),
4) Foundation Lite® fungicide- treated seed alone (0 X, 4.5 kg/ha)
5) Bare seed

The same treatments utilizing Prosper 200® - the insecticide clothianidin and the fungicides thiram and metalaxyl instead of acetamiprid, thiram and ipridion - were seeded in nearby plots. Thiamethoxam (Helix®), the canola insecticide seed treatment most commonly used by prairie canola producers, was not used in this investigation because the fungicide-only component of the Helix® protection system, consisting of the fungicides difenoconazole, fludioxonil, and metalaxyl-M, was not available. Plots were arranged in a Latin square design, with each treatment appearing once in each of the five replicates.

At both locations, flea beetle ratings were conducted on all tissues at the cotyledon, 1st leaf and 2nd leaf stage. Ten plants in each of 5 marked areas in each plot were rated at Brandon. At Saskatoon, 10 canola seedlings were rated in each of four randomly selected areas of each plot. Ratings were on a 0 to 10 scale, with a rating of 0 indicating no damage and 10 indicating the leaf was entirely removed. Feeding levels were converted to % leaf area eaten. Plant counts were conducted on three occasions after seeding at Saskatoon.

2004 Results and Discussion

Trial 1

At Brandon in 2004, flea beetle damage early in the growing season was limited in both insecticide trials regardless of the amount of seed treated because of low levels of flea beetle activity in the area. While damage increased by the second assessment date there were no significant differences due to the ratios of seed treated (Tables 1, 2). By the time of the third assessment the effectiveness of the products may have been diminished due to chemical dissipation, and feeding continued to be similar in all treatments. Plants in both insecticide trials had similar levels of feeding and the entire test was treated with malathion to prevent further damage. Subsequently, yields in both insecticide trials were found to be similar among treatments (Table 3), reflecting the similarity in flea beetle injury among treatments at the beginning of the season.

Results of treatments at Saskatoon were more variable than at Brandon in 2004. Plant stand varied with ratio of seeds treated with acetamiprid (Table 4). In the first two evaluations, treatments with pesticide-coated seed tended to have greater plant densities that the bare seed treatment. This difference was statistically significant for the 0.33X seed treatment vs the bare seed control at the second sampling date (Table 4). By the third sampling date, 19 days after emergence, plant densities were similar among all the treatments (Table 4). There were significantly different levels of flea beetle damage to canola tissues in the acetamiprid trial. The 1X and 0.66X treatments had significantly less feeding damage than did the bare seed or fungicide-only seed treatments at the first two sampling periods (Table 5, Figure 1). The 0.66X treatment, with only 2 of every 3 seeds treated, gave as great protection against flea beetle feeding as the 1X (full seed) treatment. On the last sampling

date feeding levels were similar among treatments. Feeding injury ratings for the 0.33X acetamiprid treatment were generally in between those of the high and low-injury treatments (Table 5). Growth rate differences in plants among treatments were small, although significant on the first and third sample dates (Table 6). At 19 days after emergence, 1X and 0.66X, the two treatments with the greatest numbers of treated seeds, had the slowest growth rates (Table 6).

Seed yields in the acetamiprid trial at Saskatoon in 2004 attested to the advantage of using both insecticide and fungicide in this cold, wet year. Numerically, seed yields with the greatest amounts of pesticides had the greatest yields; statistically, seed yields of the bare seed treatment were lower than those of the treatments with pesticides, and seed yields of the pesticide treatments did not vary among each other (Table 7).

Plant density varied among treatments in the clothianidin trial at Saskatoon in 2004. The 1X and 0.66X seed treatments had similar plant densities (table 8). These two treatments had greater numbers of plants per m row than did the bare seed treatment, with the differences being significant in the first and third sampling periods (Table 8). The 0.33X treatment had plant stands in between the two extremes. As in the acetamiprid trial, flea beetle feeding damage to plants in the clothianidin trial varied with the amount of insecticide-coated seed that was planted. Just after emergence, the seedlings in the1X clothianidin treatment had less feeding damage than those in any other treatment (Table 9, Figure 2). However, by the second sampling date and carrying on into the third rating, the 0.66X treatment had levels of damage similar to the 1X treatment, significantly less than seedlings in the two seed treatments without insecticide. On the second and third evaluation dates, the 0.33X treatment had feeding levels in between the high and low damage treatments (Table 9). There were no differences in growth rates among the treatments in the three evaluations of the clothianidin trial at Saskatoon in 2004 (Table 10).

In the 2004 clothianidin trial at Saskatoon the 0.66X treatment had the highest seed yields (Table 7). The 0.66X and 1X treatment had statistically greater seed yields than did the other three treatments, with the 0.33X treatment having a higher seed yield than the two no-insecticide treatments (Table 7).

Trends over Three Years 2002-2004

Data from 2002 and 2003, presented in previous annual reports, are tabulated here by year and location in Appendices 2-15. For analyzing data combined over locations and years, a mixed model analysis of variance was used, with year considered to be a random variable, so that the results could be applied to any year. Trial (insecticide, that is, acetamiprid an clothianidin) was considered to be a fixed variable, and the results apply only to those two insecticides. Location was first analysed as a random variable, with results applicable to any location. However, because of the limited number of locations and because of the disparity of the data between them, results in this report are presented with location treated as a fixed variable, with results applicable only to Saskatoon, Brandon, and Melita. Treatment, of course, was a fixed variable, since we were concerned with those specific treatments that were used.

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Brandon. Figures 3, 4, and 5 depict the feeding damage seen in all the trials at Brandon and Melita one, two, and three weeks after canola emergence in the spring (there were no third ratings of the acetamiprid trial at Brandon in 2002 or at Melita in 2003). Generally, although magnitude of feeding varied among years, the patterns of damage among treatments were similar between insecticide trials, with seedlings from the unprotected treatments bare seed and Fungicide only seed fed upon the most. The clothianidin trial in 2004 was the exception. Two and three week damage ratings of seedlings in this trial were similar, with no apparent connection to levels of insecticide. When data were combined over years, in the acetamiprid trial the 1X and 0.66X treatments had lower rates of damage than did bare seed and fungicide alone treatments 1 and 2 weeks after emergence, significantly so at two weeks after emergence (Table 11). By the time of the third assessment, treatment effects had worn off. When data from the clothianidin trials was combined over years at Brandon, the pattern of feeding damage was similar to that of the acetamiprid trial, with treatments receiving the most insecticide load having the least foliar damage (Table 12). However, the clothianidin ratings had more variable values when combined, and no significant differences were found among treatments (Table 12).

Although the two insecticides were evaluated in separate trials, analysis revealed that the pattern of treatment effects between them were similar. Therefore, data were combined for analyses over trials and years. The typical pattern of less damage to seedlings in the treatments with greater numbers of coated seeds prevailed (Table 13). At the earliest ratings the 0.66X treatment had feeding damage levels approximately equal to those of the 1X treatment. However, only in the second evaluation period were treatments significantly different, with the 1X treatment having less flea beetle feeding than treatments with no insecticide coating.

Average seed yields over years and insecticides at Brandon were inversely proportional to flea beetle feeding levels, with treatments containing the greatest level of coated seed having the greatest yields (Table 14). Over the three years of the trial, the 0.66X treatment had the numerically highest seed yields of any treatment, although large variances within treatments resulted in non-significant differences among means (Figure 9).

Saskatoon. Data on plant densities at Saskatoon combined over the three years of the project revealed a consistent pattern of increased plant stand with increased ratio of coated seed (Tables 15-17). Usually, the 0.66X insecticide treatment had similar numbers of plants per unit row as the 1X treatment, with both of these having greater plant stands than the bare seed treatment. Flea beetle feeding levels, summarized in Figures 6-8, followed this same trend. The 0.66X treatment plants were fed upon to about the same degree as the 1X treatment plants, with both fed upon less than the bare seed seedlings, and usually less than the Fungicide alone seedlings. This held true for each of the insecticides, and when data from the two insecticides were combined (Tables 18-20). Because the clothianidin trial at Saskatoon was always seeded several days later than the acetamiprid trial, it is not surprising that average feeding levels were significantly lower in the acetamiprid trial at this location (Table 20).

Average seed yields at Saskatoon over the three years of the experiment were extremely low because of the heavy flea beetle feeding pressure in 2002 and 2003. Despite this, yields varied with insecticide ratio for both insecticides, with 1X and 0.66X treatments having yields similar to each other and higher

than seed treatments without insecticide (Table 21, Figure 10). Even though clothianidin treatments had less feeding than the acetamiprid trials (Table 20), seed yields were similar between the two insecticides (Table 21).

Data Combined over Both Sites and All Three Years

For both insecticides, data on flea beetle feeding damage combined over locations within (acetamiprid Tables 22-24, clothianidin Tables 26-27) and among years (Tables 25, 28) showed patterns similar to the data from individual locations and years discussed previously. Table 29 sums feeding damage from both insecticides, all years and both Brandon and Saskatoon (data from Melita, present for acetamiprid in 2003 only, was excluded from the summary). As in previous analyses, in the first two evaluation periods the 0.66X treatment had feeding levels statistically similar to that of 1X, and both were less fed upon than the fungicide only or bare seed control treatments. Treatment differences had disappeared by the third sampling (Table 29). Location was not a significant variable affecting feeding damage. The insecticide used did affect feeding levels, but this variable was confounded in that at Saskatoon the clothianidin trials were seeded later than the acetamiprid ones. Thus it is no surprise that the insecticide by location interaction term is also significant (Table 29). Treatment by location and insecticide interactions were not significant, suggesting that main effects were of greatest importance in the experiment.

When seed yields were combined over locations within years (Tables 30-32), and over all years (Table 33), in five analyses there were no significant differences among treatments in yield. In four analyses 1X and 0.66X treatments had yields similar to each other and greater than that of fungicide alone or bare seed treatments. In only one analysis did the 1X treatment have greater seed yields than all other treatments. In 2002 and 2003 seed yields for all treatments were below commercially acceptable levels, in part because of drought, and in part because of the extreme flea beetle feeding pressure. Over the length of the project, in 21 of 32 damage evaluations ratings greater than 25% leaf area eaten occurred on at least some of the treatments. In commercial situations such feeding levels would have warranted applications of foliar insecticides.

In conclusion, the project demonstrated that treating two of every three seeds with insecticides kept feeding by flea beetles at levels equivalent to that of all seeds treated. When feeding pressure was not extreme, seed yields were not compromised by the reduction in insecticide application. Under extremely heavy flea beetle feeding pressures, additional insecticides need to be applied no matter what the initial application ratio.

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Other Activities

NEW Trial 2 2004: Impact of a non herbicide-tolerant "Lure crop" planted with a Roundup Ready Crop

In an effort to evaluate other means of reducing insecticide load to the environment, an experiment was conducted at both Brandon and Saskatoon in which herbicide-tolerant canola treated or not treated with insecticide was seeded with cheaper-priced, non-herbicide tolerant canola, to determine if increasing seeding rates could decrease levels of flea beetle feeding without the use of insecticides. The hypothesis was that an increased seeding rate would decrease flea beetle feeding levels on a per seedling basis. The non-herbicide-tolerant canola was sprayed along with weeds with an application of Roundup®, leaving the herbicide-tolerant crop.

The following treatments were planted and managed at Brandon as in Trial 1 above:

1) Canola variety 45H21 RR® canola bare seed seeded at 200 seeds per 6.1m row
2) 45H21 seed treated with Helix® and seeded at 200 seeds per 6.1m row
3) 45H21bare seed & 46A65 bare seed, each seeded at 200 seeds per 6.1m row
4) 45H21 seed treated with Helix® & 46A65 bare seed, each seeded at 200 seeds per 6.1m row
5) 46A65 bare seed seeded at 200 seeds per 6.1m row

At Saskatoon, the intent was to follow the above protocol, but an error in seed packaging resulted in a decrease in the seeding rate of the combination of cultivars, resulting in the following being seeded:

1) Canola variety 45H21 RR® canola bare seed seeded at 200 seeds per 6.1m row
2) 45H21 seed treated with Helix® and seeded at 200 seeds per 6.1m row
3) 45H21bare seed & 46A65 bare seed, each seeded at 100 seeds per 6.1m row
4) 45H21 seed treated with Helix® & 46A65 bare seed, each seeded at 100 seeds per 6.1m row
5) 46A65 bare seed seeded at 200 seeds per 6.1m row

Flea beetle feeding damage to seedlings was evaluated two to three times after emergence. The entire trial was sprayed with the Transorb® formulation of glyphosate at a rate 0f 0.5litre per acre at the 2-3 leaf canola stage. At 4 weeks after emergence, and a week after the glyphosate application, a biomass evaluation was conducted by cutting the canola from one 1m row per plot with a utility knife, taking the biomass to the laboratory, weighing, drying the plant material, and reweighing. Plots were harvested with a Hege small plot harvester at maturity, seed was cleaned, and seed yields per treatment determined.

Results Trial 2 2004: This trial was scheduled to be planted May 23 at Brandon but wet soil conditions delaying planting until June 4. Thus, differences in feeding damage among treatments were not significant because of the low total damage resulting from late seeding and other canola crops nearby diluting the numbers

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of flea beetles (Table 34). Likewise, no differences were found in seed yields among treatments at Brandon (Table 35).

At Saskatoon, results indicated that the number of canola plants per 1m row among treatments were similar at the first and third evaluation dates, not surprising given that the seeding rates were 200 seeds per row for all treatments (Table 36). At the second rating period the two treatments with Helix applied to the seed had slightly higher plant densities than did the other treatments. At 38 days after emergence, after application of glyphosate eliminating the 46A65 seedlings, the 45H21 with full Helix seed treatment had greater numbers of plants than did the other treatments. as well as weeds, Feeding damage to seedlings at all three sampling periods was lowest in the two treatments with Helix-treated seed, even though the mixture of 45H21 with Helix & 46A65 had only half the amount of seed treated with insecticide as did treatment 45H21 with Helix (Table 37). Seedlings of 45H21 with full Helix seed treatment grew slightly faster than did seedlings in other treatments (Table 38), and their fresh and dry weights were the greatest of any treatments (Table 39). Despite these factors, seed yields among the four surviving treatments were similar, attesting to the great yield flexibility that canola can express under favourable growing conditions. The only variability in harvest was the fact that the 45H21 with Helix treatment matured faster, and was combined 9 days earlier than the other treatments.

Because of the lateness of seeding at Brandon and the errors in seeding rate at Saskatoon, definitive conclusions cannot be drawn regarding our hypothesis of heavier seeding rates diluting flea beetle feeding damage. However, the results suggest that the idea should be investigated more diligently

Trial #2 2002 and 2003 - Border Trap Cropping. Border trap cropping, in which insecticides were placed with seed or foliarly-applied at the borders of fields only, was attempted in three commercial fields in Manitoba in 2002 and two fields in Alberta in 2003 with mixed results. In Manitoba, flea beetle feeding was reduced in the treated areas of all three fields when compared to untreated areas. Likewise, seed yields were increased by 15% in insecticide-treated areas of one field where yields were accurately compared. However, untreated areas at greater distance from the treated strips had similar levels of flea beetle feeding as untreated areas closer to the treated strips. This indicated that applying insecticides around the perimeters of canola fields did not reduce flea beetle feeding to a significant extent within the fields. In Alberta in 2003, strips of seed rows around the perimeters of two commercial canola fields in Alberta were treated with Helix insecticide to determine if such limited areas of treatment could keep flea beetles from entering the main body of the crops. Yellow sticky cards were used to monitor flea beetle numbers in the treated and untreated areas in the two fields, and flea beetle feeding damage was assessed during the cotyledon and first true leaf stage. One of the fields had very few flea beetles caught on cards and little impact of treatments on feeding damage or seed yields. In the second field flea beetle feeding was reduced somewhat in the Helix-treated areas when compared to insecticide-free areas. There was a lack of relationship found between flea beetle numbers on sticky cards and flea beetle damage to seedlings, confirming that flea beetle numbers per se are not a good indication of potential canola damage. There was high variability in seed yields among the treatments, with little difference among them.

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Table 1. Feeding damage expressed as percent leaf area eaten (% LAE ± standard error of the mean) to cotyledons and first true leaves of canola cv SW Arrow seed coated with the insecticide acetamiprid in various levels of coated to uncoated seed (1-0X), at Brandon, MB, 2004, evaluated at three dates after seedling emergence (DAE).

	7 DAE		14 DAE		21 DAE	
Seed Ratio	% LAE	±SE	% LAE	±SE	% LAE	±SE
Acetamiprid & Fungicide 1X	4.68	0.55	19.7	3.90	38.5	3.02
Acetamiprid & Fungicide 1X	4.74	0.99	20.8	1.94	39.6	1.14
Acetamiprid & Fungicide 1X	7.92	1.65	17.8	3.89	37.0	2.72
Fungicide alone 0X	6.50	1.17	20.3	4.67	36.6	1.38
Bare seed	7.10	1.13	23.9	3.93	37.2	2.73
P#	n.s.[1]		n.s.		n.s.	

[1] n.s. - means within columns are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability.

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Table 2. Feeding damage expressed as percent leaf area eaten (% LAE ± standard error of the mean) to cotyledons and first true leaves of canola cv SW Arrow seed coated with the insecticide clothianidin (Prosper 200®) in various levels of coated to uncoated seed (1-0X), at Brandon, MB, 2004, evaluated at three dates after seedling emergence (DAE).

	7 DAE		14 DAE		21 DAE	
Seed Ratio	% LAE	±SE	% LAE	±SE	% LAE	±SE
Clothianidin & Fungicide 1X	4.22	1.11	11.0	2.56	29.0	1.80
Clothianidin & Fungicide 0.66X	5.46	0.95	18.1	2.08	36.8	0.45
Clothianidin & Fungicide 0.33X	5.60	0.99	14.8	4.09	34.7	5.58
Fungicide alone 0X	8.10	1.55	12.2	1.21	25.5	3.66
Bare seed	8.20	1.21	13.8	3.83	29.2	5.80
P#	n.s.[1]		n.s.		n.s.	

[1] n.s. - means within columns are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability.

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Table 3. Average (± standard error of the mean) seed yield of canola cv SW Arrow seeded at Brandon with five different ratios of acetamiprid- or clothianidin-coated: uncoated seed in 2004.

	Acetamiprid		Clothianidin	
Seed Treatment	Seed yields (kg ha^{-1})	±SE	Seed yields (kg ha^{-1})	±SE
Insecticide & Fungicide 1X	1543	98	1715	33
Insecticide & Fungicide 0.66X	1512	45	1594	121
Insecticide & Fungicide 0.33X	1615	72	1610	69
Fungicide alone 0X	1670	66	1694	104
Bare seed	1639	82	1545	90
P#	n.s.[1]		n.s.	

[1] n.s. - means within columns are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability.

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Table 4. Mean (± standard error of the mean) number of canola cv SW Arrow plants per m row grown from seed with five different ratios of acetamiprid-coated:uncoated seed at Saskatoon, 2004.

	3 DAE		11 DAE		19 DAE	
Seed Ratio	Plants $^{-1}$ row	±SE	Plants $^{-1}$ row	±SE	Plants $^{-1}$ row	±SE
Acetamiprid & Fungicide 1X	15.6 [1]	1.4	15.4 ab	0.6	16.4	0.5
Acetamiprid & Fungicide 0.66X	16.0	1.8	14.9 ab	1.0	15.0	1.0
Acetamiprid & Fungicide 0.33X	14.0	1.4	16.5 a	0.9	14.9	1.0
Fungicide alone 0X	14.3	1.8	15.8 ab	1.3	16.0	1.9
Bare seed	10.0	1.7	12.2 b	1.8	13.4	2.5
P#	n.s.		0.05		n.s.	
LSD			2.66			

[1] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

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Table 5. Mean feeding damage expressed as % leaf area eaten (% LAE ± standard error of the mean) to cotyledons and first true leaves of canola cv SW Arrow seed coated with the insecticide acetamiprid in various levels of coated to uncoated seed (1X-0X) at Saskatoon, 2004, and evaluated at three dates after seedling emergence (DAE).

	3 DAE		11 DAE		19 DAE	
Seed Ratio	% LAE	±SE	% LAE	±SE	% LAE	±SE
Acetamiprid & Fungicide 1X	8.11 ab[1]	1.8	15.6 a	1.6	33.2	1.1
Acetamiprid & Fungicide 0.66X	7.90 a	1.8	17.7 a	2.6	31.7	1.2
Acetamiprid & Fungicide 0.33X	14.3 ab	3.9	18.0 ab	2.0	32.0	0.9
Fungicide alone 0X	25.5 c	6.9	23.9 c	3.0	37.2	2.5
Bare seed	20.0 c	2.9	24.0 bc	3.7	34.4	1.5
P#	0.0079		0.0271		n.s.	
LSD	9.90		5.93			

[1] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

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Table 6. Growth stage (± standard error of the mean) of canola cv SW Arrow seed coated with the insecticide acetamiprid in various levels of coated to uncoated seed (1X-0X) at Saskatoon, 2004, and evaluated at three dates after seedling emergence (DAE).

	Average Growth Stage[1] ±SE					
Seed Ratio	3 DAE		11 DAE		19 DAE	
Acetamiprid & Fungicide 1X	1.03 ab [2]	0.02	2.02	0.03	2.26 c	0.00
Acetamiprid & Fungicide 0.66X	1.04 a	0.01	2.08	0.03	2.27 c	0.01
Acetamiprid & Fungicide 0.33X	1.02 b	0.01	2.06	0.02	2.32 a	0.01
Fungicide alone 0X	1.00 b	0.00	2.06	0.02	2.29 b	0.02
Bare seed	1.00 b	0.00	2.03	0.03	2.30 ab	0.01
P# on ranked data	0.02		n.s.		0.0003	

[1] Growth stage rated according to the scale of Harper and Berkencamp (1971), whereupon canola in the cotyledon stage is rated as 1.0, at the first true leaf stage as 2.0, at the bud stage as 3.0.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability. Analysis conducted on ranked data to account for qualitative values for growth stage. n.s. - differences not significant.

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Table 7. Average (± standard error of the mean) seed yield of canola cv SW Arrow seeded at Saskatoon with five different ratios of acetamiprid- or clothianidin-coated:uncoated seed in 2004.

	Acetamiprid		Clothianidin	
Seed Treatment	Seed yields (kg ha^{-1})	±SE	Seed yields (kg ha^{-1})	±SE
Insecticide & Fungicide 1X	1778 a [1]	76	1335 a	69
Insecticide & Fungicide 0.66X	1718 a	37	1426 a	87
Insecticide & Fungicide 0.33X	1701 a	46	1189 b	100
Fungicide alone 0X	1673 a	87	1042 c	103
Bare seed	1434 b	77	981 c	64
P#	0.0017		0.0001	
LSD	129		127	

[1]Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD).

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Table 8. Mean number (± standard error of the mean) of canola cv SW Arrow plants per m row grown from seed with five different ratios of clothianidin-coated:uncoated seed at Saskatoon, 2004.

	1 DAE		112DAE		20 DAE	
Seed Ratio	Plants m row^{-1}	±SE	Plants m row^{-1}	±SE	Plants m row^{-1}	±SE
Clothianidin & Fungicide 1X	8.6 a[1]	1.1	16.6	1.0	18.2 a	1.9
Clothianidin & Fungicide 0.66X	6.8 ab	1.5	17.1	2.2	15.6 ab	1.4
Clothianidin & Fungicide 0.33X	5.6 bc	1.7	14.6	1.0	13.4 b	1.6
Fungicide alone 0X	4.1 bc	0.8	14.8	1.3	14.4 ab	0.7
Bare seed	3.8 c	1.2	12.2	1.5	9.0 c	0.4
P#	0.0264		n.s		0.0009	
LSD	3.05				3.84	

[1] Data for all three ratings transformed by log (x+1) to stabilize variances. Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant

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Table 9. Feeding damage expressed as % area leaf eaten (± standard error of the mean) to cotyledons and first true leaves of canola cv SW Arrow seed coated with various levels of the insecticide clothianidin, seeded at Saskatoon, 2004, and evaluated at three dates after seedling emergence (DAE).

	1 DAE		12 DAE		20 DAE	
Seed Ratio	% LAE	±SE	% LAE	±SE	% LAE	±SE
Clothianidin & Fungicide 1X	0.5 d[1]	0.1	13.4 c	2.8	28.2 b	2.2
Clothianidin & Fungicide 0.66X	4.4 bc	0.8	13.5 c	1.1	29.6 b	1.8
Clothianidin & Fungicide 0.33X	3.4 c	0.8	17.5 bc	1.1	35.1 a	2.2
Fungicide alone 0X	8.0 ab	3.2	27.9 ab	5.6	36.2 a	1.7
Bare seed	9.3 a	3.0	29.6 a	4.4	37.1 a	1.9
P#	0.001		0.01		0.002	
LSD	4.7		10.4		4.2	

[1] Data transformed by arcsine square root to stabilized variances. Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD).

Table 10. Growth stage (± standard error of the mean) of canola cv SW Arrow seed coated with various levels of uncoated seed: seed coated with the insecticide clothianidin, seeded at Saskatoon, 2004, and evaluated at three dates after seedling emergence (DAE).

	Average Growth Stage[1] ±SE					
Seed Ratio	1 DAE		12 DAE		20 DAE	
Clothianidin & Fungicide 1X	1.05 [2]	0.02	2.19	0.10	2.32	0.01
Clothianidin & Fungicide 0.66X	1.03	0.02	1.99	0.08	2.28	0.02
Clothianidin & Fungicide 0.33X	1.07	0.04	2.03	0.06	2.27	0.03
Fungicide alone 0X	1.06	0.04	2.03	0.03	2.26	0.04
Bare seed	1.03	0.00	2.26	0.11	2.27	0.04
Ranked data P	n.s.		n.s.		n.s.	

[1] Growth stage rated according to the scale of Harper and Berkencamp (1971), whereupon canola in the cotyledon stage is rated as 1.0, at the first true leaf stage as 2.0, at the bud stage as 3.0.

[2] Means within columns are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability. Analysis conducted on ranked data to account for qualitative values for growth stage.

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Table 11. Percent leaf area eaten by flea beetles on youngest canola cv SW Arrow tissues grown from seed with five different ratios of acetamiprid-coated:uncoated seed at Brandon, evaluated at three different time periods combined over three years, 2002-2004.

	Evaluation Period 1[1]	Evaluation Period 2	Evaluation Period 3[2]
Seed Ratio	% LAE	% LAE	% LAE
Acetamiprid & Fungicide 1X	8.41 a[3]	21.0 c	46.9 a
Acetamiprid & Fungicide 0.66X	10.7 a	24.3 c	50.3 a
Acetamiprid & Fungicide 0.33X	14.7 a	26.8 bc	49.4 a
Fungicide alone 0X	24.0 a	34.9 ab	53.9 a
Bare seed	24.0 a	35.2 a	53.9 a
Pooled Standard Error	7.05	10.8	13.5
P# for treatment	n.s.	0.0264	n.s.
P# for year	0.0096	0.0001	0.0017
P# for trt*year interaction	0.0002	0.0185	0.0030

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] No evaluation conducted in Period 3 in 2002.

[3] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

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Table 12. Percent leaf area eaten by flea beetles on youngest canola tissues cv SW Arrow grown from seed with five different ratios of clothianidin-coated:uncoated seed at Brandon, evaluated at three different time periods combined over two years, 2003-2004.

Seed Ratio	Evaluation Period 1[1] % LAE	Evaluation Period 2 % LAE	Evaluation Period 3 % LAE
Clothianidin & Fungicide 1X	9.19[2]	26.2	45.2
Clothianidin & Fungicide 0.66X	10.5	33.6	49.4
Clothianidin & Fungicide 0.33X	17.7	36.4	54.2
Fungicide alone 0X	31.0	39.0	52.2
Bare seed	30.5	38.6	54.0
Pooled Standard Error	15.7	21.3	20.6
P# for treatment	n.s.	n.s.	n.s.
P# for year	0.0273	0.0028	0.0009
P# for trt*year interaction	0.0001	0.0025	0.0023

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability.

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Table 13. Percent leaf area eaten by flea beetles on youngest canola cv SW Arrow tissues grown from seed with five different ratios of acetamiprid- or clothianidin-coated:uncoated seed at Brandon, evaluated at three different time periods combined over three years, 2002-2004.

	Evaluation Period 1[1]	Evaluation Period 2	Evaluation Period 3
Seed Ratio	% LAE	% LAE	% LAE
Insecticide & Fungicide 1X	9.30	20.5 b	46.1
Insecticide & Fungicide 0.66X	10.8	25.3 ab	49.9
Insecticide & Fungicide 0.33X	16.0	28.7 ab	51.8
Fungicide alone 0X	27.5	34.1 a	53.0
Bare seed	27.2	33.4 a	53.9
Acetamiprid mean damage[3]	16.5 A	28.4 A	50.8 A
Clothianidin mean damage[3]	19.8 A	28.4 A	51.1 A
Pooled Standard Error	8.26	12.4	17.0
P# for treatment	0.0864	0.0501	n.s.
P# for insecticide	n.s.	n.s.	n.s.
P# for year	0.0057	0.0001	0.0010

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

[3] Mean damage over all five treatments.

Table 14. Average seed yield from canola cv SW Arrow seeded with five different ratios of acetamiprid- or/and clothianidin-coated:uncoated seed at Brandon, evaluated over three (acetamiprid) or two (clothianidin) years, 2002-2004.

Seed Ratio	Acetamiprid Seed yield (kg ha^{-1})	Clothianidin Seed yield (kg ha^{-1})	Both insecticides Seed yield (kg ha^{-1})
Insecticide & Fungicide 1X	1070[1]	1220	1200
Insecticide & Fungicide 0.66X	1110	1170	1170
Insecticide& Fungicide 0.33X	979	1130	1100
Fungicide alone 0X	959	1170	1130
Bare seed	927	1060	1030
Pooled standard error	320	482	458
Acetamiprid	---	---	1110
Clothianidin	---	---	1150
P# for treatment	n.s.	n.s.	n.s.
P# for year	0.0001	0.0001	0.0001
P# for insecticides	---	---	n.s.
P# for trt*year	0.0017	n.s.	n.s.

[1] Means within columns and groupings are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability. n.s. - differences not significant.

Table 15. Mean number of canola cv SW Arrow plants per m of row grown from seed with five different ratios of acetamiprid-coated:uncoated seed at Saskatoon, evaluated at three different time periods combined over three years, 2002-2004.

Seed Ratio	Evaluation Period 1[1] plants m row^{-1}	Evaluation Period 2 plants m row^{-1}	Evaluation Period 3 plants m row^{-1}
Acetamiprid & Fungicide 1X	13.7 a[2]	11.2 a	13.5 a
Acetamiprid & Fungicide 0.66X	12.4 ab	10.4 ab	11.7 ab
Acetamiprid & Fungicide 0.33X	11.4 bc	8.38 abc	11.0 ab
Fungicide alone 0X	6.77 c	5.92 bc	9.32 b
Bare seed	4.92 c	4.22 c	8.02 b
Pooled standard error	2.47	3.74	2.89
P# for treatment	0.0102	0.0376	0.0193
P# for year	0.0069	0.0001	0.0006
P# for trt*year	0.0035	0.0001	0.0001

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD).

Table 16. Mean number of canola cv SW Arrow plants per m of row grown from seed with five different ratios of clothianidin-coated:uncoated seed at Saskatoon, evaluated at three different time periods combined over two years, 2003-2004.

Seed Ratio	Evaluation Period 1[1] plants m row^{-1}	Evaluation Period 2 plants m row^{-1}	Evaluation Period 3 plants m row^{-1}
Clothianidin & Fungicide 1X	7.80	13.1 a[2]	19.7 a
Clothianidin & Fungicide 0.66X	7.69	13.3 a	17.1 ab
Clothianidin & Fungicide 0.33X	8.90	11.9 ab	16.1 ab
Fungicide alone 0X	5.50	9.92 bc	14.3 bc
Bare seed	5.41	7.88 c	10.8 c
Pooled standard error	1.69	3.96	1.78
P# for treatment	n.s.	0.0032	0.0266
P# for year	n.s.	0.0037	n.s.
P# for trt*year	0.0001	n.s.	n.s.

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

Table 17. Mean number of canola plants per m of row grown from seed with five different ratios of acetamiprid- or clothianidin-coated:uncoated seed at Saskatoon, evaluated at three different time periods combined over three years, 2002-2004.

Seed Ratio	Evaluation Period1[1] plants m row^{-1}	Evaluation Period 2 plants m row^{-1}	Evaluation Period 3 plants m row^{-1}
Insecticide & Fungicide 1X	10.3 a[2]	11.5 a	16.6
Insecticide & Fungicide 0.66X	9.63 a	11.3 a	14.4
Insecticide & Fungicide 0.33X	9.65 a	9.65 ab	13.7
Fungicide alone 0X	5.74 b	7.15 bc	12.0
Bare seed	4.72 b	5.31 c	9.63
Pooled standard error	1.73	3.19	1.55
Acetamiprid mean damage[3]	9.79 A	8.02 A	10.7 A
Clothianidin mean damage[3]	6.23 B	9.97 A	15.9 B
P# for treatment	0.0216	0.0117	n.s.
P# for insecticide	0.0294	n.s.	0.0086
P# for year	0.0207	0.0001	0.0046

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns followed by the same letter and case are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

[3] Mean damage over all five treatments.

Table 18. Percent leaf area eaten by flea beetles on youngest canola tissues grown from seed with five different ratios of acetamiprid-coated:uncoated seed at Saskatoon, evaluated at three different time periods combined over three years, 2002-2004.

	Evaluation Period 1[1]	Evaluation Period 2	Evaluation Period 3
Seed Ratio	% LAE	% LAE	% LAE
Acetamiprid & Fungicide 1X	6.01 c[2]	35.5 c	36.8 a
Acetamiprid & Fungicide 0.66X	8.14 bc	38.7 bc	40.9 a
Acetamiprid & Fungicide 0.33X	14.4 b	42.1 b	46.8 a
Fungicide alone 0X	46.4 a	59.3 a	54.9 a
Bare seed	50.0 a	61.6 a	54.6 a
Pooled standard error	9.45	15.5	14.9
P# for treatment	0.0005	0.0001	n.s.
P# for year	n.s.	0.0001	0.0003
P# for trt*year	0.0001	n.s.	0.0001

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

Table 19. Percent leaf area eaten by flea beetles on youngest canola tissues grown from seed with five different ratios of clothianidin-coated:uncoated seed at Saskatoon, evaluated at three different time periods combined over two years, 2003-2004.

	Evaluation Period 1[1]	Evaluation Period 2	Evaluation Period 3
Seed Ratio	% LAE	% LAE	% LAE
Clothianidin & Fungicide 1X	1.38 a[2]	9.93 b	21.7
Clothianidin & Fungicide 0.66X	2.74 a	11.5 b	25.3
Clothianidin & Fungicide 0.33X	2.62 a	15.4 ab	30.4
Fungicide alone 0X	5.07 a	32.7 a	37.1
Bare seed	5.12 a	36.9 a	40.4
Pooled standard error	1.88	5.25	4.48
P# for treatment	0.0794	0.0365	n.s.
P# for year	0.0519	n.s.	n.s.
P# for trt*year	n.s.	0.0005	0.0001

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

Table 20. Percent leaf area eaten by flea beetles on youngest canola tissues grown from seed with five different ratios of acetamiprid- or clothianidin-coated:uncoated seed at Saskatoon, evaluated at three different time periods combined over three years, 2002-2004.

	Evaluation Period 1[1]	Evaluation Period 2	Evaluation Period 3
Seed Ratio	% LAE	% LAE	% LAE
Insecticide & Fungicide 1X	3.24 c [2]	23.2 c	26.4
Insecticide & Fungicide 0.66X	5.43 bc	25.8 c	30.3
Insecticide & Fungicide 0.33X	8.35 b	29.5 bc	36.0
Fungicide alone 0X	26.2 a	47.8 ab	43.3
Bare seed	28.0 a	51.2 a	44.8
Pooled standard error	6.07	10.7	11.0
Acetamiprid mean damage[3]	24.9 A	47.2 A	46.8 A
Clothianidin mean damage[3]	3.54 B	23.8 B	25.5 B
P# for treatment	0.0002	0.0195	n.s.
P# for insecticide	0.0001	0.0011	0.0105
P# for year	n.s	0.0012	0.001

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Data from Evaluation Periods 1 and 2 transformed by log10(x+1) to stabilize variances. Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

[3] Mean damage over all five treatments.

Table 21. Average seed yield from canola seeded with five different ratios of acetamiprid- and clothianidin-coated:uncoated seed at Saskatoon, evaluated over three (acetamiprid, insecticides combined) or two (clothianidin) years, 2002-2004.

Seed Ratio	Acetamiprid[1] Seed yield (kg ha^{-1})	Clothianidin Seed yield (kg ha^{-1})	Both insecticides Seed yield (kg ha^{-1})
Insecticide & Fungicide 1X	834 a	984 a	799 a
Insecticide & Fungicide 0.66X	781 ab	1013 a	787 a
Insecticide& Fungicide 0.33X	697 b	925 a	701 a
Fungicide alone 0X	585 c	690 b	528 b
Bare seed	514 c[2]	688 b	491 b
Pooled standard error	480	338	383
Acetamiprid[2]	---	---	682 A
Clothianidin[2]	---	---	640 A
P# for treatment	0.0005	0.0383	0.0004
P# for year	0.0001	0.0001	0.0001
P# for insecticides	---	---	n.s.

[1] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

[2] Mean seed yields over all five treatments.

Table 22. Percent leaf area eaten by flea beetles on youngest canola tissues grown from seed with five different ratios of acetamiprid-coated:uncoated seed at Saskatoon and Brandon, evaluated at two time periods in 2002 (no late evaluation at Brandon in 2002).

	Evaluation Period 1[1]	Evaluation Period 2
Seed Ratio	% LAE	% LAE (Log10)
Acetamiprid & Fungicide 1X	8.19 c[2]	23.0 c
Acetamiprid & Fungicide 0.66X	10.5 c	25.2 c
Acetamiprid & Fungicide 0.33X	15.2 c	30.2 b
Fungicide alone 0X	33.4 b	47.4 a
Bare seed	46.1 a	45.8 a
Pooled standard error	3.61	4.02
Brandon[3]	17.0 B	15.4 B
Saskatoon[3]	28.3 A	53.3 A
P# for treatment	0.0001	0.0014
P# for location	0.0020	0.0001
P# for trt*location	0.0002	n.s.

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

[3] Mean damage over all five treatments.

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Table 23. Percent leaf area eaten by flea beetles on youngest canola tissues grown from seed with five different ratios of acetamiprid-coated:uncoated seed at Brandon, Melita, and Saskatoon, evaluated at three different time periods in 2003.

	Evaluation Period 1[1]	Evaluation Period 2	Evaluation Period 3
Seed Ratio	% LAE	% LAE	% LAE
Acetamiprid & Fungicide 1X	6.30 c[2]	44.5 c	51.4 b
Acetamiprid & Fungicide 0.66X	9.02 bc	49.4 bc	59.7 a
Acetamiprid & Fungicide 0.33X	13.2 b	54.8 ab	57.9 ab
Fungicide alone 0X	41.2 a	48.2 c	42.3 c
Bare seed	39.0 a	56.7 a	41.4 c
Pooled standard error	2.07	2.16	2.35
Brandon[3]	26.0 B	49.4 C	64.0 A
Melita[3]	7.09 C	61.7 B	—[4]
Saskatoon[3]	32.1 A	41.1 A	37.2 B
P# for treatment	0.0001	0.0038	0.0001
P# for location	0.0001	0.0001	0.0001
P # for trt*location	0.0001	0.0014	0.0001

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD).

[3] Mean damage over all five treatments.

[4] No third evaluation at Melita in 2003.

Table 24. Percent leaf area eaten by flea beetles on youngest canola tissues grown from seed with five different ratios of acetamiprid-coated:uncoated seed at Brandon and Saskatoon, evaluated at three different time periods in 2004.

	Evaluation Period 1[1]	Evaluation Period 2	Evaluation Period 3
Seed Ratio	% LAE	% LAE	% LAE
Acetamiprid & Fungicide 1X	6.34 b[2]	16.5 b	35.8
Acetamiprid & Fungicide 0.66X	6.31 b	18.4 b	36.9
Acetamiprid & Fungicide 0.33X	11.1 ab	18.1 b	34.5
Fungicide alone 0X	16.0 a	23.3 a	36.9
Bare seed	13.5 a	24. 1 a	35.8
Pooled standard error	1.70	1.98	1.43
Brandon[3]	6.17 B	20.5 A	37.8 A
Saskatoon[3]	15.2 A	19.8 A	33.7 B
P# for treatment	0.0032	0.0080	n.s.
P# for location	0.0001	n.s.	0.0056
P# for trt*location	0.0208	n.s.	n.s.

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

[3] Mean damage over all five treatments.

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Table 25. Percent leaf area eaten by flea beetles on youngest canola tissues grown from seed with five different ratios of acetamiprid-coated:uncoated seed at Brandon and Saskatoon, evaluated at three different time periods in 2002-2004. Log 10 transformation used.

	Evaluation Period 1[1]	Evaluation Period 2	Evaluation Period 3
Seed Ratio	% LAE	% LAE	% LAE[2]
Acetamiprid & Fungicide 1X	7.12 bc	26.7	43.6
Acetamiprid & Fungicide 0.66X	9.30 bc	30.3	47.7
Acetamiprid & Fungicide 0.33X	14.4 b	33.2	46.2
Fungicide alone 0X	35.6 a	36.0	39.6
Bare seed	37.5 a	40.0	38.6
Pooled standard error	7.37	9.99	9.35
Brandon[3]	16.4	28.4	50.9
Saskatoon[3]	25.2	38.1	35.4
P# for treatment	0.0018	n.s.	n.s.
P# for location	n.s.	n.s.	n.s.
P# for trt*location	0.0001	n.s.	n.s.

[1]Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). Evaluation Period 1 - data transformed by log10(x+1) to stabilize variances. n.s. - differences not significant.

[2] No third evaluation at Brandon in 2002. Data from 2003-2004.

[3] Mean damage over all five treatments.

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Table 26. Percent leaf area eaten by flea beetles on youngest canola tissues grown from seed with five different ratios of clothianidin-coated:uncoated seed at Saskatoon and Brandon, evaluated at three different time periods in 2003.

	Evaluation 1[1]	Evaluation 2	Evaluation 3
Seed Ratio	% LAE	% LAE	% LAE
Clothianidin & Fungicide 1X	7.38 a [2]	23.5 c	38.2 c
Clothianidin & Fungicide 0.66X	8.35 a	29.0 bc	41.7 c
Clothianidin & Fungicide 0.33X	15.6 b	35.3 b	49.3 b
Fungicide alone 0X	28.7 c	52.2 a	58.3 a
Bare seed	27.9 c	54.7 a	61.5 a
Pooled standard error	1.07	2.59	1.58
Brandon [3]	33.3 A	55.5 A	70.9 A
Saskatoon [3]	1.89 B	22.3 B	28.7 B
P # for treatment	0.0001	0.0001	0.0001
P # for location	0.0001	0.0001	0.0001
P # for trt*location	0.0001	0.0075	0.0432

[1] Evaluation 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns followed by the same letter and case are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD).

[3] Mean damage over all five treatments.

Table 27. Percent leaf area eaten by flea beetles on youngest canola tissues grown from seed with five different ratios of clothianidin-coated:uncoated seed at Saskatoon and Brandon, evaluated at three different time periods in 2004.

	Evaluation 1[1]	Evaluation 2	Evaluation 3
Seed Ratio	% LAE	% LAE	% LAE
Clothianidin & Fungicide 1X	2.34 a[2]	21.7 a	28.6
Clothianidin & Fungicide 0.66X	4.91 a	20.1 a	33.2
Clothianidin & Fungicide 0.33X	4.49 a	16.1 ab	34.9
Fungicide alone 0X	8.03 a	15.8 ab	30.9
Bare seed	8.72 a	12.2 b	33.2
Pooled standard error	1.00	2.23	2.02
Brandon[3]	6.31 A	14.0 B	31.0 A
Saskatoon[3]	5.10 A	20.4 A	33.3 A
P # for treatment	0.0007	0.0479	n.s.
P # for location	n.s.	0.0039	n.s.
P# trt*location	n.s.	0.0115	0.0466

[1] Evaluation 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

[3] Mean damage over all five treatments.

Table 28. Percent leaf area eaten by flea beetles on youngest canola tissues grown from seed with five different ratios of clothianidin-coated:uncoated seed at Brandon and Saskatoon, evaluated at three different time periods in 2003 and 2004.

	Evaluation Period 1[1]	Evaluation Period 2	Evaluation Period 3
Seed Ratio	% LAE	% LAE	% LAE
Clothianidin & Fungicide 1X	4.86[2]	17.8	33.5
Clothianidin & Fungicide 0.66X	6.63	22.4	37.5
Clothianidin & Fungicide 0.33X	10.0	25.7	42.3
Fungicide alone 0X	18.3	36.1	44.5
Bare seed	18.3	38.2	47.1
Pooled standard error	7.88	11.8	10.9
Brandon[3]	19.8	34.7	51.0
Saskatoon[3]	3.49	21.4	31.0
P# for treatment	n.s.	n.s.	n.s.
P# for location	n.s.	n.s.	n.s.
P# for trt*location	n.s.	0.0001	n.s.

[1] Evaluation Period 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation Period 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation Period 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Means within columns and groupings are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability. n.s. - differences not significant.

[3] Mean damage over all five treatments.

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Table 29. Percent leaf area eaten by flea beetles on youngest canola tissues grown from seed with five different ratios of acetamiprid- or clothianidin-coated:uncoated seed at Saskatoon and Brandon, evaluated at three different time periods in 2002-2004.

	Evaluation 1[1]	Evaluation 2	Evaluation 3
Seed Ratio	% LAE	% LAE	% LAE
Insecticide & Fungicide 1X	6.23 c[2]	22.8 c	32.2 a
Insecticide & Fungicide 0.66X	8.24 bc	26.9 bc	34.4 a
Insecticide & Fungicide 0.33X	12.4 b	29.8 abc	34.7 a
Fungicide alone 0X	26.8 a	35.9 ab	33.9 a
Bare seed	28.9 a	39.0 a	34.5 a
Pooled standard error	6.52	7.88	1.24
Brandon[3]	18.3 A	29.0 A	34.4 A
Saskatoon[3]	14.4 A	32.7 A	33.5 A
Acetamiprid[3]	20.7 a	33.2 A	35.8 A
Clothianidin[3]	12.3 b	28.5 A	32.1 B
P # for treatment	0.0006	0.0192	n.s.
P # for location	n.s.	n.s.	n.s.
P # for insecticide	0.0389	n.s.	0.0027
P# for location*insecticide	0.0384	n.s.	0.0078
P# trt*location	n.s.	n.s.	0.0073
P# for trt*insecticide	n.s.	n.s.	n.s.
P# trt*location*insecticide	n.s.	n.s.	n.s.

[1] Evaluation 1 - the first assessment date, 1 to 6 days after seedling emergence. Growth stage was cotyledon to first true leaf; Evaluation 2 - the second assessment date, 7 to 13 days after seedling emergence. Growth stage was cotyledon to second true leaf; Evaluation 3 - the third assessment date, 14 to 21 days after seedling emergence. Growth stage was first to third true leaf.

[2] Data from Evaluation 1 transformed by log (x+1) to stabilize variances. Means within columns followed by the same letter and case are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

[3] Mean damage over all five treatments.

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Table 30. Average seed yield from canola cv SW Arrow seeded with five different ratios of acetamiprid-coated:uncoated seed at Brandon and Saskatoon, 2002.

	Acetamiprid
Seed Ratio	Seed yield (kg ha^{-1})
Insecticide & Fungicide 1X	508 b[1]
Insecticide & Fungicide 0.66X	549 b
Insecticide & Fungicide 0.33X	423 a
Fungicide alone 0X	361 a
Bare seed	306 a
Pooled standard error	40.7
Brandon	626 A
Saskatoon	233 B
P# for treatment	0.0025
P# for location	0.0001
P # for trt*location	n.s.

[1]Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

Table 31. Average seed yield from canola cv SW Arrow seeded with five different ratios of acetamiprid- or clothianidin-coated:uncoated seed, or seed yields combined over both insecticides, at Brandon, Melita, and Saskatoon, 2003.

	Seed yield (kg ha^{-1})		
Seed Ratio	Acetamiprid	Clothianidin	Both insecticides
Insecticide & Fungicide 1X	1050[1]	678 a	690 a
Insecticide & Fungicide 0.66X	914	693 a	606 b
Insecticide & Fungicide 0.33X	892	664 a	558 b
Fungicide alone 0X	871	488 b	409 c
Bare seed	878	468 b	457 c
Pooled standard error	47.4	44.1	25.9
Brandon[2]	806 B	670 A	738 A
Melita[2]	1790 A	---	---
Saskatoon[2]	174 C	526 B	350 B
P# for treatment	n.s.	0.0095	0.0001
P# for location	0.0001	0.0039	0.0001
P # for trt*location	0.0093	n.s.	0.0592
P# for insecticides	---	---	0.0001

[1] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

[2] Mean damage over all five treatments.

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Table 32. Average seed yield from canola seeded with five different ratios of acetamiprid- or clothianidin-coated:uncoated seed, or seed yields combined over both insecticides at Brandon and Saskatoon, 2004.

	Acetamiprid	Clothianidin	Both insecticides
Seed Ratio	Seed yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Seed yield (kg ha^{-1})
Insecticide & Fungicide 1X	1650 a[1]	1520 a	1590 a
Insecticide & Fungicide 0.66X	1610 a	1510 a	1560 ab
Insecticide & Fungicide 0.33X	1660 a	1400 b	1530 ab
Fungicide alone 0X	1630 a	1370 cd	1500 b
Bare seed	1540 a	1260 d	1400 c
Pooled standard error	31.1	34.4	23.5
Brandon[2]	1600 A	1630 A	1610 A
Saskatoon[2]	1640 A	1190 B	1420 B
Acetamiprid [2]	---	---	1620 a
Clothianidin[2]	---	---	1410 b
P# for treatment	0.0726	0.0001	0.0001
P# for location	n.s.	0.0001	0.0001
P # for trt*location	0.0002	0.0007	0.0001
P# for insecticides	---	---	0.0001

[1]Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

[2] Mean damage over all five treatments.

Table 33. Average seed yield from canola cv SW Arrow seeded with five different ratios of acetamiprid- or clothianidin-coated: uncoated seed, at Brandon and Saskatoon, 2002 (acetamiprid) or 2003(clothianidin) -2004, or both insecticides (2002-2004).

	Acetamiprid	Clothianidin	Both insecticides
Seed Ratio	Seed yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Seed yield (kg ha^{-1})
Insecticide & Fungicide 1X	942 [1]	1110	925
Insecticide & Fungicide 0.66X	895	1090	895
Insecticide & Fungicide 0.33X	842	1030	851
Fungicide alone 0X	779	934	771
Bare seed	766	877	723
Pooled standard error	409	413	426
Brandon [2]	1010	1160	985
Saskatoon [2]	682	860	677
Acetamiprid [2]	---	---	847
Clothianidin [2]	---	---	815
P# for treatment	n.s.	n.s.	n.s.
P# for location	n.s.	n.s.	n.s.
P # for trt*location	n.s.	n.s.	n.s.
P# for insecticides	---	---	n.s.

[1]Means within columns and groupings are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability.

[2] Mean damage over all five treatments.

Table 34. Feeding damage expressed as % leaf area eaten to cotyledons and first true leaves of canola cvs 46A65, conventional canola, and 45H21, herbicide tolerant canola with or without the insecticide Helix®, seeded at 200 seeds per 6.1 m row at Brandon, MB, 2004, and evaluated at three dates after seedling emergence (DAE)

	7 DAE	14 DAE			21 DAE		
Seed Treatment	cot	cot	leaf1	leaf2	cot	leaf1	leaf2
46A65 canola bare seed	6.7	14.1	6.6	1.4	19.0	10.8	3.3
45H21 canola bare seed	8.2	14.2	8.4	2.9	19.4	12.3	5.9
45H21 canola with Helix®	4.8	12.7	3.9	0.7	17.0	11.0	6.5
45H21 bare seed & 46A65	6.4	11.4	5.7	3.2	13.2	9.7	6.4
45H21 with Helix® & 46A65	4.6	10.1	3.1	1.5	14.5	8.9	7.6
P#	n.s.[1]	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

[1]Means within columns are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability. Analysis conducted on ranked data to account for qualitative values for growth stage.

Table 35. Seed yield of canola cv 45H21, Roundup Ready® canola with and without the insecticide Helix®, seeded at 200 seeds per 6.1 m row at Brandon, MB, 2004.

Treatment	Seed Yield (kg ha^{-1})
46A65	---
45H21 Bare seed	1795
45H21+Helix	1791
45H21+46A65	1755
45H21+H+46A	1701
P#	n.s.

[1]Means within columns are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability.

Table 36. Average (± standard error of the mean) number of canola plants per m row of cvs 46A65, conventional canola, and 45H21, Roundup Ready® canola with and without the insecticide Helix®, seeded at 200 seeds per 6.1 m row at Saskatoon, SK, 2004, and evaluated at four dates after seedling emergence (DAE).

	Average number canola plants 1 m row $^{-1}$							
TRT	5 DAE		11 DAE		20 DAE		38 DAE	
46A65 canola bare seed	27.2	1.1	20.2b[1]	0.5	25.0	1.1	–[2]	
45H21 RR canola bare seed	23.4	2.8	21.4b	1.9	21.8	1.7	19.1 b	1.6
45H21 canola with Helix®	26.6	2.3	26.6a	1.4	24.5	1.4	25.4 a	1.5
45H21 with Helix® & 46A65	27.0	0.7	26.4a	2.1	27.0	1.0	18.2 b	2.5
45H21 bare seed & 46A65	26.2	0.9	23.8ab	0.6	23.0	1.4	16.5 b	2.6
P#	n.s.		0.0120		n.s.		0.0037	
LSD			3.87				4.31	

[1]Means within columns followed by the same letter are not significantly different from one another as determined by the general linear model of analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

[2] Treatment 46A65 non-herbicide tolerant canola sprayed with Transorb Roundup at a rate of 0.5l per acre on June 25, 2004, 27 DAE.

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Table 37. Feeding damage expressed as % leaf area eaten to cotyledons and first true leaves of canola cvs 46A65, conventional canola, and 45H21, Roundup Ready® canola with and without the insecticide Helix®, seeded at 200 seeds per 6.1 m row at Saskatoon, SK, 2004, and evaluated at three dates after seedling emergence (DAE).

	% Leaf Area Eaten					
TRT	5 DAE		11 DAE		20 DAE	
46A65 canola bare seed	13.8 b	2.0	35.8 a	2.6	36.9 a	2.8
45H21 RR canola bare seed	13.6 b	2.3	30.8 ab	1.3	36.9 a	1.7
45H21 canola with Helix®	4.4 a	1.5	16.2 d	1.2	20.2 c	1.2
45H21 with Helix® & 46A65	6.3 a	1.8	22.5 c	1.1	28.0 b	0.5
45H21 bare seed & 46A65	11.7 b	2.6	28.7 b	1.7	33.4 a	0.7
P#	0.0033		0.0001		0.0001	
LSD	3.48		5.07		5.16	

[1] Data from rating taken 5 days after emergence transformed by log(x+1) to stabilize variances. Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD).

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Table 38. Growth stage (± standard error of the mean) of canola cvs 46A65 and 45H21 seeded at Saskatoon, 2004, and evaluated at three dates after seedling emergence (DAE).

	Average Growth Stage[1]					
TRT	5 DAE		11 DAE		20 DAE	
46A65 canola bare seed	1.0	0	1.8 d[2]	0	2.3 d	0
45H21 RR canola bare seed	1.0	0	2.1 bc	0.1	2.4 b	0
45H21 canola with Helix®	1.0	0	2.2 a	0	2.4 a	0
45H21 with Helix® & 46A65	1.0	0	2.1 b	0	2.3 c	0
45H21 bare seed & 46A65	1.0	0	2.0 c	0	2.3 c	0
P # for ranked data	n.s.		0.0001		0.0001	

[1] Growth stage rated according to the scale of Harper and Berkencamp (1971), whereupon canola in the cotyledon stage is rated as 1.0, at the first true leaf stage as 2.0, at the bud stage as 3.0.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - not significant.

Table 39. Canola biomass and plant density per m row (± standard error of mean) 46 days after emergence and 18 days after application of glyphosate to eliminate non-herbicide tolerant 46A65 seedlings, Saskatoon, 2004.

	Canola biomass per 1 m row					
TRT	Fresh weight (g)		Dry weight (g)		Plant count	
46A65 canola bare seed[1]	4.80 d[2]	0.1	1.0 d	0.3	21.6	3.2
45H21 RR canola bare seed	596 b	58.5	64.4 b	5.7	25.4	3.8
45H21 canola with Helix®	833 a	71.7	101 a	8.1	31.0	3.3
45H21 with Helix® & 46A65	548 b	52.6	62.0 b	4.9	22.6	4.0
45H21 bare seed & 46A65	415 c	52.0	45.9 c	4.2	18.6	2.4
P#	0.0001		0.0001		n.s.	
LSD	129		13.5			

[1] Non herbicide-tolerant 46A65 and/or volunteer canola grew in the rows after glyphosate application.

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD).n.s. - not significant.

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Table 40. Seed yield of canola cv 45H21 with and without the insecticide Helix® and with and without seed of the non-herbicide tolerant cv 36A65, seeded at 200 seeds per 6.1 m row and subsequently sprayed with glyphosate 27 days after emergence at Saskatoon, SK, 2004.

Treatment	Seed Yield (kg ha^{-1})	±SE
46A65	---	
45H21 Bare seed	2190 [1]	70.3
45H21+Helix	2080	41.9
45H21+46A65	2120	80.5
45H21+Helix+46A65	2040	89.8
P#	n.s.	

[1]Means within columns are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability.

Figure 1. Feeding damage to cotyledons and first true leaves of canola CV SW Arrow seed coated with various levels of the insecticide acetamiprid, seeded at Saskatoon, SK, 2004, and evaluated at three dates after seedling emergence.

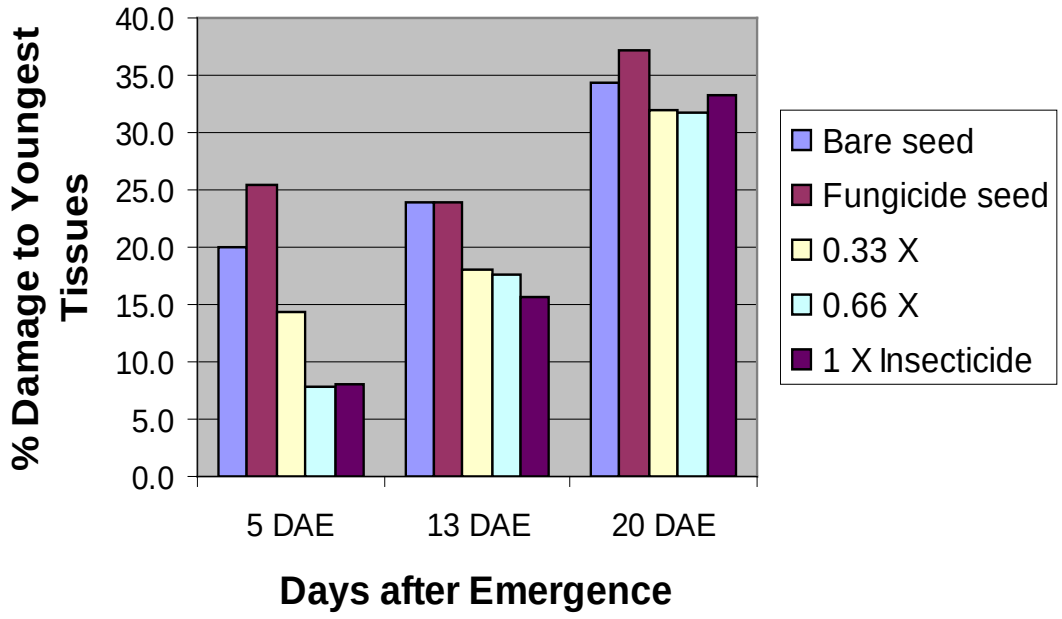

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Figure 2. Feeding damage to cotyledons and first true leaves of canola CV SW Arrow seed coated with various levels of the insecticide clothianidin (Prosper 200®) seeded at Saskatoon, SK, 2004 and evaluated on three days after seedling emergence.

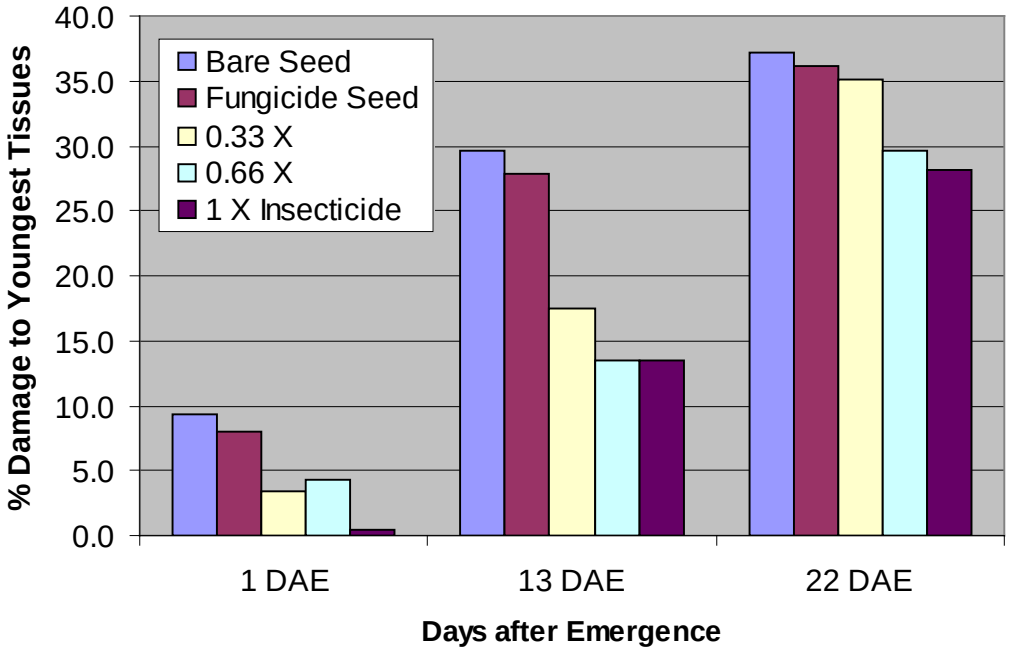

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Figure 3. Mean flea beetle damage to youngest canola cv SW Arrow foliage grown from seed planted in different ratios of seed coated with acetamiprid or clothianidin insecticides and rated 1-6 days after emergence, Brandon, 2002-2004 and Melita acetamiprid 2003.

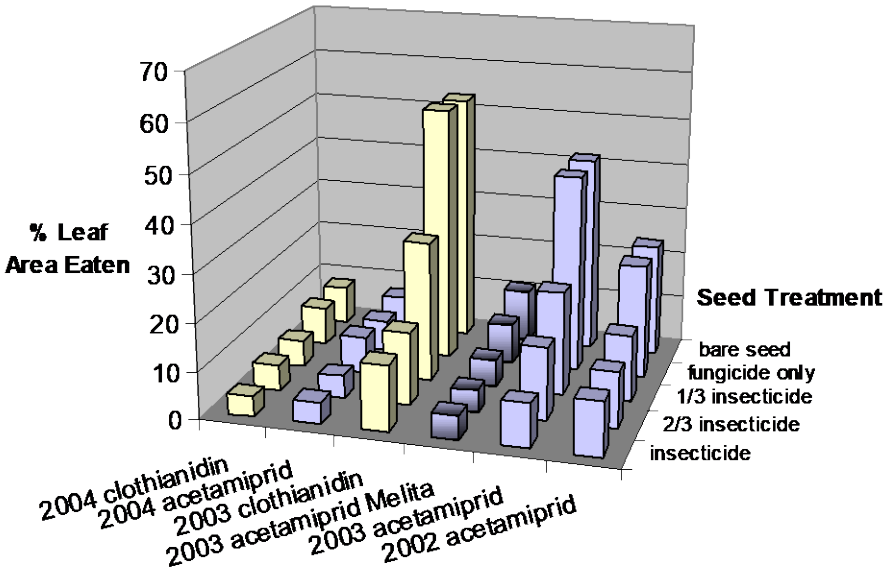

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Figure 4. Mean flea beetle damage to youngest canola cv SW Arrow foliage grown from seed planted in different ratios of seed coated with acetamiprid or clothianidin insecticides and rated 7-13 days after emergence, Brandon 2002-2004 and Melita acetamiprid 2003.

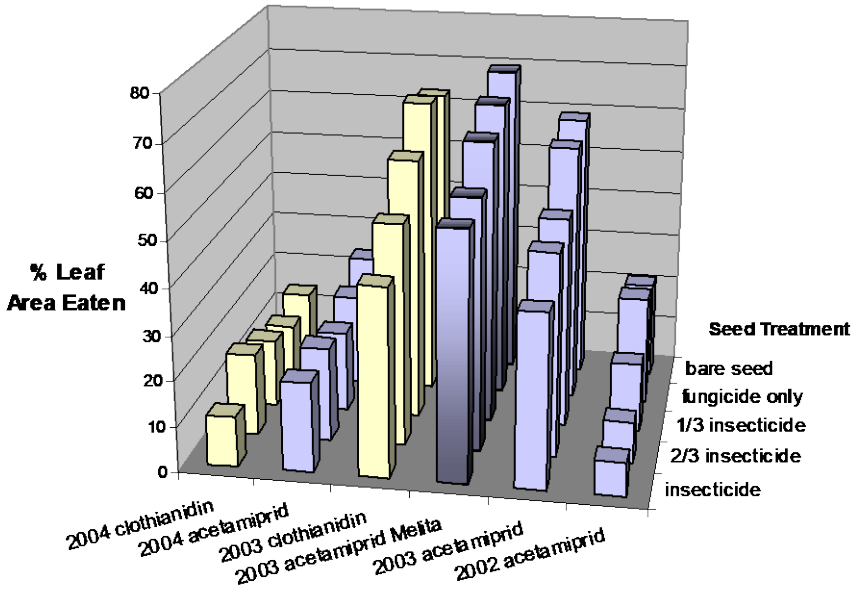

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Figure 5. Mean flea beetle damage to youngest canola cv SW Arrow foliage grown from seed planted in different ratios of seed coated with acetamiprid or clothianidin insecticides and rated14-21 days after emergence, Brandon 2002-2004 and Melita acetamiprid 2003.

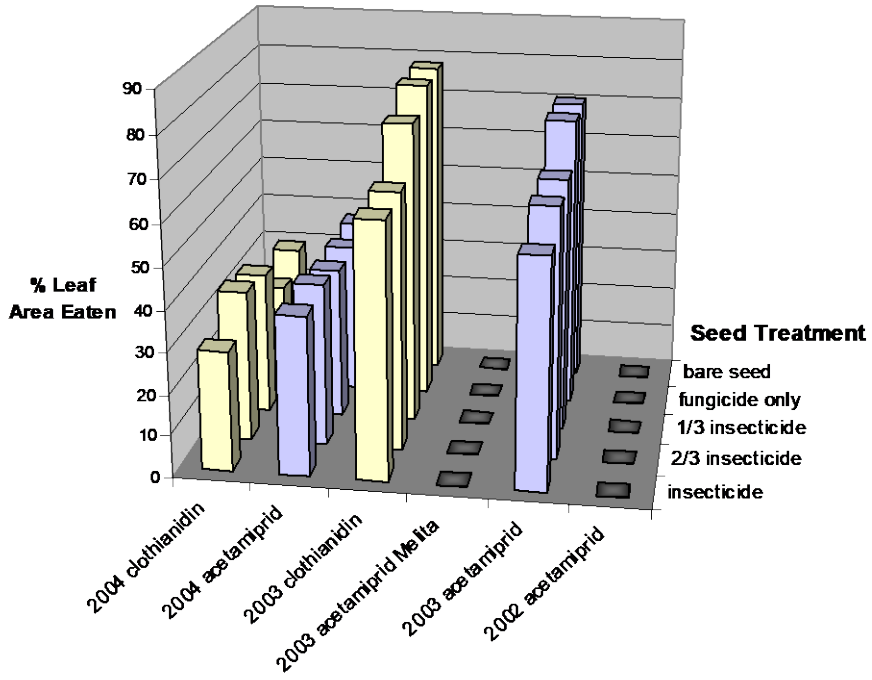

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Figure 6. Mean flea beetle damage to youngest canola cv SW Arrow foliage grown from seed planted in different ratios of seed coated with acetamiprid or clothianidin insecticides and rated 1-6 days after emergence, Saskatoon, 2002-2004.

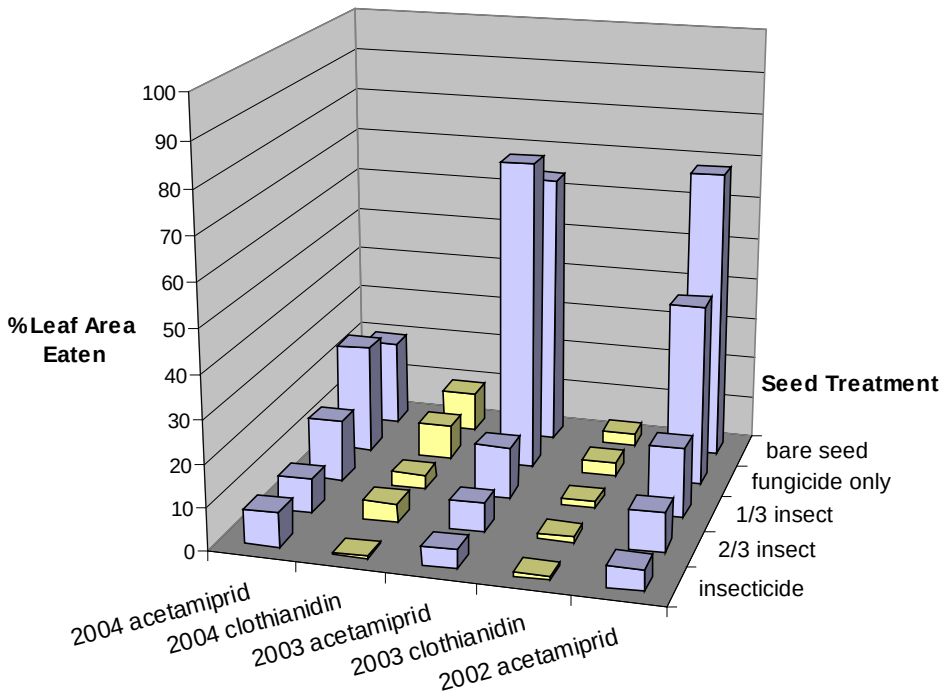

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Figure 7. Mean flea beetle damage to youngest canola cv SW Arrow foliage grown from seed planted in different ratios of seed coated with acetamiprid or clothianidin insecticides and rated 7-13 days after emergence, Saskatoon, 2002-2004.

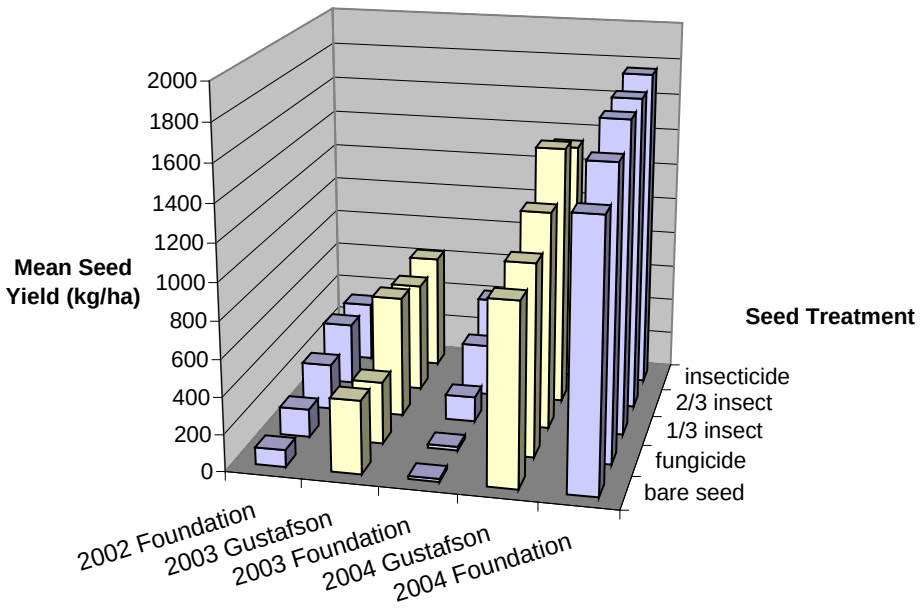

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Figure 8. Mean flea beetle damage to youngest canola cv SW Arrow foliage grown from seed planted in different ratios of seed coated with acetamiprid or clothianidin insecticides and rated 14-21 days after emergence, Saskatoon, 2002-2004.

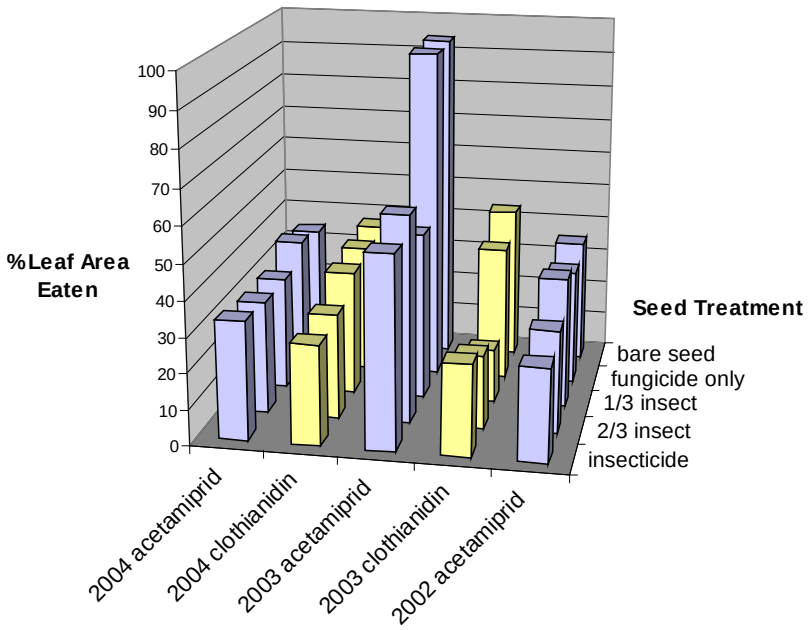

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Figure 9. Seed yields of canola cv SW Arrow grown from seed planted in different ratios of seed coated with one of two insecticides, Brandon 2002-2004.

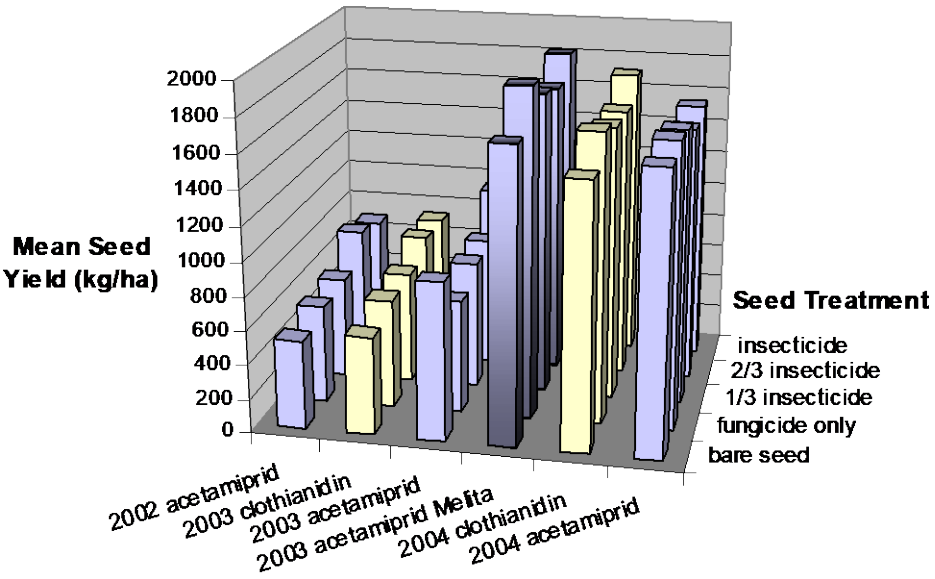

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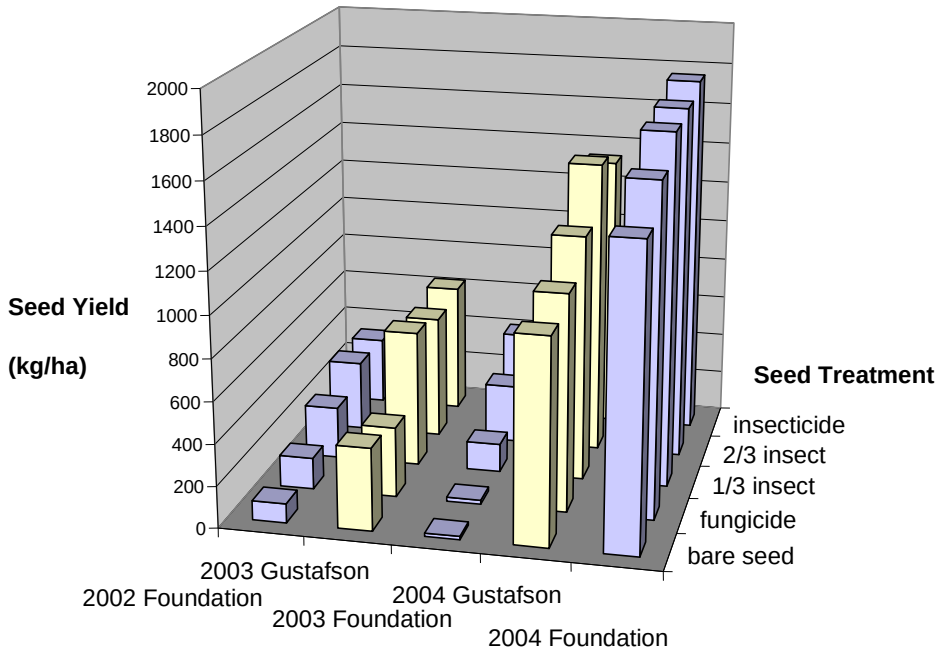
Figure 10. Seed yields of canola cv SW Arrow grown from seed planted in different ratios of seed coated with one of two insecticides, Saskatoon 2002-2004.



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APPENDIX 1. Weather statistics for the 2004 growing season

Weather conditions for Brandon AAC 2004:

Month	Avg. Temp.	Max. Temp.	Min. Temp.	Deviation from normal	Precip. (mm)	% Normal
May	7.1	13.7	0.5	-4.1	142	315
June	14.2	20.6	7.9	-2.3	39	59
July	18	24.3	11.7	-1.2	76	146
August	13.9	20	7.7	-3.6	73.6	74

Weather conditions for Saskatoon AAC 2004:

Month	Avg. Temp.	Max. Temp.	Min. Temp.	Deviation from normal	Precip. (mm)	% Normal
May	8.3	15.1	1.4	-3.2	32	77
June	13.4	19.4	7.3	-2.6	87	142
July	18	23.9	12	-0.2	83	138
August	14.1	20.4	7.7	-3.3	73	188

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APPENDIX 2. Mean percent leaf area eaten by flea beetles on youngest canola cv SW Arrow tissues grown from seed with five different ratios of acetamiprid-coated:uncoated seed at Brandon, evaluated at 7 and 14 days after seedling emergence, and canola seed yields in 2002.

	% Leaf Area Eaten		Seed yield
Seed Ratio	7 DAE	14 DAE	(kg ha^{-1})
Acetamiprid & Fungicide 1X	11.5 a [1]	7.45 c	690
Acetamiprid & Fungicide 0.66X	11.8 a	9.00 c	757
Acetamiprid & Fungicide 0.33X	14.0 a	15.2 b	594
Fungicide alone 0X	24.1 a	24.1 a	569
Bare seed	23.7 a	21.2 ab	519
P#	n.s.	0.0001	n.s.
LSD		8.55	

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APPENDIX 3. Mean percent leaf area eaten by flea beetles on youngest canola cv SW Arrow tissues grown from seed with five different ratios of clothianidin-coated:uncoated seed at Brandon, evaluated at 7, 14, and 21 days after seedling emergence, and canola seed yields in 2003.

	% Leaf Area Eaten			Seed yield
Seed Ratio	7 DAE	14 DAE	21 DAE	(kg ha^{-1})
Acetamiprid & Fungicide 1X	9.28 c [1]	38.2 c	55.5 c	941 a
Acetamiprid & Fungicide 0.66X	15.3 c	45.0 bc	61.0 bc	753 b
Acetamiprid & Fungicide 0.33X	21.8 b	46.8 b	61.9 b	748 b
Fungicide alone 0X	41.9 a	57.5 a	71.1 a	664 b
Bare seed	41.6 a	59.3 a	70.6 a	923 a
P#	0.0001	0.0001	0.0004	0.0035
LSD	6.51	7.06	6.03	135

[1]Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

APPENDIX 4. Mean percent leaf area eaten by flea beetles on youngest canola cv SW Arrow tissues grown from seed with five different ratios of clothianidin-coated:uncoated seed at Melita, MB, evaluated at 7 and 14 days after seedling emergence, and canola seed yields in 2003.

	% Leaf Area Eaten		Seed yield
Seed Ratio	7 DAE	14 DAE	(kg ha^{-1})
Acetamiprid & Fungicide 1X	4.75 c [1]	54.4 b	1822
Acetamiprid & Fungicide 0.66X	5.28 c	55.7 b	1706
Acetamiprid & Fungicide 0.33X	5.85 c	62.8 ab	1774
Fungicide alone 0X	8.37 b	66.4 a	1918
Bare seed	11.2 a	69.5 a	1708
P#	0.0021	0.0161	n.s.
LSD	2.45	8.82	

[1]Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

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APPENDIX 5. Mean percent leaf area eaten by flea beetles on youngest canola cv SW Arrow tissues grown from seed with five different ratios of clothianidin-coated:uncoated seed at Brandon, evaluated at 7, 14, and 21 days after seedling emergence, and canola seed yields in 2003.

	% Leaf Area Eaten			Seed yield
Seed Ratio	7 DAE	14 DAE	21 DAE	(kg ha^{-1})
Clothianidin & Fungicide 1X	14.0 c [1]	41.5 c	61.8 b	730
Clothianidin & Fungicide 0.66X	15.4 c	49.1 bc	62.6 b	739
Clothianidin & Fungicide 0.33X	29.7 b	57.9 ab	73.7 a	658
Fungicide alone 0X	54.1 a	65.8 a	78.2 a	640
Bare seed	53.1 a	63.3 a	78.2 a	574
P#	0.0001	0.0013	0.0013	n.s.
LSD	5.99	10.4	8.35	

[1]Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

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APPENDIX 6. Mean (± standard error of the mean) number of canola cv SW Arrow plants per 6.1 m row grown from seed with five different ratios of acetamiprid-coated:uncoated seed on four dates after seedling emergence, Saskatoon, 2002.

	7 days after emergence		14 days after emergence		21 days after emergence		28 days after emergence	
Seed Treatment	Plants Row^{-1}	SE	Plants Row^{-1}	SE	Plants Row^{-1}	SE	Plants Row^{-1}	SE
Full seed 1X	125 a	23	111 a	15	169 a	22	145 a	13
2/3 seed 0.6X	94 a	16	108 a	8	148 a	13	142 a	3
1/3 seed 0.3X	103 a	32	87 a	31	146 a	18	137 a	7
Fungicide alone 0X	52 b	17	21 b	14	128 ab	19	118 a	14
Bare seed	43 b	10	1 b	0.5	114 bc	14	91 b	6
P#	0.0001		0.0001		0.005		0.001	
LSD	34		37		23		19	

[1] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - means not significantly different.

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APPENDIX 7. Mean percent leaf area eaten by flea beetles on youngest canola cv SW Arrow tissues grown from seed with five different ratios of acetamiprid-coated:uncoated seed, evaluated at 7 to 28 days after seedling emergence at Saskatoon, 2002.

	7 days after emergence		14 days after emergence		21 days after emergence		28 days after emergence	
	Mean %		Mean %		Mean %		Mean %	
Seed treatment	LAE	SE	LAE	SE	LAE	SE	LAE	SE
Full seed 1X	5 b	1	38 b	6	26	5	50 b	4
2/3 seed 0.6X	9 b	3	41 b	7	29	3	56 ab	4
1/3 seed 0.3X	16 b	4	45 b	6	37	10	59 ab	5
Fungicide alone 0X	43 a	7	71 a	7	33	9	60 a	8
Bare seed	68 a	10	70 a	12	36	3	64 a	3
P#	0.0001		0.05		n.s.		0.05	
LSD	24		24				8	

[1]Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s.- differences not significant.

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APPENDIX 8. Mean growth stage, based on Harper and Berkenkamp's 1 (seedling) to 5 (mature plant) scale, of canola seeded with or without one of four rates of insecticide-coated seed and subject to heavy flea beetle feeding near Saskatoon, 2002.

	Mean Growth Stage[1]			
Seed Treatment	7 days after emergence	14 days after emergence	21 days after emergence	28 days after emergence
Full seed 1X	1	2 a [2]	1.2	2.1
2/3 seed 0.6X	1	2 a	1.2	2
1/3 seed 0.3X	1	1.9 a	1.5	2
Fungicide alone 0X	1	1.5 b	1.2	1.9
Bare seed	1	1.2 c	1.1	1.9
P#	n.s.	0.0001	n.s	n.s.

[1] 1 = seedling, 2 = rosette (2.1 = first true leaf expanded)

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

APPENDIX 9. Mean seed yield and thousand seed weight (± SEM) of B. napus canola seeded with different ratios of acetamiprid-treated seed at Saskatoon, 2002.

Ratio of Seed Treated with Insecticide	Seed Yield (kg ha^{-1})	1000 Seed Weight (g)
Full seed rate 1X	326 ± 96	2.43 ± 0.12
2/3 seed rate 0.6X	340 ± 102	2.41 ± 0.08
1/3 seed rate 0.3X	252 ± 64	2.40 ± 0.16
Fungicide alone 0X	152 ± 33	2.11 ± 0.08
Bare seed	93 ± 22	2.10 ± 0.17
P#	0.005	0.005
LSD	123	0.18

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APPENDIX 10. Mean (± standard error of the mean) number of canola cv SW Arrow plants per m row grown from seed with five different ratios of acetamiprid-coated:uncoated seed at Saskatoon, 2003.

	3 DAE		11 DAE		17 DAE	
Seed Ratio	Plants $^{-1}$ row	±SE	Plants $^{-1}$ row	±SE	Plants $^{-1}$ row	±SE
Acetamiprid & Fungicide 1X	26.9 a[1]	2.5	14.0 a	0.6	17.7 a	0.5
Acetamiprid & Fungicide 0.66X	24.7 ab	2.4	14.0 a	1.0	13.9 ab	1.0
Acetamiprid & Fungicide 0.33X	20.6 b	1.5	3.3 b	0.9	10.7 b	1.0
Fungicide alone 0X	5.1 c	1.5	0.2 b	1.3	4.6 c	1.9
Bare seed	3.1 c	0.68	0.3 b	1.8	3.2 c	2.5
P#	0.0001		0.0001		0.0001	
LSD	4.81		3.61		4.83	

[1] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

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APPENDIX 11. Mean percent leaf area eaten by flea beetles on youngest canola cv SW Arrow tissues grown from seed with five different ratios of clothianidin-coated:uncoated seed at Saskatoon, evaluated at 3, 11, and 17 days after seedling emergence, and canola seed yields in 2003.

	3 DAE	11 DAE	17 DAE
Seed Ratio	% LAE	% LAE	% LAE
Acetamiprid & Fungicide 1X	4.36 c[1]	49.6 b	50.3 c
Acetamiprid & Fungicide 0.66X	6.78 bc	54.6 b	62.0 bc
Acetamiprid & Fungicide 0.33X	12.2 b	61.4 b	72.4 b
Fungicide alone 0X	73.0 a	87.3 a	94.1 a
Bare seed	64.2 a	94.1 a	94.2 a
P#	0.0001	0.0001	0.0001
LSD	17.9	14.1	10.4

[1] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD).

APPENDIX 12. Mean growth stage, based on Harper and Berkenkamp's 1 (seedling) to 5 (mature plant) scale, of canola seeded with or without one of four rates of acetamiprid-coated seed and canola seed yields, Saskatoon, 2003.

	Mean Growth Stage[1]			
Seed Treatment	3 days after emergence	11 days after emergence	17 days after emergence	Seed Yields (kg ha^{-1})
Full seed 1X	1.00	2.02	2.19 ab[2]	411 a
2/3 seed 0.6X	1.01	2.09	2.25 a	283 a
1/3 seed 0.3X	1.00	1.85	1.95 b	137 b
Fungicide alone 0X	1.00	1.71	1.14 c	19.8 c
Bare seed	1.00	1.64	1.15 c	16.2 c
P#	n.s.	n.s.	0.0001	0.0013

[1]1 = seedling, 2 = rosette (2.1 = first true leaf expanded)

[2] Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD). n.s. - differences not significant.

APPENDIX 13. Mean number canola cv SW Arrow seedlings per 1 m row grown from seed with five different ratios of clothianidin-coated:uncoated seed at Saskatoon, evaluated at 1, 7, and 15 days after seedling emergence, and canola seed yields in 2003.

	No. Plants Row^{-1}		
Seed Ratio	1 DAE	7 DAE	15 DAE
Clothianidin & Fungicide 1X	13.6 bc[1]	17.5 a	38.8 a
Clothianidin & Fungicide 0.66X	15.8 b	17.5 a	34.0 ab
Clothianidin & Fungicide 0.33X	21.3 a	17.3 a	34.8 a
Fungicide alone 0X	12.4 c	8.7 b	25.8 bc
Bare seed	12.6 c	6.3 b	23.2 c
P#	0.0001	0.02	0.009
LSD	2.8	8.2	8.5

[1]Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD).

APPENDIX 14. Mean percent leaf area eaten by flea beetles on youngest canola cv SW Arrow tissues grown from seed with five different ratios of clothianidin-coated:uncoated seed, evaluated at 7 to 28 days after seedling emergence at Saskatoon, and canola seed yields 2003.

	% Leaf Area Eaten			Seed yield
Seed Ratio	1 DAE	7 DAE	15 DAE	(kg ha^{-1})
Clothianidin & Fungicide 1X	0.8 a [1]	5.42 c	15.1 d	632.3 a
Clothianidin & Fungicide 0.66X	1.3 a	8.93 bc	20.8 c	600.6 a
Clothianidin & Fungicide 0.33X	1.4 a	12.8 b	25.6 c	662.2 a
Fungicide alone 0X	3.2 a	38.6 a	38.1 b	338.7 b
Bare seed	2.8 a	46.0 a	43.8 a	395.8 b
P#	n.s.	0.0001	0.0001	0.0001
LSD		12.2	5.0	86.1

[1]Means within columns followed by the same letter are not significantly different from one another as determined by analysis of variance at the 0.05 level of probability, with means separation using Least Significant Differences (LSD).

APPENDIX 15. Mean growth stage, based on Harper and Berkenkamp's 1 (seedling) to 5 (mature plant) scale, of canola seeded with or without one of four rates of clothianidin-coated seed, Saskatoon, 2003.

	Mean Growth Stage[1]		
Seed Treatment	1 day after emergence	7 days after emergence	15 days after emergence
Full seed 1X	1	1.70 a	1.57 a[2]
2/3 seed 0.6X	1.01	1.62 a	1.63 a
1/3 seed 0.3X	1.01	1.63 a	1.65 a
Fungicide alone 0X	1	1.27 b	1.49 ab
Bare seed	1.01	1.30 b	1.39 b
P#	n.s.	0.005	0.03

[1] 1 = seedling, 2 = rosette (2.1 = first true leaf expanded)

[2] Values in columns followed by the same letter are not significantly different, ANOVA Growth Stage Rank and P≤0.05. n.s. = not significantly different

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