AgriInnovation Program Stream B

2016-17 Annual Performance Report

For projects or activities that started late, it is expected that answers may be brief for some questions and not applicable or premature for other questions. Indicate "Not applicable" if the question is not relevant at this time.

Name of Recipient: Eastern Canada Oilseeds Development Alliance Inc. (ECODA)	
Project Title: Market-Driven Research for Soybean and Canola Supply Chain Profitability	
Project Number: AIP-P025	Period Covered by Report: 2016-04-01 to 2017-03-31
Activity #: 12 Name of Activity: Integrated pest management strategies against insect pests of canola in Eastern Canada	Principal Investigator: Geneviève Labrie

1. Performance Measures. See Annex A for an explanation of each measure.

Innovation Items	**Results Achieved**	Provide a description (2-3 paragraphs) for each item produced and describe its importance to the target group or sector. Explain any variance between results achieved and targets. Use plain language.
# of Intellectual property items flowing from the project		
# of new/improved products		
# of new/improved processes or systems		
# of new/improved practices		
# of new varieties		
# of new/improved genetic materials		
# of new/ improved gene sequences		
# of improved knowledge	4	1- Knowledge about impact of different seeding date on flea beetles abundance 2- Knowledge about efficacy of three insecticides against flea beetles 3- Information about parasitism rate of cabbage seedpod weevil and thresholds 4- Knowledge about efficacy of insecticides against pollen beetles.

Information Items	Results Achieved	Provide the complete citation for each item. Please see Annex A for examples.
# of peer reviewed publications		
# of information items		
# of media reports		
# of information events		
		Provide the # of attendees
# of individuals attending information events		
		Provide the # of attendees who intended to adopt new information or technology
# of individuals attending information event who intend to adopt new innovation		
		Provide the name, degree completed and date of completion
# of persons who completed a M.Sc. or Ph.D. during project		

2. Executive Summary

The Executive summary contains two parts: Key highlights of activities and scientific results and Success story. Information may be used for internal and external communication purposes. Write for a general audience using plain language. Do not include sensitive or confidential information.

Key Highlights - This section describes the key activities and final scientific results of an activity/ project in such a way that readers can rapidly become acquainted with a large body of material without having to read it all. Include a brief statement of the problem(s), background information, concise analysis and main conclusions. Suggested length – maximum 1 page.

The overall objective is to develop integrated pest management strategies against flea beetle, pollen beetle and cabbage seedpod weevil (CSW) in Eastern Canada.

Specific objectives are 1) Evaluate the influence of seeding date against flea beetles, CSW and pollen beetle. 2) Evaluate the efficiency of chemical control against flea beetles. 3) Determine the economic threshold for cabbage seedpod weevil (CSW). 4) Determine the economic threshold and efficiency of insecticides for pollen beetle.

1) Flea beetle abundance and defoliation were very low in 2016 on both sites. Similarly to precedent years, yield was lower on third seeding date on both sites. However, a 76% decrease in yield at Normandin the third seeding date was directly linked to a high pressure of swede midge at this late seeding date. CSW was more abundant on first seeding date while pollen beetle increase the third seeding date, but no one reach a threshold on both sites.
2) Flea beetle defoliation did not reach the 25% threshold at Normandin. Insecticides did not

reduce defoliation, but reduce flea beetles' abundance on sticky traps. Yield was however highest with Decis treatment than the untreated.

3) CSW was observed in 80% of the fields. Only one reach the threshold of 2 CSW/sweep, but no fields reach the economic threshold of 25% damaged pods. Parasitoids were observed in 50% of the fields, with parasitism rate varying between 6,8 and 50%, which is lower than in 2015. The main natural enemy of CSW, the parasitoid *T. perfectus*, was observed in 70% of the fields with parasitoids. A reduction of 56% of pods consumed by CSW was observed in pods with parasitoids.
4) Introduction of 9 pollen beetles/plants in the cages at CEROM showed that almost 100% of buds presented at least one larvae. Yield was reduced by 336 kg/ha on those cages, but not significantly different from control. Insecticides reduced abundance of pollen beetle in Normandin, with no difference in yield between treated and control plots.

Success Story - A success story presents a significant result or an important milestone achieved. It is intended to showcases achievements in applied research. Focus on research results, successful technology transfer, potential for pre-commercialization, and/or potential impact. A Success Story is not a progress report for each activity (suggested length 2 – 3 paragraphs).

N/A

3. Objectives/Outcomes (technical language is acceptable for this section)

Provide a brief summary that includes introduction, objectives, approach/methodology, deliverables/outputs, results and discussion, and any Ph.D or Master students recruited to work on the project.

<u>Introduction</u>

Three main pest of canola are present in Eastern Canada, the flea beetles (*Phyllotreta striolata* and *P. crucifera*), the cabbage seedpod weevil (*Ceutorhynchus obstrictus*), and the pollen beetle *Brassicogethes viridescens* (Fabricius) (syn. *Meligethes viridescens*) (Bilodeau et al. 2012; Dosdall and Mason 2012; Labrie et al. 2010; Mason et al. 2003). While some strategies are used in western Canada against flea beetles and cabbage seedpod weevil, conditions are different in the east and we need to develop adapted IPM strategies. The pollen beetle is present only in the Maritimes and Quebec and little information on this species and its damage is available.

Flea beetle damage and use of foliar insecticide are increasing in some areas of Quebec (Bilodeau et al. 2012). Feeding by these pests at early stages reduces photosynthate production, and seedlings can be killed when beetles sever the shoot apex. Although some seedlings recover from flea beetle damage, the impact on the crop can be considerable because of reduced stand density and delayed maturity. Flea beetles have been controlled by seed treatment, but their efficacy seems to be reduced in recent years (Tansey et al. 2008) and many producers need to treat two or three times with foliar insecticides to avoid high yield loss (Parent, unpublished data). The main foliar active ingredient used against flea beetles is lambda-cyhalothrine. However, this product is not registered against the striped flea beetle, which is the main species observed in canola fields in Quebec (Labrie et al. 2010). We thus need to test the efficacy of other insecticides against these pests. Cultural control practices can also be used against flea beetles to reduce their impact and the use of insecticide. A recent study demonstrated that early seeding of canola attracted flea beetles and that damage to canola was concentrated to these earliest dates (Labrie, Vanasse and Pageau unpublished data). These results are opposite to studies in Alberta, which demonstrated less damage when canola is sown early (Carcamo et al. 2008). A strategy that used different seeding dates could reduce damages by flea beetles, but it will depend on temperature and ecoregion (Carcamo et al. 2008). More studies are needed on the impact of seeding date on flea beetles in Eastern Canada.

The cabbage seedpod weevil is prevalent in Ontario and Quebec (Dosdall and Mason 2010; Labrie et al. 2010), with increasing abundance in some areas. Expansion of the species to the Maritimes could occur if acreages of canola increase. Cabbage seedpod larvae consume 5-6 grains per pod and can reduce yield between 10 to 35% (Buntin 1999; Nilsson 1987). Work on this species has been intensive in western Canada and control strategies has been evaluated (Dosdall and Mason 2010). However, we discovered a European parasitoid of the cabbage seedpod weevil, *Trichomalus perfectus*, in Quebec and Ontario (Labrie et al. 2010; Mason et al. 2011). In Europe, *T. perfectus* is the most important parasitoid responsible for reducing *C. obstrictus* abundance (Williams 2003). Estimates of parasitism by *T. perfectus* are in the range of 10% to up to 95%, and can be high even at low pest densities (Büchi 1991; Buntin 1998; Haye et al. 2010; Kulhmann et al. 2006; Murchie et al. 1997; Murchie and Williams 1998). Parasitism of cabbage seedpod weevil observed in Saint-Augustin-de-Desmaures (U. Laval experimental site) between 2010 and 2012 increased from 12% to 90% (Létourneau et al., 2012, unpublished data). Economic thresholds for cabbage seedpod weevil in North America were developed without consideration of natural enemy control. Foliar insecticides are applied when two to four cabbage seedpod weevils are caught by sweep net at the beginning of flowering period. With the recent presence of parasitoids, we need to evaluate the economic threshold for this species, taking into account the parasitism rate in each area, which is not included in the threshold in western Canada (Dosdall and Mason 2010).

Another insect pest which is increasing in range and abundance is the pollen beetle, *Brassicogethes viridescens* (Fabricius) (syn. *Meligethes viridescens*) (Labrie et al. 2010; Mason et al. 2003). This species was first observed in the Maritimes and in Maine in the 1990's (Hoebeke and Wheeler 1996) and in Quebec in 2001 (Mason et al. 2003). Very high abundance was observed in 2012 in some areas of Prince Edward Island and Quebec (Noronha and Labrie, 2012, unpublished data). Females deposit their eggs inside flower buds, where larvae feed on the pollen on developing stamens in the bud, causing bud losses (Ekbom and Borg 1996). The pollen beetles have decreased yield by 70-80% in Europe (Hansen 2004; Nilsson 1987) and no strategies have been developed against this pest for Canada. In Europe, the economic threshold is between 0.1 and 3 pollen beetles per plant (Hansen 2004). In our conditions, no information is available on the amount of damage and yield loss this species can cause. We thus need to develop economic thresholds under our conditions and evaluate the efficiency of insecticides against this new species.

<u>Objectives</u>

The overall objective is to develop integrated pest management strategies against flea beetle, pollen beetle and cabbage seedpod weevil (CSW) in Eastern Canada.

Specific objectives are 1) Evaluate the influence of seeding date against flea beetles, CSW and pollen beetle. 2) Evaluate the efficiency of chemical control against flea beetles. 3) Determine the economic threshold for cabbage seedpod weevil (CSW). 4) Determine the economic threshold and efficiency of insecticides for pollen beetle.

Methodology

Trials at Saint-Augustin-de-Desmaures (SA) have been conducted by Anne Vanasse (U. Laval, QC). Trials at Normandin (NO) have been conducted by Denis Pageau (AAFC-Normandin, QC). Trials at St-Mathieu-de-Beloeil have been conducted by Geneviève Labrie (CÉROM, QC) and trials at Harrington Research Center (HA) have been conducted by Christine Noronha (AAFC – Charlottetown, PEI)

1) Seeding dates trials

In 2016, canola (variety 45H29) has been sown at two different dates (May 26th, June 20th) at NO, with or without insecticide treatment, in plots of 8 rows x 5.5 m (replicated four times). Flea beetle damage (% of surface consumed) has been assessed five times on fifteen plants per plot (three plants at five locations) for each seeding date between cotyledon and five leaves stage. Two yellow sticky cards have been placed vertically, flush with the ground, in each plot to assess flea beetle abundance and species composition. Half of the plots have been treated with Decis® (150 ml/ha) at 2-3 leaves stages, while the others have been left untreated.

At SA, canola (variety L150) has been sown at three different dates (May 6th, May 20th, June 1st), with or without insecticide treatment. Canola has been sown in plots of 9 rows x 6,53m for flea beetles (8 plots) and in 8 other plots for cabbage seedpod weevil and pollen beetle evaluation. Flea beetle damage and abundance has been assessed the same manner than at Normandin. Half of the plots have been treated with Decis® (150 ml/ha) at three leaves stages, while the others have been left untreated. During flowering period, three sweeps at two different locations in the border of each plot has been done to evaluate abundance of CSW and pollen beetle. Insects has been counted in the field and returned in the same plot. Half of the plots has been treated with Matador (83 ml/ha) at 20% flowering period, while the others has been left untreated.

Canola has been harvested in the center of each plot to compare yield between treatments (NO: September 23th and October 4th; SA: August 26th, September 6th, September 13th).

2) IPM trials against flea beetles

2a. Insecticide trials against flea beetles

Canola (45H29) has been sown on May 30th at NO in plots of 6m x 10m (replicated four times for each product and with control). Flea beetle damages have been assessed four times for each seeding date between cotyledon and five leaf stage by estimating the proportion of each cotyledon surface consumed by the beetles on fifteen plants per plot (three plants at five locations). Two yellow sticky cards have been placed vertically, flushed with the ground, in each plot to assess flea beetle abundance and species composition. Half of the plots have been treated at the cotyledon stage (Decis@150 ml/ha, Sevin@750 ml/ha, Malathion 500@1.12L/ha) on June 20th, while the others have been left untreated. No insecticide trials have been done in 2016 at St-Augustin site.

Canola has been harvested on September 23th in the center of each plot to compare yield between treatments.

3) Economic threshold against cabbage seedpod weevil with consideration of parasitism

3a. Evaluation of damages by CSW and parasitism rate in Quebec canola fields.

Evaluation of damages and parasitism rate of CSW have been done for 24 canola fields monitored by the Ministry of Agriculture of Québec (MAPAQ) during summer 2015. For each field, 1000 pods were collected and sent to CÉROM, where they were placed in emergence boxes and left at controlled temperature and humidity (21C; 65%RH) during 6 weeks. All parasitoids that emerged were collected, counted and placed in alcohol 70% for future identification. After 6 weeks, all pods were opened and presence of CSW larvae, parasitoids nymphs or adults and number of grains consumed or not were counted. Identification of parasitoids to species or Family level has been done at CEROM in 2016 and identification confirmed by the Laboratoire de diagnostic en Phytoprotection of MAPAQ.

3b. Introduction of CSW in cages (CÉROM).

No introduction of CSW have been done in cages at CÉROM in 2016.

4. Determine the economic threshold and efficacy of insecticides for pollen beetle

4a. Introduction of pollen beetle in cages to evaluate yield loss and economic threshold (CÉROM)
Cages of muslin (1m x 1,5m x 2m) have been installed at cotyledon stage in canola plots at the research center. Pollen beetles were introduced at the rate of 720/cage (which correspond to 9 pollen beetles/plant) and replicated three times. Control cages have been installed at the same time. Presence of the insects (adults and larvae) has been noted two times per week during all the season. At bud stage, 25 buds have been observed in each cage on July 15th and 20th. Canola has been harvested in each cage on September 6th for yield evaluation.

4b. Trials of insecticides against pollen beetle (St-Augustin-de-Desmaures (QC), Normandin (QC), Harrington Research Farm (PEI)).

The plots (SA: 4,86 m x 6,53m; NO: 6 x 10m; HA: 4 x6m) were set up in a randomized complete-block design and planted with variety L140P (SA; May 21th), L150 (HA) or 45H29 (NO; May 30th) at a seeding rate of 6 kg/ha. Treatments consisted of three insecticides (Malathion 500 @ 1.12 L/ha, Matador 120 EC @ 83 ml/ha, Success 480 SC @ 182 ml/ha) and untreated plots. Pollen beetle abundance has been observed by sweep net (6 sweeps in Qc sites and 10 sweeps in PEI site) one day before insecticide treatment (SA: July 5th; NO: July 14th) and three to four days after. In HA, because of rain and wind during the spray period of 10% bloom prevented spray application at the correct time and the trial was abandoned. Insecticides have been applied at the beginning of the flowering period. Canola has been harvested in the center of each plot to compare yield between treatments (SA: September 6th; NO: September 23th).

Results

1a. Seeding date

Defoliation by flea beetles was very low both sites in 2016 and did not reach threshold of 25% defoliation. At Normandin, defoliation was highest the 3rd seeding date compared to the first ($F_{1, 1676}$ = 5.44; *P* = 0.02; Figure 1) and in untreated than treated plots the third seeding date ($F_{1, 1676}$ = 5.49; *P* = 0.02; Figure 1). At St-Augustin, defoliation was highest at 1st seeding date ($F_{2, 2261}$ = 4.72; P = 0.009; Figure 1). Captures of flea beetles on sticky traps was not different at Normandin (P > 0.05; Figure 2A) and highest the 1st than the 3rd seeding date at St-Augustin ($F_{2, 162}$ = 5.28; P = 0.006; Figure 2B). Very high infestation by swede midge was observed the third seeding date at Normandin (more than 2000 adults on pheromone trap between June 30 and July 22th).

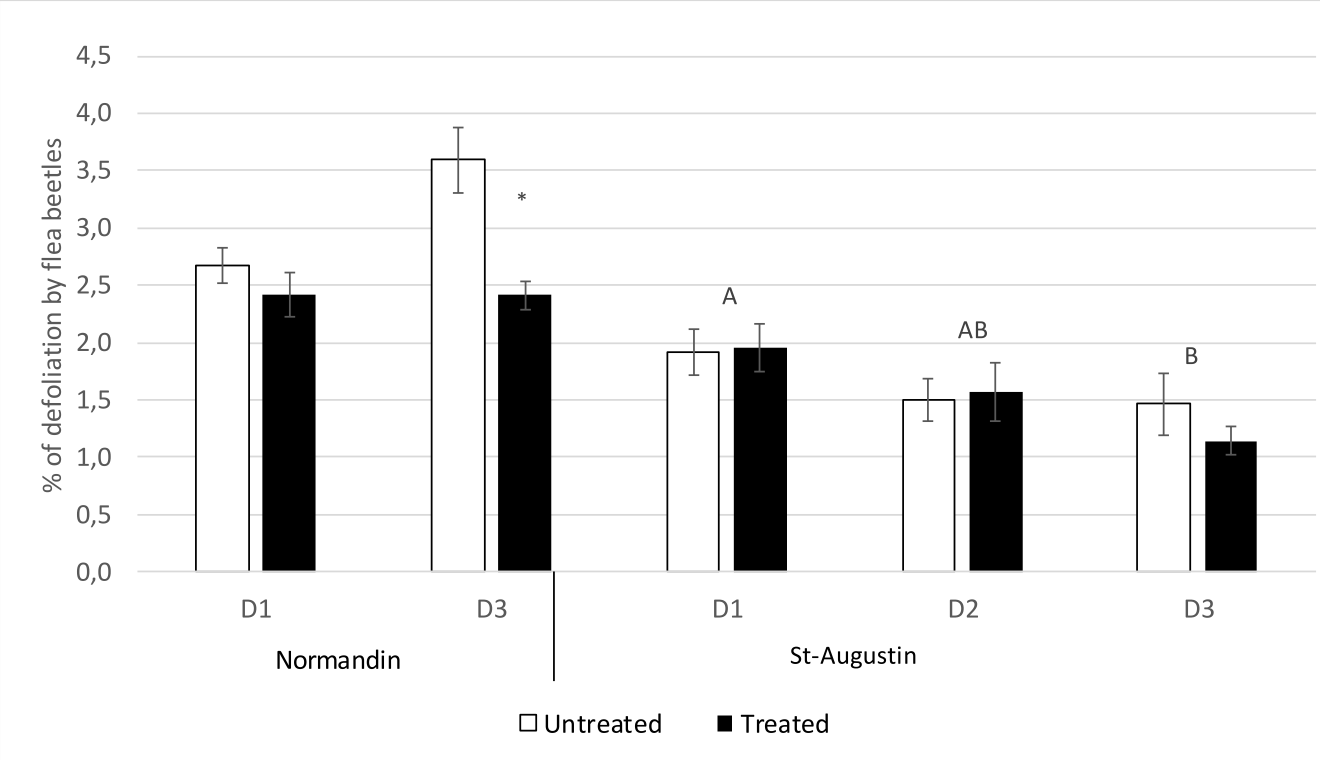
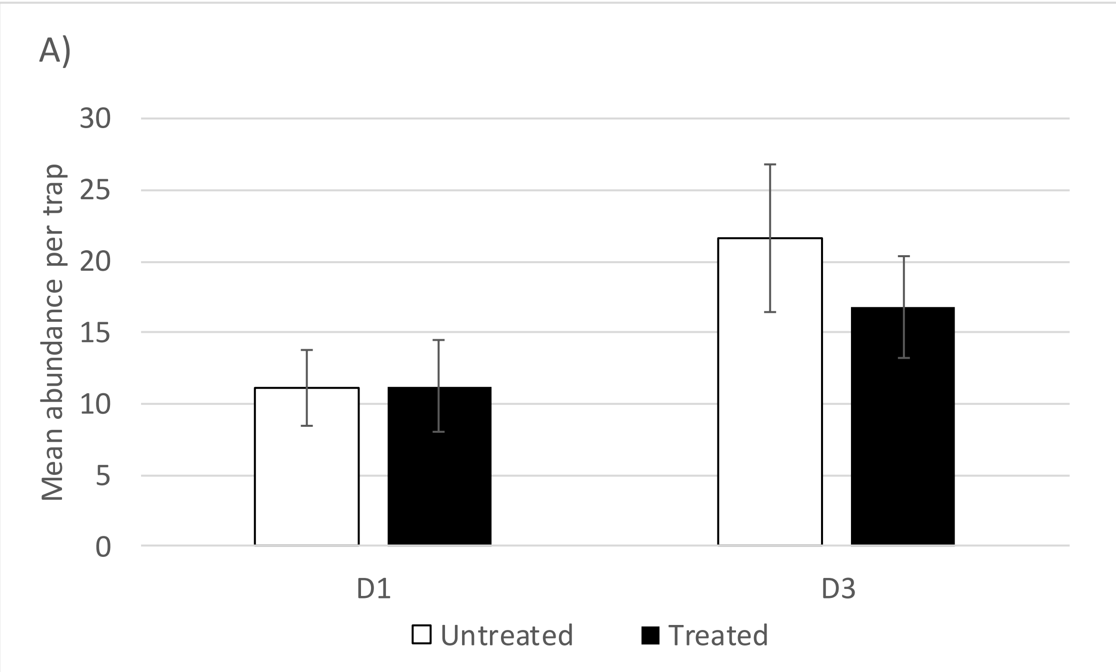


Figure 1. Damage by flea beetles following two and three seeding dates and insecticide at Normandin and St-Augustin respectively during summer 2016. Note: Different letters indicate significant differences between seeding date on a site, while asterisk indicate significant differences between insecticide treatment for one seeding date.



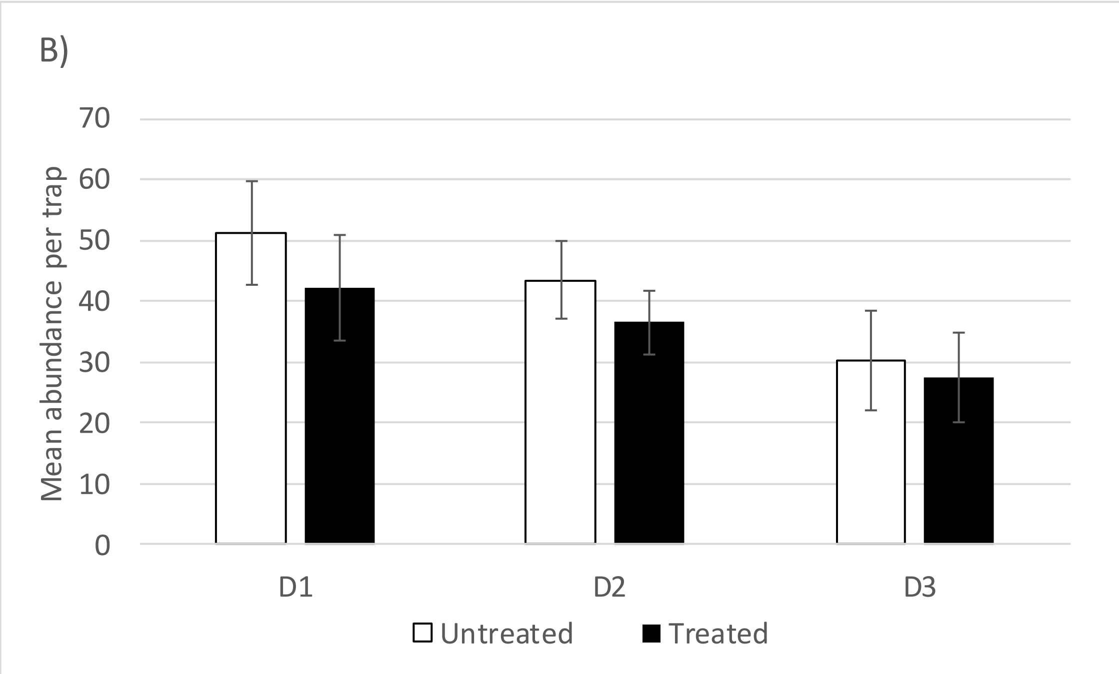
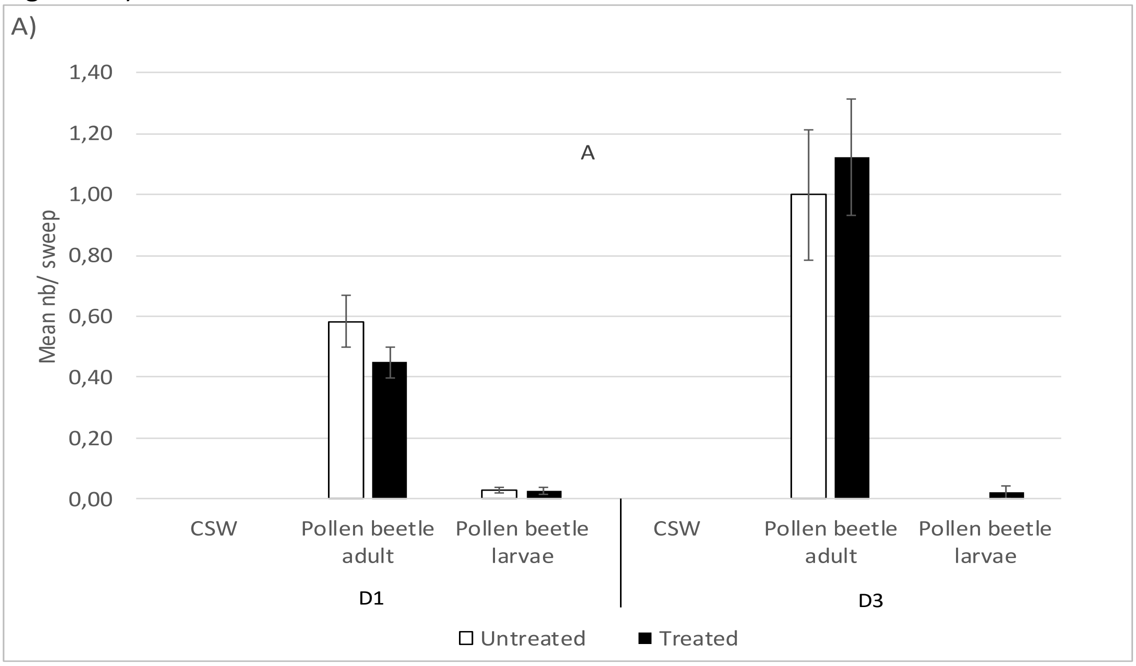


Figure 2. Mean abundance of flea beetles on sticky card at Normandin (A) and St-Augustin (B) following two or three seeding dates and insecticides.

Abundance of pollen beetle was significantly highest the third seeding date compared to first seeding date at Normandin (χ^2 = 20.88; df = 1; P < 0.001; Figure 3A). No CSW was observed at Normandin. At St-Augustin, there was highest abundance of CSW the first seeding date (χ^2 = 89.20; df = 2; P < 0.001; Figure 3B).



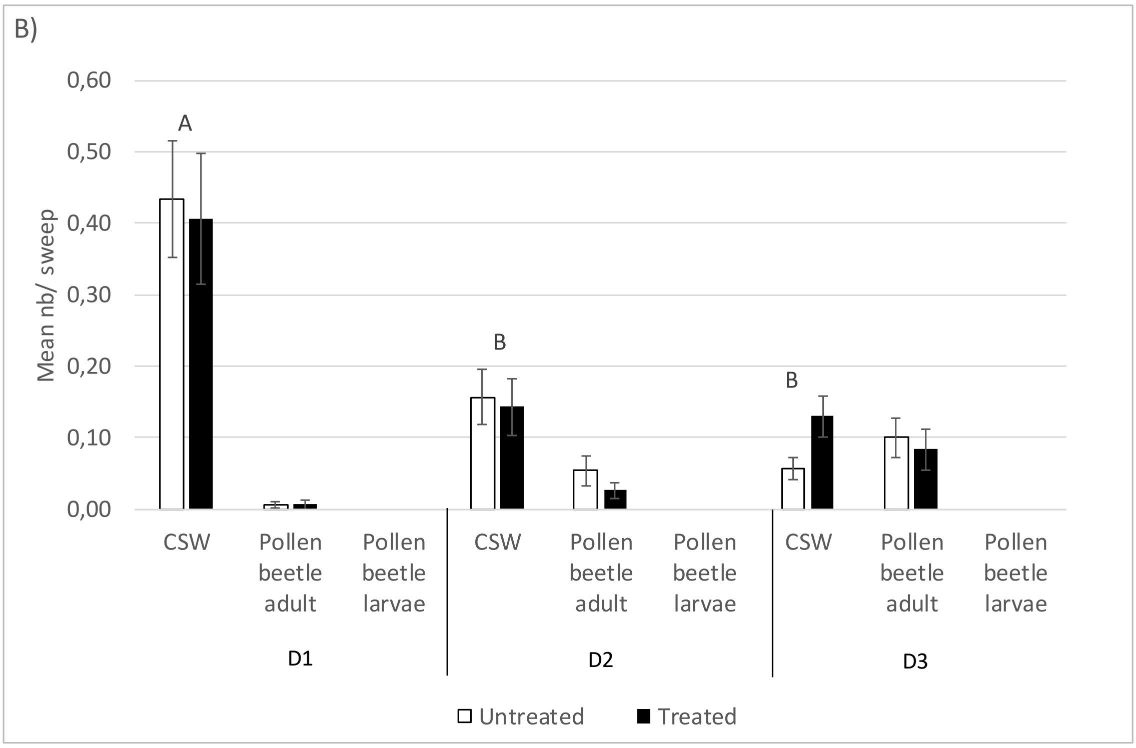
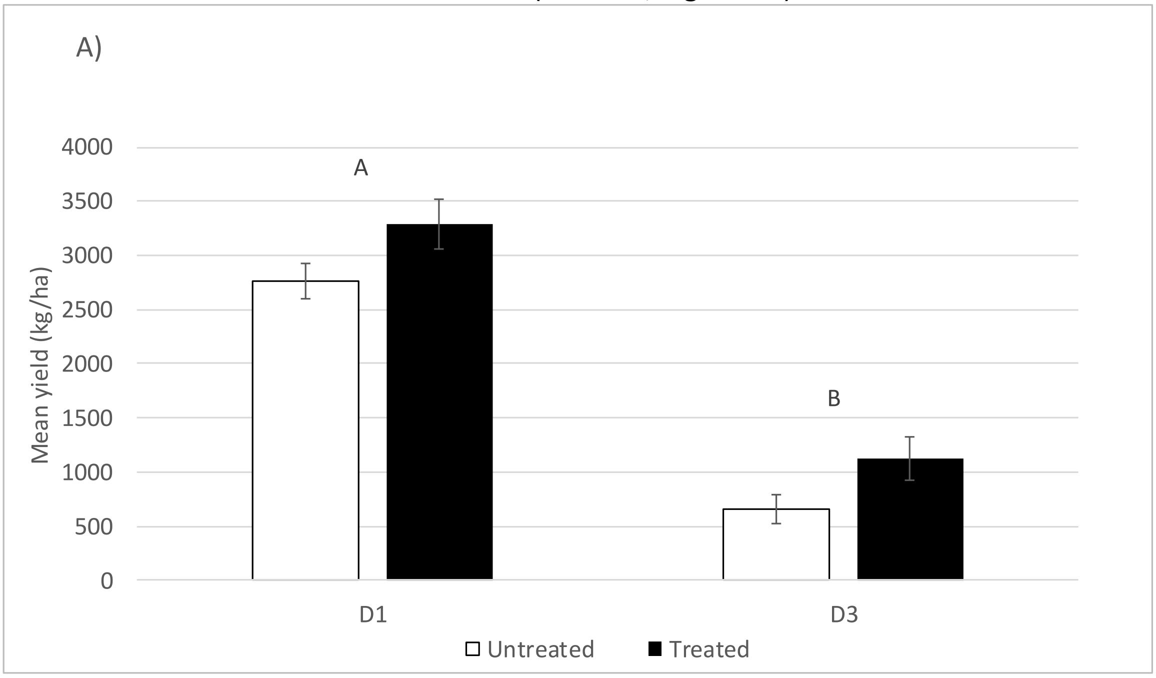


Figure 3. Abundance of CSW and pollen beetle in sweep net at A) Normandin and B) St-Augustin following two or three seeding dates and insecticide during summer 2016. Note: Different letters indicate significant differences between seeding date.

Yield was highest the first seeding date at Normandin ($F_{1,13}$ = 146.96; $P < 0.001$; Figure 4A) and with insecticide treatment ($F_{1,13}$ = 7.94; $P = 0.01$; Figure 4A). At St-Augustin, yield was highest at first and second seeding date compared to third seeding date ($F_{2,18}$ = 11.16; $P < 0.001$; Figure 4B), but was not different between insecticide treatment ($P > 0.05$; Figure 4B).



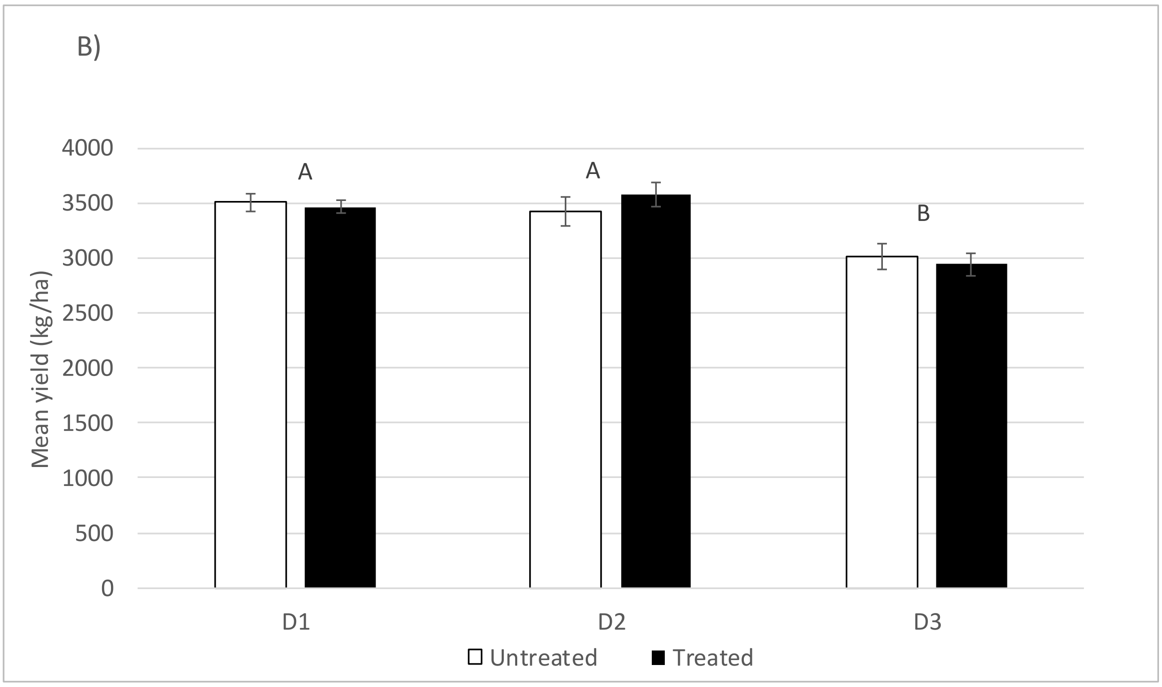
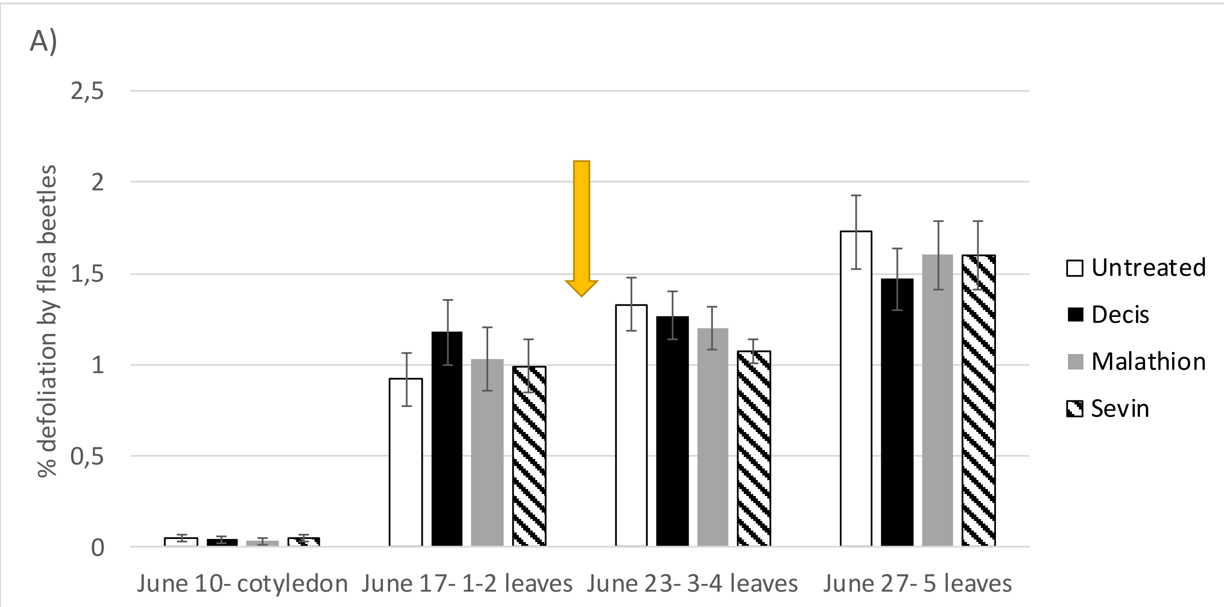


Figure 4. Mean yield of canola at A) Normandin and B) St-Augustin in 2016 following two or three seeding date and insecticide against canola insect pests. Note: different letters indicate significant differences between seeding date.

2. Insecticide trials against flea beetles

Defoliation by flea beetles did not reach economic threshold of 25% of defoliation and no differences in defoliation was observed at Normandin for each stage or insecticide treatments (Figure 5A). However, there was a significant reduction of flea beetles on sticky traps after the insecticides treatments in all plots (Figure 5B).



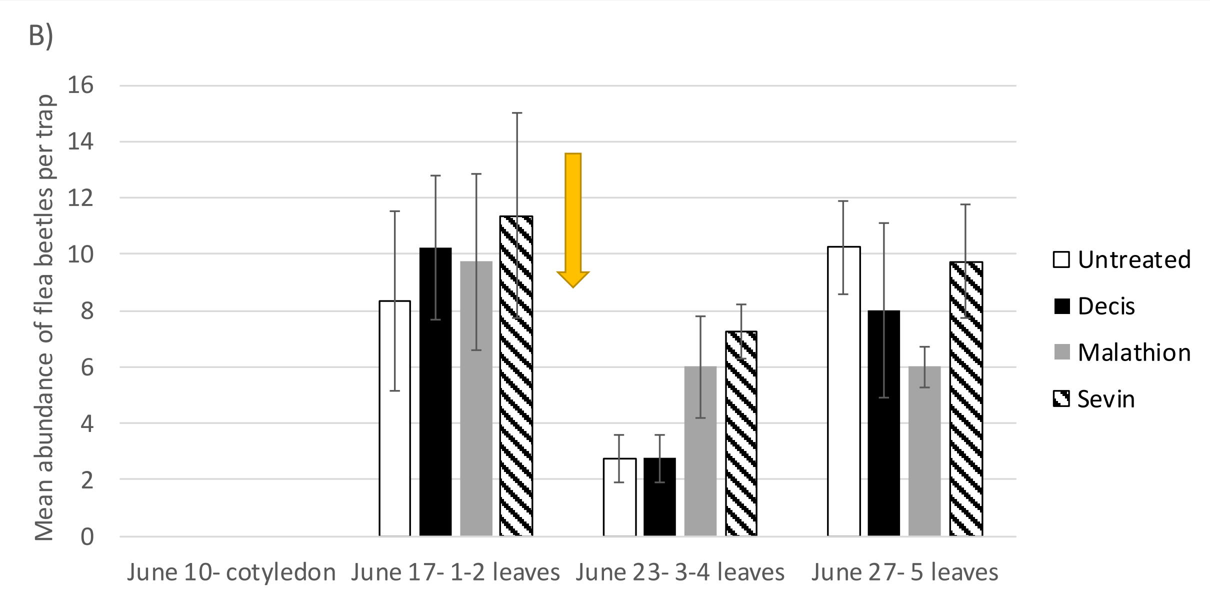


Figure 5. Defoliation by flea beetles (A) and presence of flea beetles on sticky traps (B) following different insecticide treatments at Normandin in 2016.

Highest yield was observed in plots treated with Decis compared to untreated plots ($F_{3,12}$ = 5.12; *P* = 0.02 ; Figure 6).

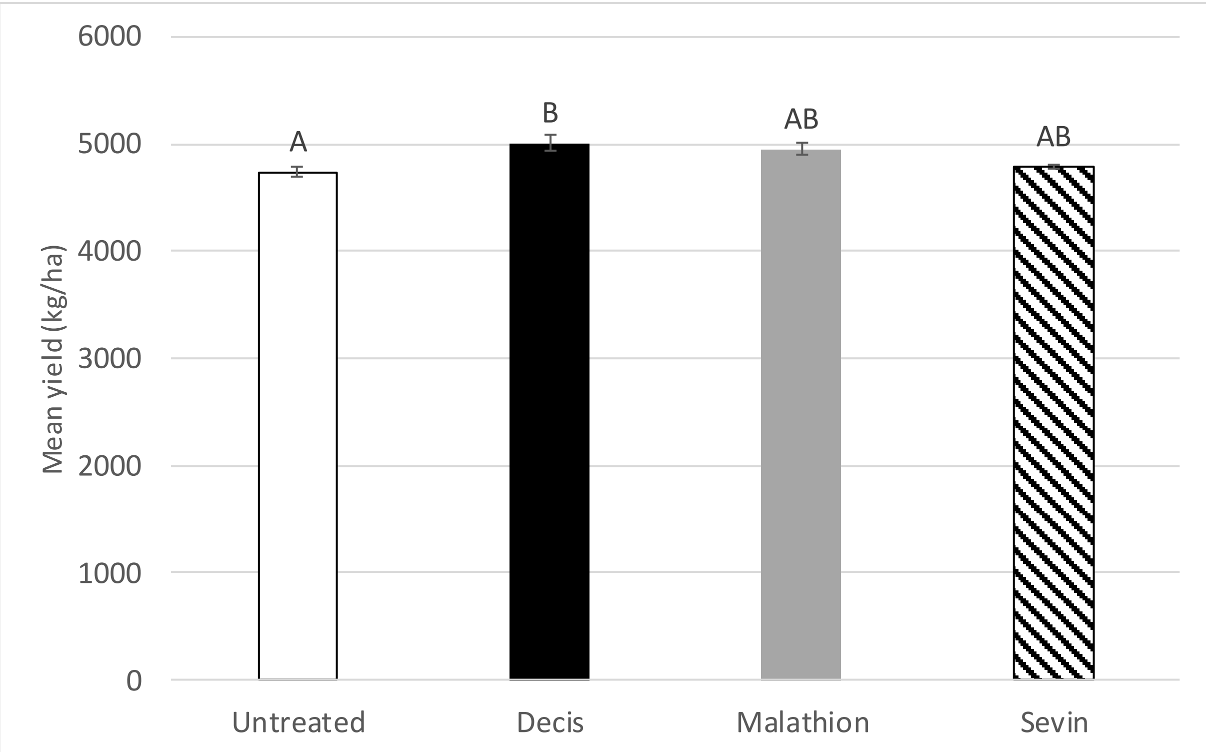


Figure 6. Mean yield of canola at Normandin in 2016 following insecticides treatments against flea beetles. Note: different letters indicate significant differences between insecticide treatments.

3.Economic threshold against cabbage seedpod weevil with consideration of parasitism

3a. Evaluation of damages by CSW and parasitism rate in Quebec canola fields.

Cabbage seedpod weevil (CSW) has been captured in 16 fields of Quebec province (80% of fields;

Figure 7). Threshold of 2 CSW/sweep was reached in one field in Bas St-Laurent area. It is the first year where threshold was reach in this area. Damaged pods by CSW was observed in 16 fields out of 20 (Figure 8). However, no fields reached the economic threshold of 25% damaged pods.

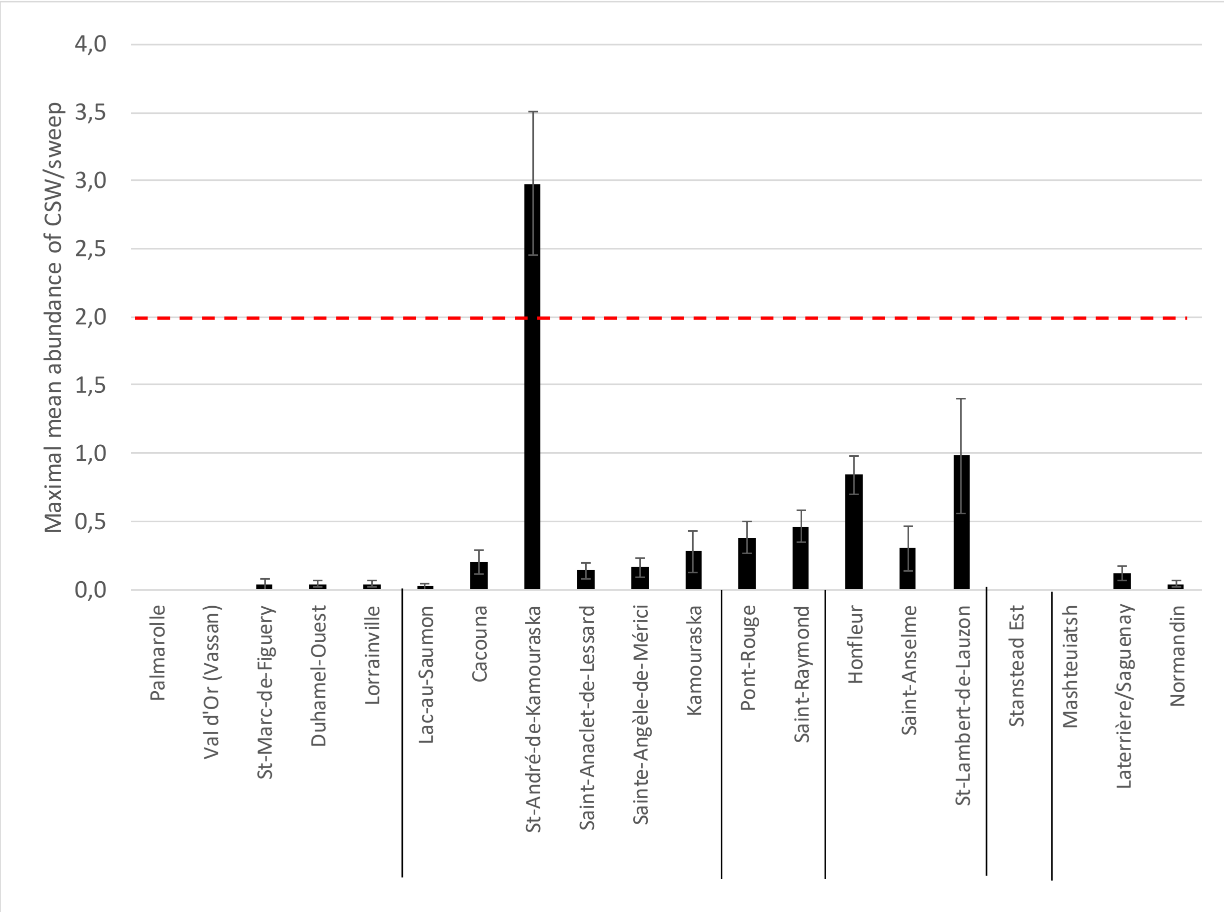


Figure 7. Maximal mean abundance of CSW in canola fields of Québec during summer 2016. Note: threshold is at 2 CSW/sweep.

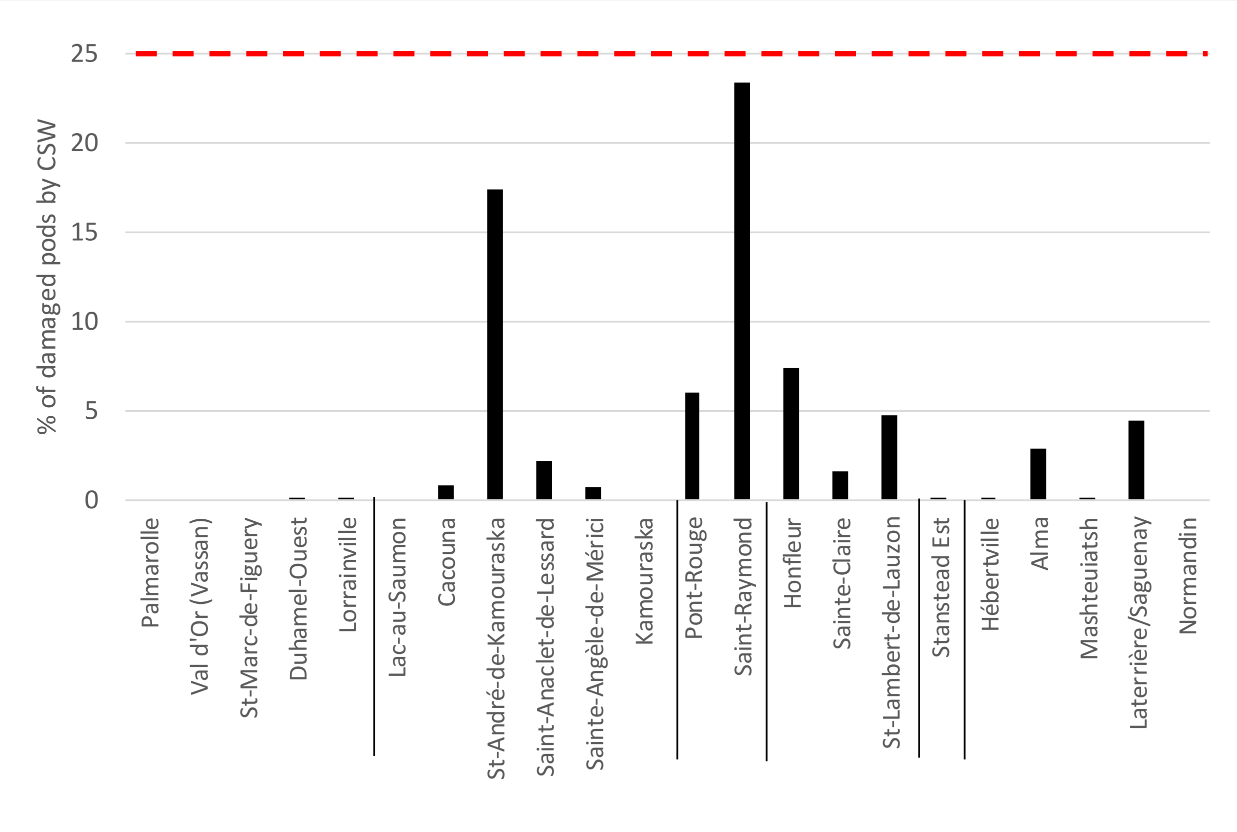


Figure 8. Percentage of damaged pods by CSW in canola fields of Québec during summer 2016. Note: Threshold is at 25% of damaged pods.

On those fields, 101 parasitoids emerged from 10 fields, representing 50% of fields with parasitoids (Figure 9), an increase of 5% from 2015. Parasitism rate varied between 6.8 and 50%, with a mean parasitism rate of 20.39% (Figure 10), a decrease of 56% compared to 2015. Percentage of grains consumed by CSW was 56% less in pods with parasitoids than in pods without parasitism (Figure 11). Identification of parasitoids have been done for specimens of 2016. Main species observed is *Trichomalus perfectus*, which was present on 70% of the sites, but other Pteromalidae are also present (Figure 12).

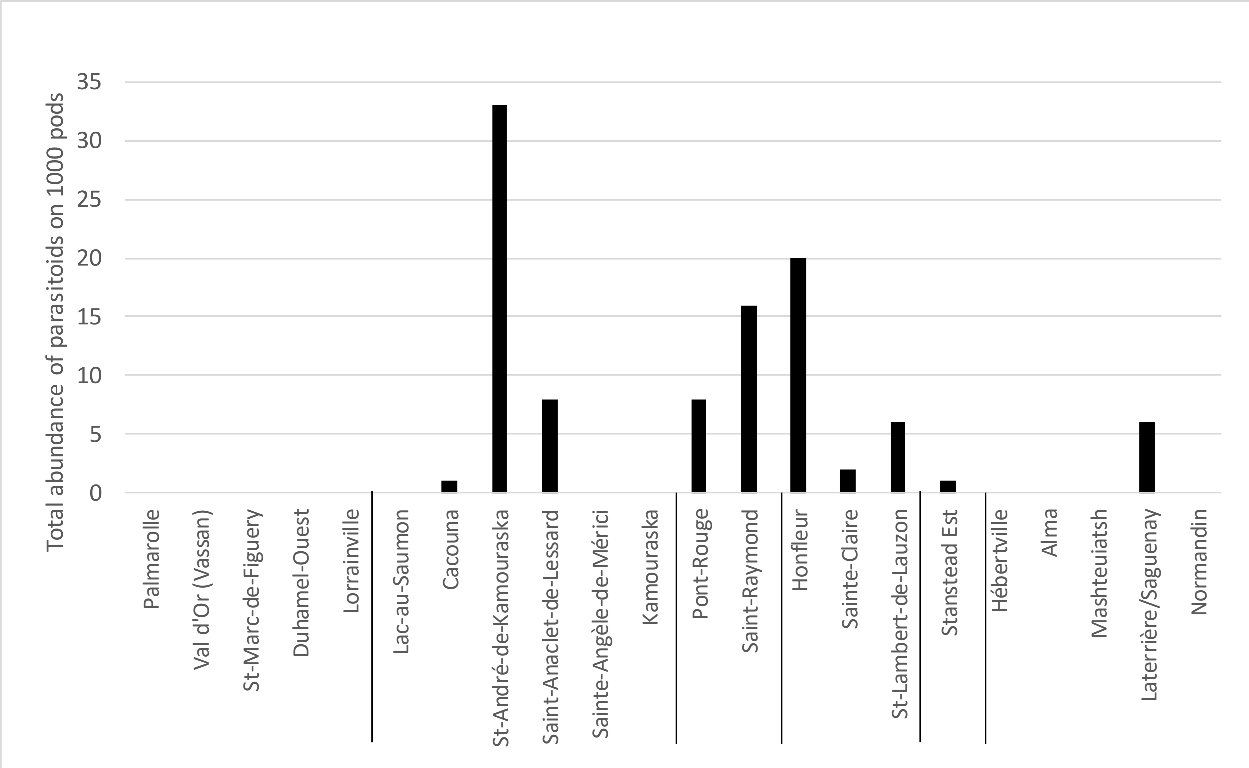


Figure 9. Total abundance of parasitoids of CSW in canola fields of Québec during summer 2016.

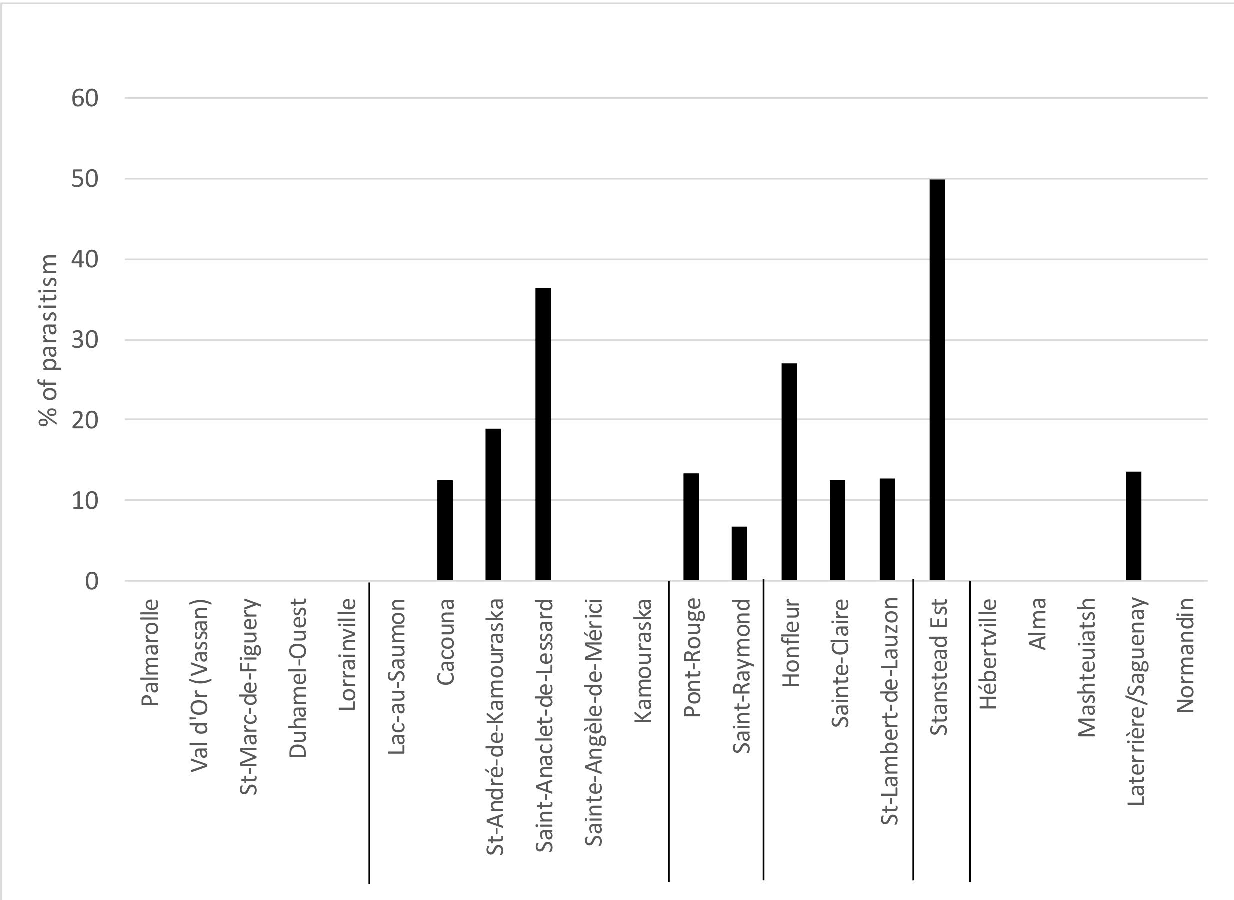


Figure 10. Parasitism rate of CSW in canola fields of Québec during summer 2016.

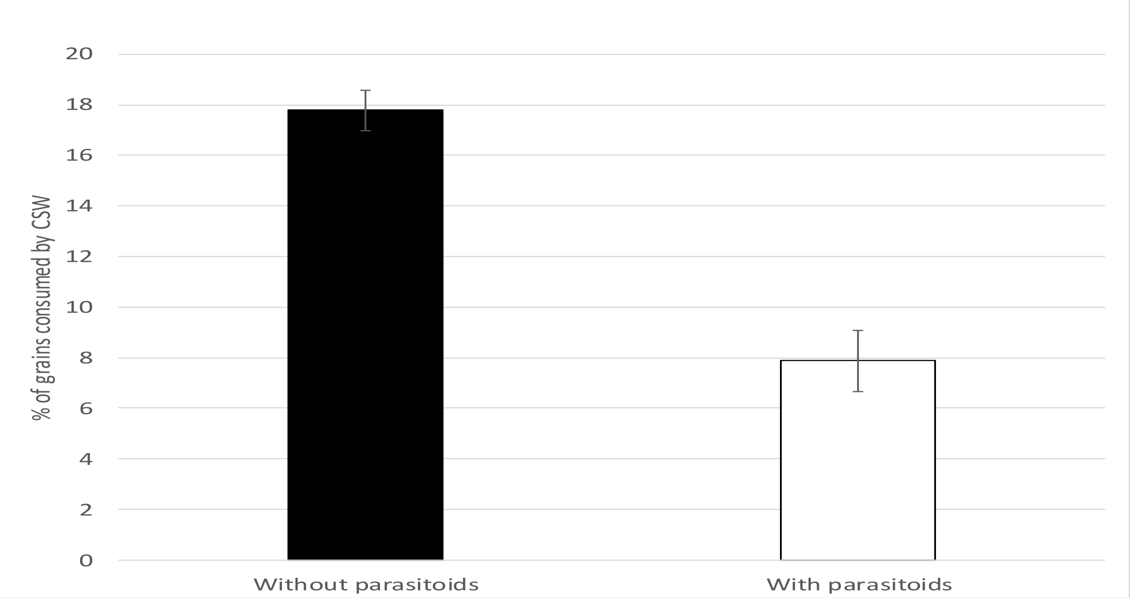


Figure 11. Percentage of grains consumed by CSW in pods with and without parasitoids in canola fields of Québec during summer 2016.

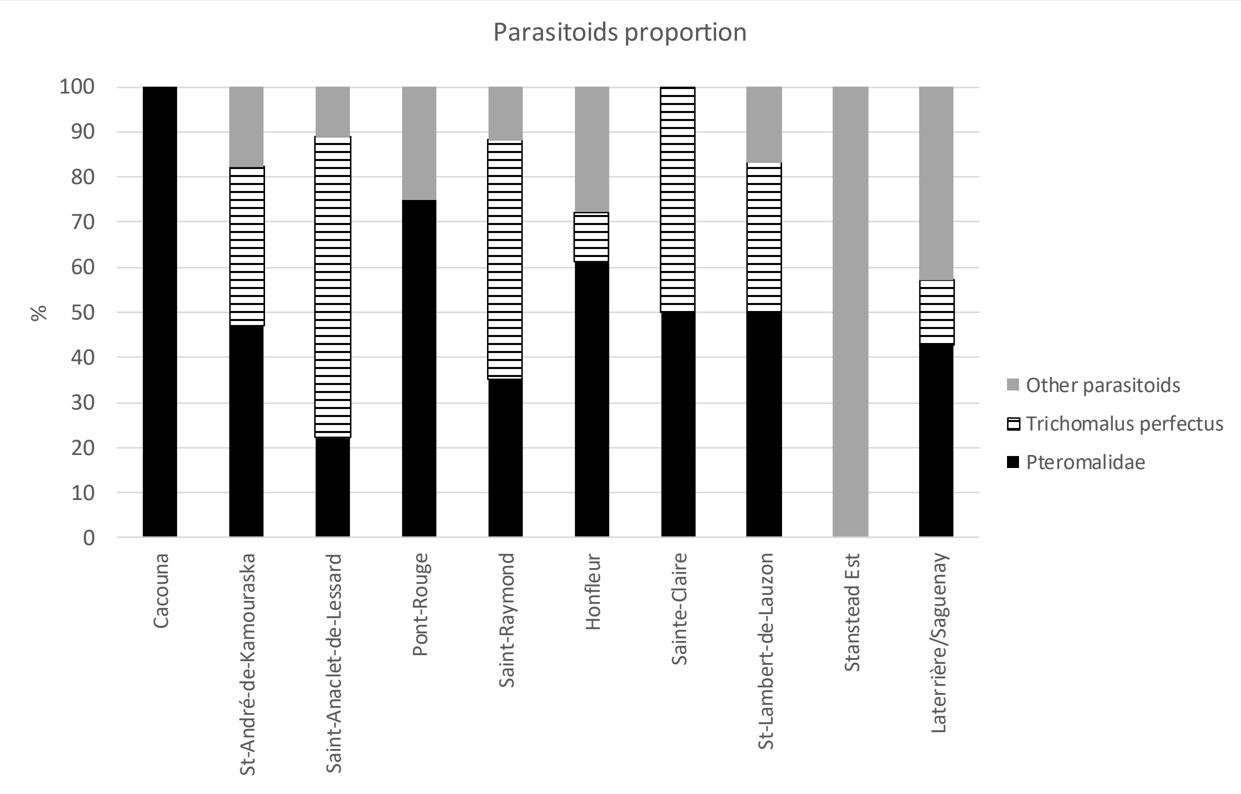


Figure 12. Identification of parasitoids to species or Family and proportion of each group at each site in 2016.

4.Determine the economic threshold and efficacy of insecticides for pollen beetle

4a. Introduction of pollen beetle in cages to evaluate yield loss and economic threshold (CÉROM)

There was a mean of 35 pollen beetle eggs and larvae by 25 buds collected on July 15 and July 20th in the cage with introduction rate of 9 pollen beetle/plant (Figure 13A). Almost 100% of buds were damaged by pollen beetle (Figure 13B). Yield was similar between control and 9 pollen beetle/plant, but variability was high between cages ($F_{1,4}$ = 0.33; P = 0.61; Figure 13C).

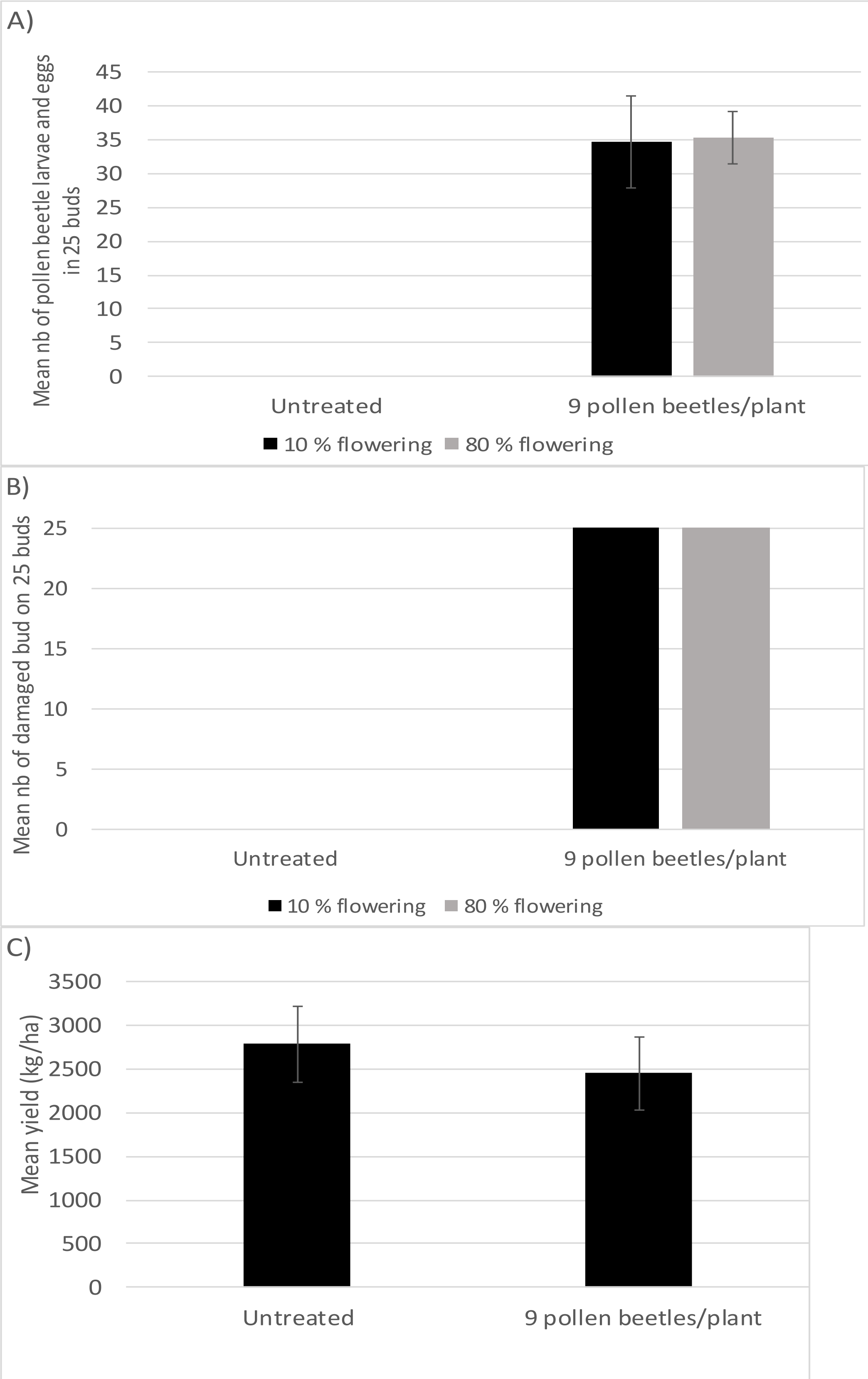


Figure 13. Abundance of pollen beetle eggs and larvae (A), % of damaged buds (B) in 25 buds collected in each cage at 10 and 80% flowering period and yield (C) of canola following introduction of 9 beetle/plant at bud stage in 2016.

4b. Trials of insecticides against pollen beetle (St-Augustin-de-Desmaures (QC), Normandin (QC), Harrington Research Farm (PEI)).

Abundance of pollen beetle was very low at Normandin and St-Augustin in this trial. There were significant differences in abundance of pollen beetles after the four treatment at Normandin (χ^2 = 144.40.26; df = 7; $P < 0.001$; Figure 14A), but no differences were observed between insecticides and control. At St-Augustin, no differences were observed after insecticides treatment ($P > 0.05$; Figure 14B).

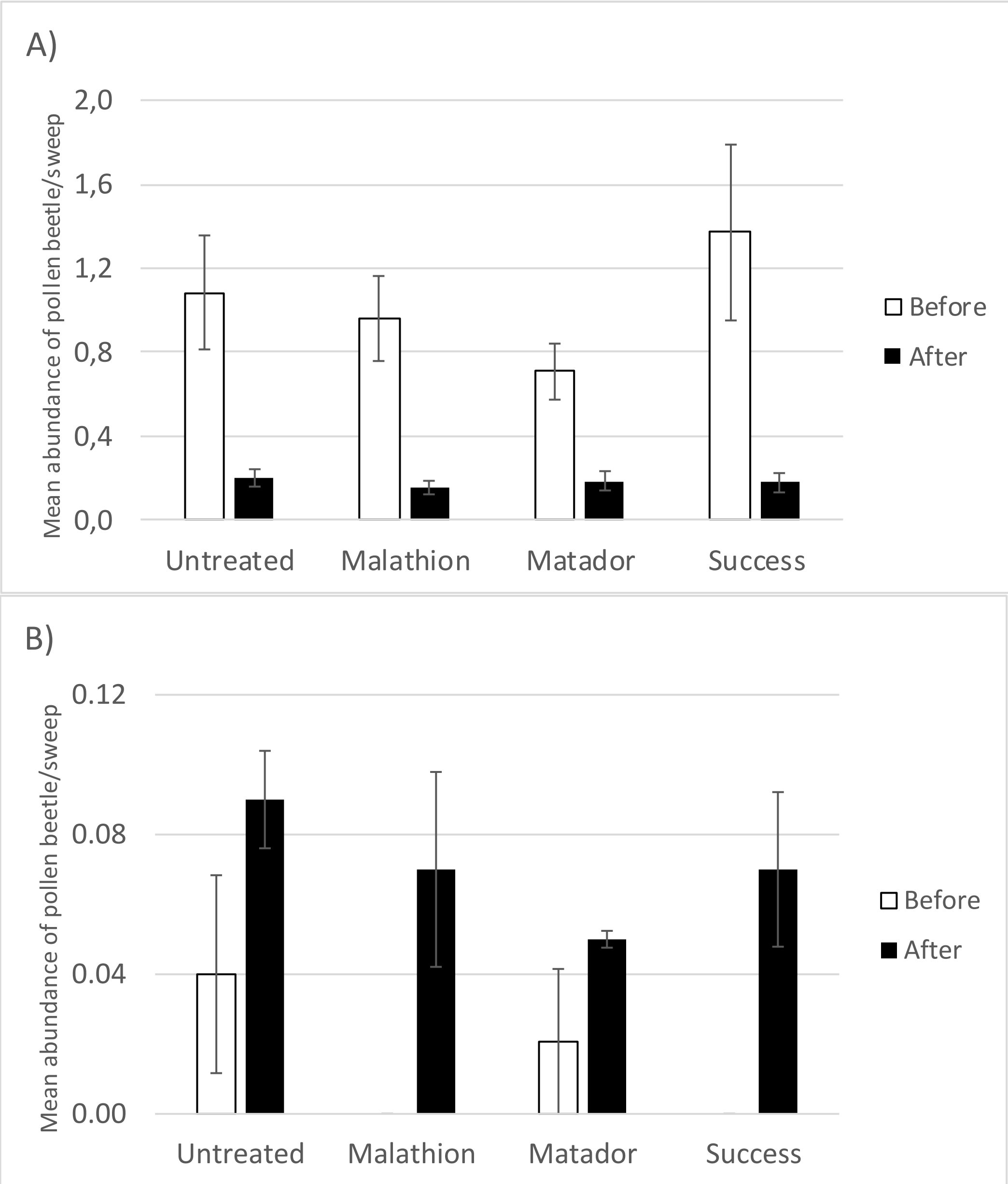


Figure 14. Abundance of pollen beetle adults before and after different insecticide treatment in A) Normandin, B) St-Augustin and C) Harrington Research Center during summer 2016. Note: asterisk or different letters represents significant differences between treatment.

There were no yield differences between insecticide treatment at Normandin ($F_{3,12} = 0.16$; $P = 0.92$; Figure 15A) or St-Augustin ($F_{3,12} = 0.24$; $P = 0.87$; Figure 15B).

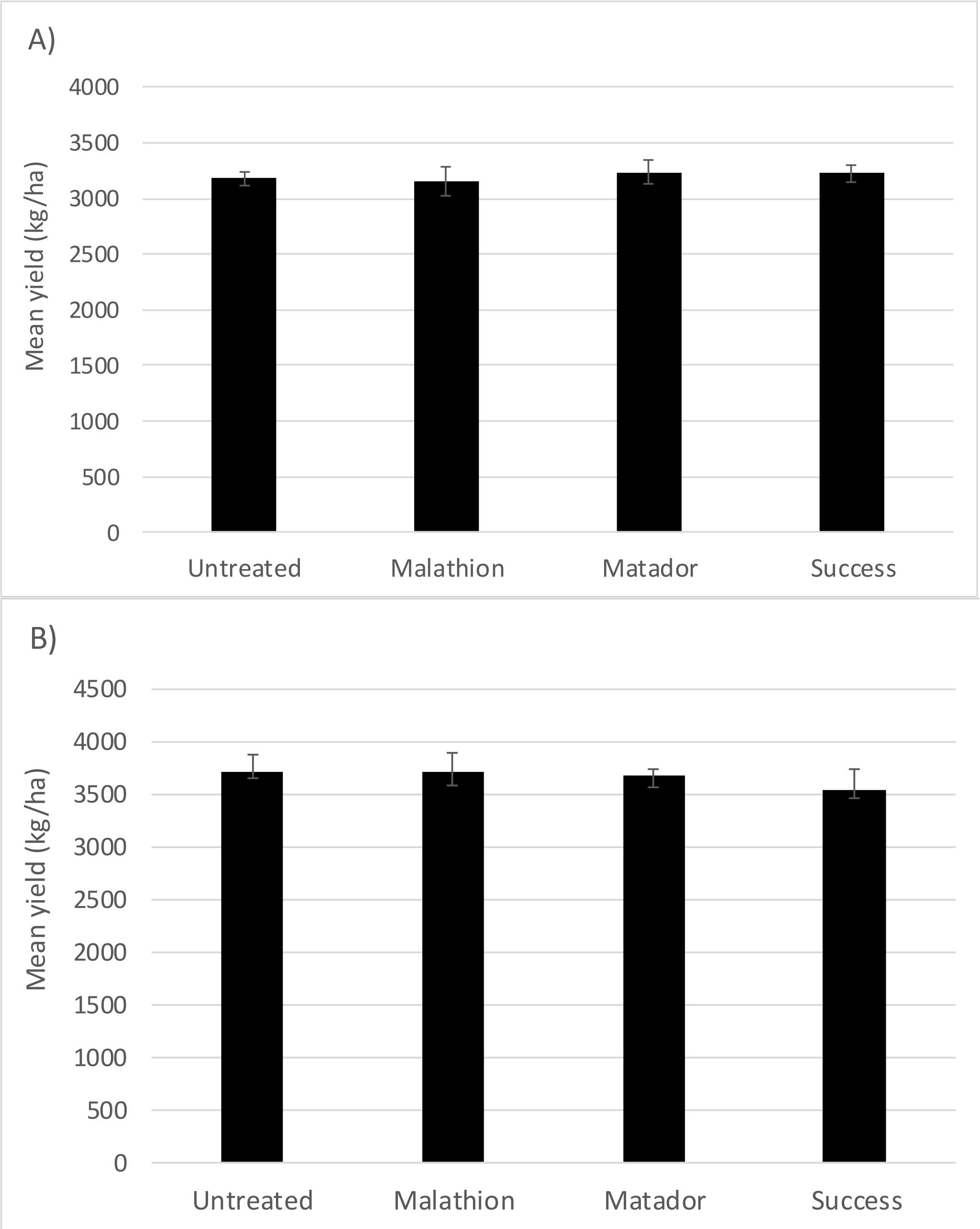


Figure 15. Yield of canola in plots treated by three insecticides against pollen beetles at Normandin (A) and St-Augustin (B) during summer 2016.

Discussion

Flea beetles. Flea beetles were at their lowest abundance since the beginning of the project, with less than 5% defoliation on both sites and trials. Yield differences were observed between seeding date, but not linked to the pressure of flea beetles. It has to be noted that swede midge was very abundant at Normandin the 3rd seeding date, and the loss of 76% of yield between the seeding date could be attributed to this new insect pest in the area. However, this seeding date is not representative of the producer's practices and risk of yield loss by swede midge could not be so high. However, seeding early will be a good strategy against this new pest.

Cabbage seedpod weevil. In 2016, CSW was captured in 80% of the fields, and one site reach the economic threshold of 2 CSW/sweep in Bas-St-Laurent. It is the first time CSW was observed at this highest abundance in this area. However, no site reached the 25% of damaged pods, but two fields presented between 17 and 23% of damage. Those two fields presented less than 20% of parasitism, which could explain this high level of damage. Parasitoids were observed in 50% of the fields monitored, an increase of 5% from 2015. However, parasitism rate was less than in 2015, and varied between 6.8 and 50%. Percentage of grains consumed by CSW was 56% less in pods with parasitoids. While the parasitism increase since the first observation in 2009, what could be observed is that in area where parasitoids are less present, CSW could generate quite high damage. Also, identification of parasitoids show that the main natural enemy of CSW, *T. perfectus*, is not present in every field (in 70% of fields with parasitoids). Identification to species level of parasitoids on precedent years will confirm this presence or not of this species, and will help to define the natural control of CSW and the threshold.

Pollen beetle. Introduction of pollen beetles in cages at CÉROM demonstrated highest number of larvae in flowers at 9 pollen beetle/plant with almost 100% of buds with larvae. Threshold in Europe varied between 1 to 3 pollen beetle/plant at bud stages, and highest than 10 during flowering period. While no statistical differences were observed in cages with 9 pollen beetle/plant compared to control, there was 336 kg/ha more yield in treated cages. Pollen beetles could play the role of pollinators in canola, and canola could compensate when climatic conditions are good. Introduction at highest rate in 2017 will allow to evaluate the yield reduction in canola caused by this pest. All insecticides succeed to reduce abundance of pollen beetle adults in Normandin. While the threshold was not reached and no yield differences were observed, some insecticides are demonstrating efficiency against this pest.

5- Issues

- Describe any challenges or concerns faced during the project. How were they overcome or how do you plan to overcome?
- Describe any potential changes to the work plan and the budget. How were or how will they be managed?

In PEI strong winds and/or rain during the prescribed spraying period (10% bloom) prevented insecticide applications and the trial had to be abandoned. A degree day study in PEI found the first sighting of pollen beetles was at 119dd and the first eggs were at 227 dd. This information will be used next year to overcome the issues faced by wind and rain preventing spray applications associated with plant growth stage.

6- Lessons Learned:

Describe the key lessons learned gained as a result of executing the project (e.g., a more efficient approach to performing a specific task for activity / project).

Not applicable.

7- Future Related Opportunities:

Describe the next steps for the innovation items produced by the activity/project. Is additional research required? Is there potential for commercialization or adoption?

Experiment to be repeated in 2017.

Annex A

Innovation Items	
Performance Measures	**Description**
# of Intellectual property items flowing from the project	These include: declaration of invention, patent application, patents, trademarks, copyrights, trade secrets, signed license agreements, and royalties generated. This does not include IP for plant varieties; those should be reported under "# of new varieties" below.
# of new/improved products	New products could include: a new commercial product, bacterial strain, cartographic product, cell culture, analysis certificate, computer software, database, enzyme, equipment/instrument, fertilizer, hormone, methodology, model, monoclonal antibody, pest control product, polyclonal antibody, standard reference-chemical, standard reference-biological, standard reference-plant, etc.
# of new/improved processes or systems	This is the set of operations performed by equipment in which variables are monitored or controlled to produce an output. A combination of inter-related components or processes is arranged to perform a specific function and generate a given outcome.
# of new/improved practices	This is for a research that generated new knowledge that can be applied directly on the ground by the sector. This is mostly for new agronomic practices but can also cover new practices by processors.
# of new varieties	This includes registered varieties, cultivars, or breeds. This includes invention disclosure, protection and license for new plant varieties. For each new variety, please provide the registration number and the variety name.
# of new/improved genetic materials	This could include genetic map and gene probes. Include new varieties, cultivars or breeds in category "New varieties."
# of new/ improved gene sequences	The discovery of order of bases of a DNA [segment] making up a gene.
# of improved knowledge	This category is for reporting results following completion of the final year of the activity, or results against an activity's improved knowledge target. It is intended for results that do not fit in any of the above categories.
Information Items	
Performance Measures	**Description**
# of peer reviewed publications	These are published items such as: research papers published in scientific journals, books, book chapters, review articles, conference proceedings, research notes, or other that receive peer-review. Items that are not yet published (ex. manuscripts in development or review) should not be reported. For each reported item, please provide the following: author(s), year of publication, article title, title of journal, volume (issue), and page number(s). If the item is a book or a book chapter, add name of publisher. If the item is an article for conference proceedings, add title of published proceedings, location, and year/month/day.
# of information items	Information items include: posters, abstracts, pieces in publications such as trade journals, articles in industry magazines or press, industrial reports (confidential or not), technical bulletins, brochures, guides, flyers, newsletters, other technical transfer publications. If an item is published in a medium whose audience is the general public, it should be reported in the # of media reports category below. For each reported item, please provide the following: author(s), article title, title of magazine/trade publication etc., page number(s), type of information item such as poster or abstract or guide etc., and year/month/day.

# of media reports	Examples include articles or interviews about project results in media such as newspaper, tv, radio, and internet (announcements about project funding are excluded). (These are items prepared by a third party, usually with input by the project). If an item is published in an industry journal, newspaper, or magazine, it should be reported in the # of information items category above. For each reported item, please provide the following: author(s), article title, name of interviewee(s), source of reports (TV or radio interview etc.), and year/month/day.
# of information events	These are events such as a scientific meeting, symposium, conference, industry meeting, or field day where a project participant has been invited to present a talk or presentation directly related to the activity. For each reported item, please provide the following: name of presenter, title of presentation, name of the event, location, and year/month/day.
# of individuals attending information events	Please provide the number of attendees per event.
# of individuals attending information event who intend to adopt new innovation	Please provide the number of attendees intending to adopt the new innovation per event.
# of persons who completed a MSc or PhD during project	Only students who completed their MSc or PhD in the last year should be included in this category. For each reported graduate, please provide the following: the name of the student, degree completed and date of completion.