Annual Report 2019/20

August 19, 2020

Eastern Canada Oilseed Development Alliance

Authored by: Treasa Pauley

ECODA UPDATE

Vision

Facilitating oilseed supply chain partnerships to drive innovation and capitalize on economic value.

Mission

Profits through partnerships and innovation.

The **Eastern Canada Oilseeds Development Alliance (ECODA)** is a private, not-for-profit company based in Charlottetown, Prince Edward Island (P.E.I.). Formed in 2009, we have built links to reputable partners from across the value chains for Canadian oilseeds including soybeans, canola and novel crops. ECODA aims to benefit oilseed growers, processors, and exporters in Eastern Canada by establishing oilseed crop options that match regional factors and market needs. When oilseed growers succeed, then processors and exporters prosper, too.

ECODA's current round of funding, the AAFC-CAP AgriScience Projects, is a research and commercialization program that includes multiple AAFC, university, private sector research organizations, grower and industry partners from eastern Canada, including collaborators from Europe, Japan, and the United States. The project focuses its crop research on soybeans, canola, brown mustard, camelina, pulses, and hemp.

Although the AAFC-CAP contract and funding was not finalized until late 2018/early 2019, we have quickly reached our third year of our five-year program. We currently have upwards of 20 active research projects running involving multiple AAFC research stations, higher education institutions, and grower cooperators spanning 5 Eastern Canadian Provinces. The last 3 years of this program has been nothing if not exciting. Year one (2018/19) was conducted on many sites on a risk basis as funding was not confirmed until well into the third quarter of the year. Year two (2019/20) was challenged with very cool and wet conditions across all Eastern Canada which delayed seeding by at least 2 weeks in many areas and impacted establishment of many plots. Year 3, although looking bleak at the beginning due to challenges posed by the global pandemic COVID-19, actually has become a much better year than expected with a good portion of activities going forward with little modifications required due to imposed COVID-19 restrictions. In fact, while respecting COVID protocols, we were able to conduct a successful field day in the beautiful Annapolis Valley, Nova Scotia.

Over the last two years ECODA has pulled together a dynamic board of directors that represent industry researchers, experts, and private stakeholders. The current board members include Rory Francis (President, ECODA), Dr. Don Smith (McGill University), John Oliver (Maple Leaf BioConcepts), Tyson MacInnis (PEI AgriAlliance), Etienne Tardif (Viterra), Roy Culberson (Atlantic Grains Council representative), and Chris Chilvilo (W.A. Grains & Pulse Solutions). We have also revamped the ECODA website and messaging, including the corporate vision and mission. Staff have also been active in social media posting a minimum of monthly on both Twitter and Instagram pages (Twitter:@CanadaOilseeds, Instagram: easterncanadaoilseeds). The new website launched in early 2020 (www.ecodainc.ca).

CANOLA REPORT

Plant-microbe Interactions to Overcome the Negative effects of Stress and Enhance Canola Yields

Principal Investigator: Donald L. Smith, McGill University

Thuricin 17 was identified as a microbe-to-plant signal produced by a *Bacillus thuringiensis* strain isolated from soybean nodules in southwestern Quebec. It has been shown to enhance plant growth of many crop species when the plants are under stress. However, it has not been evaluated for key stresses (low temperature, drought, the combination of high temperature and drought) for canola, a key Canadian crop. This work seeks to address this. Much of the research to date has focused on the first phase of plant growth, seed germination, and has examined low temperature stress, the stress likely to be encountered by germinating seeds under field conditions. The work to date has shown that treatment with thuricin 17 enhance both germination velocity and the proportion of seeds that successfully germination, under low temperature stress.

Use of biologicals in agriculture systems can reduce environmental impacts. Application of plant-associated microbes, or signal compounds produced by them, can increase plant resistance to stress (Subramanian et al. 2016a,b), including those associated with climate change (drought, high temperature). There is an increasing interest in biological technologies for production of the bioproducts and biofuels underpinning the Canadian bioeconomy. Biofuels from cellulosic biomass are “advanced” and the feedstock crops are often grown on marginal lands (more likely to be stressful for crops) to limit competition with food production. Work conducted in the Smith laboratory at McGill has shown that plant-associated microbes produce signal compounds that cause plants to grow better under stressful conditions (Smith et al. 2015b; Subramanian et al 2016a,b). Several of these technologies have been commercialized and are now applied to ~100 million ha of crop land each year. Similar technologies could be extremely useful in the context of canola production.

The overall objective of this work is to determine the utility of the microbe-to-plant signal compound thuricin 17 in mitigating stress effects on canola. Specific objectives include: 1. Determine the efficacy of thuricin 17 in mitigating low temperature stress effects; 2. Determine the efficacy of thuricin 17 in mitigating drought stress effects; 3. Determine the efficacy of thuricin 17 in mitigating a combination of drought and high temperature stress effects; 4. Determine the efficacy of thuricin 17 in improving crop yield through stress mitigation under field conditions

The research is being conducted in two parts – controlled environment studies and field studies.

Results to date:

A thorough review of the background literature review has been compiled, providing a better sense of how, regarding use of thuricin 17 in canola production, to approach the research and the associated technology development.

Initial results (germination evaluations across a range of temperatures) have indicated that the two concentrations of thuricin 17 enhance germination velocity and germination percentage of canola under stressful temperatures. Seeds treated with two specific thuricin 17 treatments germinated earlier than the controls. The positive thuricin 17 treatments caused a later initiation of germination compared the other concentrations, indicating excessive levels of the compound. Furthermore, it seems that thuricin 17, at any concentration tested, does not have a significant effect under optimal temperature (20^0C) conditions, indicating that it is providing benefit to seeds under conditions of stress, in this case low temperature stress. However, to make definitive statements will require repeating the experiments two more times.

The controlled environment experiments are being conducted to assess the utility of thuricin 17 in improving canola growth in the presence of two stress conditions: 1) water deficit and 2) the combination of water deficit and high temperature. Since high temperature stress work has already been published from our laboratory this work will not be repeated. Thuricin 17 was applied either as a pre-planting seed treatment or spray at the time of stress. For the seed treatment experiment, seeds were soaked in two concentrations of thuricin 17 suggested by the germination experimentation and distilled water for before seeding while thuricin 17 solutions and distilled water sprayed on to leaves with an atomizer just prior to stress induction for foliar experiments. Plants were grown in 10 cm pots and watered regularly until the five-leaf stage, and then were exposed to four levels of the stressors in question, where one level was the control. The plants were allowed to grow for 2 weeks following the onset of treatment, and then sampled for data collection. Photosynthetic CO_2 uptake rate, transpiration rate, stomatal conductance and CO_2 concentration inside the leaves were measured. Readings were taken one day before treatment onset, one day after, one week after and just prior to final sampling. Plants sampled at the end of the experiment were used for the following collection of data on the following variables: plant height, leaf area, dry weight, root branching, root fractal dimension, root length and root weight. Each experiment was repeated twice, and the data pooled for analysis.

Our initial results agree with previous research done by our laboratory, in that it has shown that application of other microbe-to-plant signals, such as lipo-chitooligosaccharides (LCOs) can enhance seed germination of *Arabidopsis*, common bean (*Phaseolus vulgaris* [L.]), beet (*Beta vulgaris* [L.]), cotton (*Gossypium hirsutum* [L.]), soybean (*Glycine max*), rice (*Oryza sativa*), and corn (*Zea mays*) under laboratory, greenhouse, and field conditions. Controlled condition experiments visually indicated that seeds treated with thuricin 17 have more leaf area and stem height than the controls, although we still need to conduct statistical analysis of all measurements, both morphological and physiological, to determine significance levels of apparent affects.

2020 Progress:

All field trials are being conducted as planned and activity progresses with minimal impact of COVID-19.

Specialty Canola Germplasm with Clubroot Resistance for Eastern Canada

Principal Investigator: Sally Vail, AAFC, Saskatoon, Saskatchewan

The goal of this research is to develop non-GMO specialty canola varieties with resistance to Clubroot for Eastern Canada. Lack of these types of canola varieties has reduced capacity to produce GMO-free canola seed and oil on a competitive scale. As a result, an industry which could easily exceed a value of $2M if Clubroot

Resistant (CR) GMO-free varieties were available is currently hampered. This is a distinct market from the main Canadian canola industry in the Canadian Prairies which relies on production of herbicide tolerant canola varieties. The AAFC *Brassica napus* canola breeding program, housed at the Saskatoon Research and Development Centre (SRDC), has focussed for many years on the development of non-GMO, diverse, specialty germplasm, mainly that which is yellow-seeded with highly reduced seed fibre compared to the conventional canola grown across Canada. As a component of the Growing Forward 2 Canola Cluster, novel CR resistance genes, *Rcr1* and *Rcr1* were introgressed from two different *B. rapa* accessions into two different AAFC canola breeding lines, one which was a conventional black-seeded line the other yellow-seeded. A third resistance gene, *Rcr3*, is also available for pyramiding with *Rcr1* or *Rcr1* and introgression into the AAFC lines will be initiated through the current project.

There are three primary objectives of this research:

1) Pre-registration yield and in-field resistance testing of N99-508CR (black-seeded) and YN01-429CR (yellow-seeded) breeding lines with *Rcr1* and *Rcr1* resistance;
2) Introgression of *Rcr3* resistance into N99-508CR and YN01-429CR backgrounds;
3) Introduction of *Rcr1*/*Rcr2* and *Rcr3* into three additional yellow-seeded or low fibre AAFC breeding populations.

Results to Date:

<u>Yield Trials</u>

An extreme drought in central Saskatchewan resulted in failed trials in the Saskatoon area, even when irrigation was available. It is expected that, once analyzed, 7 of the 10 trials will produce valuable yield data to support registration packages. The yield trial conducted in Charlottetown resulted in valuable observational data that supports the need for continued yield trials at this location.

Of specific interest to this project is the adaptation and yield potential of the AAFC canola lines in the Maritimes given this is one of the target growth regions of the specialty lines. Observation of yield and seed quality data showed interesting patterns that warrant follow-up testing at the Charlottetown site. When the parental, non-CR lines were examined, both black seeded and yellow seeded showed expected open-pollinated yield potentials compared to hybrid checks. However, when the overall means of the CR breeding lines of the two different pedigrees (ie. black and yellow seeded) were compared, the black-seeded breeding lines showed very low yield potential averaging only 29% yield of the hybrid checks. Even the CR breeding line with the greatest average was only 54% of the yield of the black-seeded recurrent parent. This observation requires follow-up trials in 2020 and onward at this site to see if this is a pattern for these particular lines in PEI or if these differences could be attributed to unique agronomic challenges within the 2019 trial or relate back to the seedlots utilized for planting the trial. This observational result was quite surprising given yield of several of the black-seeded CR lines was equivalent or exceeded this line in previous yield trials in 2017 and 2018, including an AAFC site in Normandin Quebec in 2018 where yield of a couple of the CR black-seeded lines even exceeded the hybrid check. On the other hand, the yield potential of the yellow-seeded lines showed great promise with the mean of all seven lines tested being 69% of the hybrid check and exceeding the yield potential of the recurrent parent.

Trends were comparable to 2019, however the yield differences between the lines was much larger than that found in 2019. Also, of interest from the 2016 trial was the relative yield potentials of lines of the other yellow seeded pedigrees. In conclusion, all these results support continuing to work with AAFC in Charlottetown to optimize yield testing protocols to obtain high quality results from the CR breeding lines as well as current and potential recurrent parents. These results could have implications on registration and breeding decisions over the duration of the current project.

When the preliminary seed quality traits (oil and protein contents) are examined it is clear that the black-seeded lines are very similar to the commercial checks. In contrast, with the very high oil content of the yellow seeded lines, there is an accompanying decrease in protein of about 1% compared to the commercial checks. Based on the 2018 yield trial results and previous yield and nursery testing, this is an expected trend. Target specialty markets will dictate the necessity of addressing the slightly deficient protein levels found in this line. Interestingly, when tested in 2016, lines of the other yellow-seeded AAFC pedigrees showed higher protein levels suggesting there is variation within the AAFC breeding program to address different target markets (ie. oil and/or protein).

Clubroot Nursery

Seed germination in the field plot was excellent resulting in a very even plant stand. Plants grew well and the plot was maintained essentially free of weeds. During the growing season, plants of all canola lines appeared healthy, no stunting or weak plants were observed. At the time of disease assessment, 72 days after seeding, very little disease was found. Clubroot was mostly apparent as moderate swellings restricted to secondary roots.

It is noteworthy that the level of clubroot infections decreased dramatically over the four years (2016-2019) that the trials were carried out in the same field. During each of the four years, distribution of clubroot was uniform as evidenced by the consistent disease index readings of replications within the plot. Not only did the incidence of clubroot decline over the four years of testing, the severity of disease also declined. In 2017 the percentage of clubs in the severity classes 1, 2, and 3 was 9, 11, and 80% respectively. In contrast, in 2019, the percentage in the three classes, respectively was 78, 13, and 9%. Going forward, different fields with higher levels of inoculum will be selected for conducting the Clubroot nursery.

Breeder Seed Production

Testing for adventitious GMO or transgene presence in the source seedlots indicated that the source seed used for planting in Chile was GMO-free (0.00%). However, all four of the tents produced in Chile were contained with the p35S transgene but showed different levels of contamination. The lowest level of transgene contamination was estimated that approximately 0.025% of the seeds (approx. 10 of the 40,000 seeds sampled). This level of contamination falls within low-level presence (LLP) limits for non-transgenic crops. For exports to the European Union, generally a detection quantity less than 0.1% is acceptable.

Approximately 1.5 acres was seeded the first week of June in 2020 for Breeder Seed production. Soil conditions were very dry at seeding and, unfortunately, sufficient rain to germinate the seed did not occur till mid-June resulting in very late emergence towards the end of June. The stand was very consistent once emerged thus the crop was maintained for the season. Unfortunately, a hard/freezing frost occurred the first week of October while the crop was in the latter phase of seed maturation resulting in excessive (95%) green seeds in the harvested seeds with very poor germination rates. Thus, the harvested seed was discarded as it could not be used for subsequent plantings.

Moving forward, we are now aware of new contra-season service providers and protocols that will reduce the risk of GMO contamination in Chile or in Canada. Consultation with end-users for the specialty canola being developed within this project to determine attainable target LLP standards is required to plan future increases of seed accordingly.

2020 Progress:

33% of planned field trials in the Maritimes and 40% of planned trials in Prairie provinces are being conducted in 2020. Greenhouse/Lab project truncated mid-March with ~6months + Covid-19 down-time lost.

Occurrence of Swede Midge and Evaluation of Potential Control Mechanisms in Canola Production in Ontario and Quebec

Principal Investigators: Rebecca Hallett, University of Guelph & Sebastien Boquel, CEROM

The swede midge (SM), *Contarinia nasturtii*, is an invasive pest of cruciferous crops that can negatively impact canola production in Ontario and Quebec. To improve SM management in canola, we are investigating the biological control potential of *Synopeas myles*, a parasitoid of SM. Relatively high rates of SM parasitism by *S. myles* in the field have been observed in the past years, suggesting that *S. myles* is well established in Ontario and Quebec. However, before *S. myles* can be incorporated into an IPM program for SM, its abundance, distribution, potential to suppress SM, and compatibility with other IPM tactics must be determined.

The overarching goal of this research is to gain knowledge about the swede midge (SM) in Ontario and Quebec and investigate the potential for biological control agents to improve management of this devastating pest of canola. This goal is being achieved through the following specific objectives: 1. Population dynamics of SM and *S. myles* in different parts of Ontario and Quebec; 2. Distribution of *S. myles* parasitoids in canola regions; 3. Evaluate the occurrence of other parasitoids in canola regions; 4. Study the biology of the parasitoid *S. myles* and its efficacy against SM; 5. Survey for the presence of new canola flower galling midges; 6. Transfer of knowledge to growers and crop consultants.

Results to Date:

Population dynamics of SM in different parts of Ontario and Quebec

Quebec

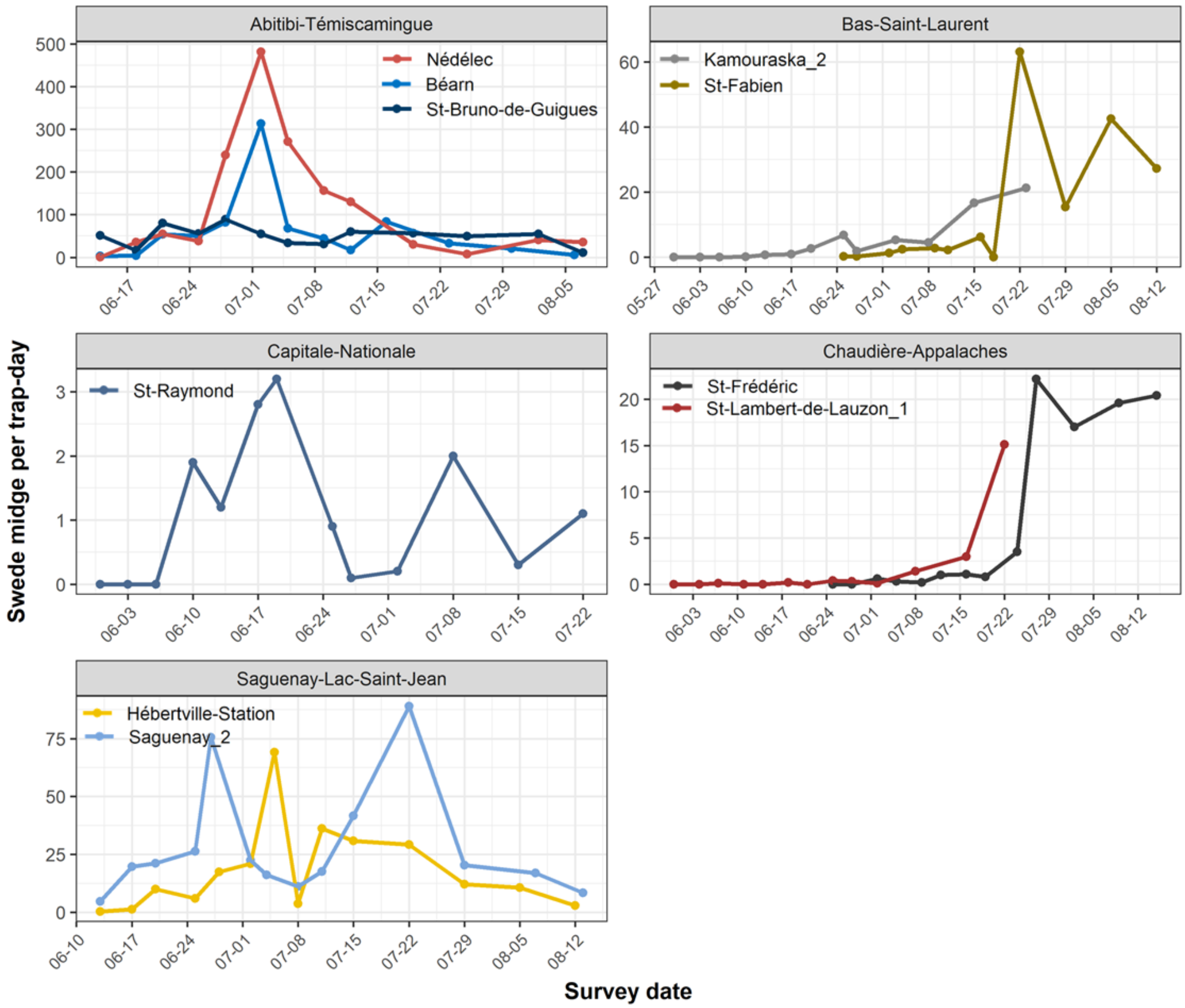


Figure 1. Population dynamics of swede midge (SM/trap/day) in 10 fields located in 5 different regions of Quebec.

Because of the high number of sites followed for SM (30 sites), only the population dynamics of the 10 sites that were followed for parasitoid emergence are presented in this year's progress report. In 24 out of the 30 fields surveyed in 2019, the first SM captures were made during the second and the third week of June. Interestingly, the dates of first capture were later for sites further north. The earliest capture was on June 10 and the latest on July 2. The highest numbers of SM (SM/trap/day) were observed in Abitibi-Témiscamingue region, where 4 out of the 10 sites exceeded 45 SM/trap/day. Only one site (Val-d'Or) had an extremely low pressure of SM with only one SM trapped over the season. The second region with high numbers of SM was in Saguenay-Lac-Saint-Jean. In this region, 3 fields reached over 25 SM/trap/day and five other fields were above 10 SM/trap/day. The site in St-Raymond (Capitale-Nationale) is the only one where the populations remained below the action threshold of 5 SM/trap/day. The low population of SM observed in this region could be linked to the small acreage of canola grown in this area. More fields should be followed in this area to confirm this hypothesis.

No significant correlation was found between the number of SM/trap/day and the percentage of plants showing symptoms of infestation. However, a positive trend was observed during the second period (between bolting and ripening) for the traps located in the border of the fields. The more SM that were caught, the more plants were showing SM damage. More data over several years would be required to be able to draw any conclusions.

Ontario

In Ontario, SM was monitored for weekly in 5 fields around Shelburne. Swede midge was first detected in the pheromone traps between June 11 and 18 (Figure 4). Trapping ceased on September 26, and from the beginning of September onwards, populations were generally very low (fewer than 20 SM/trap/day) (Figure 4). The highest mean number of SM/trap/day was recorded at site DU5-19, with 117 SM/trap/day between August 6 and 8 (Figure 4). Two SM emergence peaks occurred between July 9 and 11, and August 8 and 9 (Figure 4).

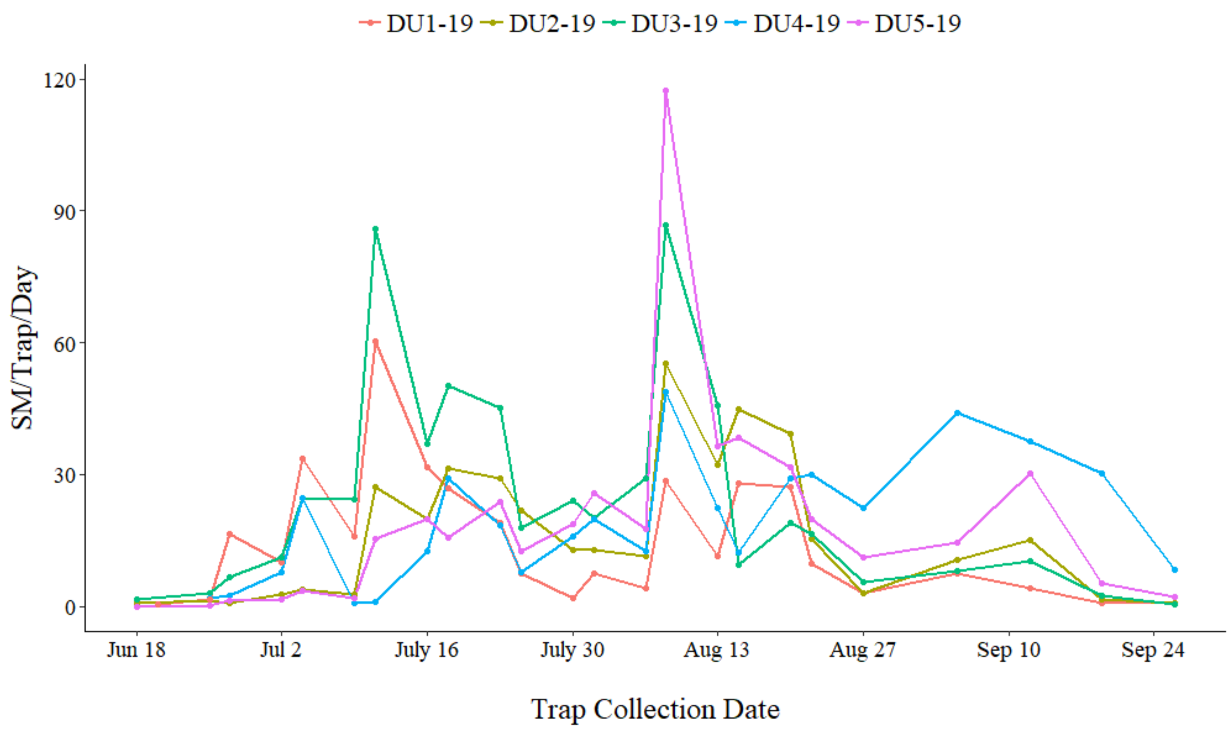


Figure 2. Mean number of swede midge caught per trap per day (SM/trap/day) between June and September 2019 in 5 canola fields (DU1-19, DU2-19, DU3-19, DU4-19, and DU5-1) located near Shelburne, Ontario.

Distribution of Synopeas myles parasitoids in canola regions

Quebec

Field surveys were conducted throughout canola growing regions of Quebec to evaluate the occurrence of the SM parasitoid, *S. myles.* Both SM and *S. myles* were found in all regions followed in 2019 and only 2 sites in Chaudière-Appalaches and Bas-Saint-Laurent were not hosting *S. myles*. Of the 780 canola plants collected during the season, 357 were infested with SM (46% of the plants). From these infested plants, a total of 19,699 SM and 2,865 *S. myles* emerged and the proportion of infested plants showing parasitism was 0.61. The average number of SM and *S. myles* per plant was 55.2 and 8.0, respectively.

With respect to abundance and parasitism rate, significant differences were observed between regions. Almost half of the SM (9635) and three quarters of the *S. myles* (2181) individuals were from plants collected in

Abitibi-Témiscamingue. The 2 sites sampled in Bas-Saint-Laurent were drastically different. A high number of SM (6903) and *S. myles* (227) were collected from plants sampled in Kamouraska, while few to none (364 SM, zero *S. myles*) were collected from plants sampled in St-Fabien. In Saguenay-Lac-Saint-Jean, the numbers of SM at both sites (1896 and 487) were not as high as in Abitibi-Témiscamingue, but they were hosting quite a lot of *S. myles* (344 and 103). Very few individuals of SM and *S. myles* were collected from sites located in Chaudière-Appalaches and Capitale-Nationale.

The global parasitism rate was 12.7%. Parasitism rates were the highest in Abitibi-Témiscamingue (ranging from 15.9 – 19.9%) and in Saguenay-Lac-Saint-Jean (15.4 – 17.5%). In the other regions, the parasitism rates were lower than 5%.

Ontario

Out of the 23 sites sampled in Ontario, *S. myles* was found at 16. *S. myles* emerged between July 19 and August 28. A total of 1,815 *S. myles* and 37,585 SM emerged from all collected plants. Relatively high numbers of S. myles emerged from samples collected in Dufferin, Renfrew, and West Nipissing Counties, while none emerged from samples collected in Wellington County. Across all sites, the average parasitism rate was 5.8%, with the highest rates generally found in Temiskaming, West Nipissing, and Renfrew Counties. Generally, parasitism rates were less than 10%.

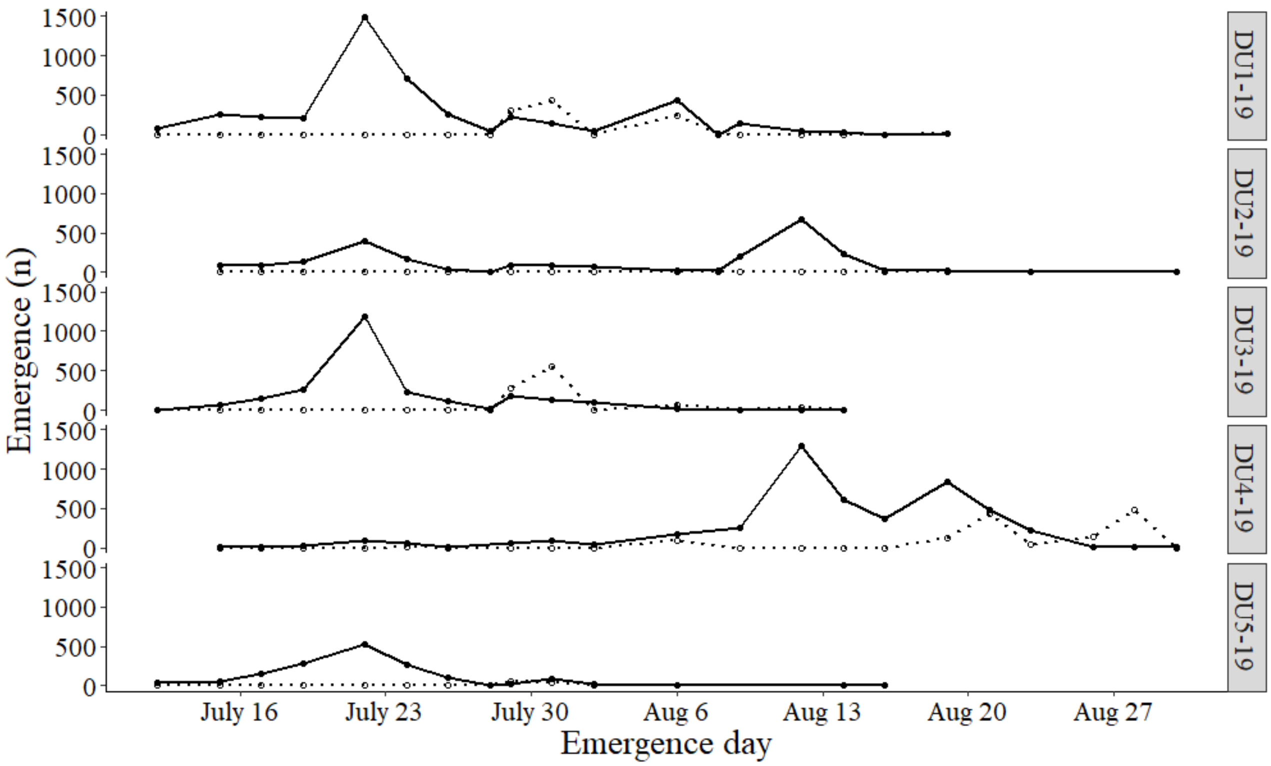


Figure 3. Number of swede midge (solid black lines and circles) and *Synopeas myles* (dashed lines and open circles that emerged from canola plants sampled from 5 fields (DU1-19, DU2-19, DU3-19, DU4-19, and DU5-19) near Shelburne, Ontario in June and July 2019. Numbers of emerged *S. myles* were multiplied by 10 for ease of display.

Evaluate the occurrence of other parasitoids in canola regions

Any parasitoids that emerged from the collected samples that could not be identified as *S. myles* will be sent to a taxonomic expert(s) in 2020 for identification.

Study the biology of the parasitoid S. myles and its efficacy against SM

With the parasitoids that emerged from *S. myles* distribution surveys, a laboratory colony was started. At the time of this report, the colony was successfully maintained for 7 complete generations in a mass rearing set-up. Several experiments will be conducted to understand the biology of *S. myles* and be able to ramp up the number of parasitoids produced. These experiments will set the base for conducting field cage experiments with different densities of SM and parasitoids to assess and determine the (i) time of release, (ii) efficacy of the parasitoid with different densities of SM, (iii) the effect of using parasitoids on the reduction of damage, and (iv) the indirect effect of using parasitoids on yield. These studies will help to determine the optimal protocols for biological control releases (time of release, number of parasitoids per release, number of releases).

Survey for the presence of new canola flower galling midges

No bottle-shaped galled flowers characteristic of the canola flower midge (*Contarinia brassicola*) were observed in any field in 2019.

SM and *S. myles* are most abundant in the regions where canola is more widespread. Moreover, almost 75% of the infested plants sampled also hosted *S. myles*, which suggests that *S. myles* is well established in those regions. However, low numbers of parasitoids were found in regions where canola is less widespread. It will be interesting to follow how the population of *S. myles* will change based on the acreage of canola and cruciferous crops in the different regions of Quebec and Ontario. The rearing protocol for *S. myles* will be improved in 2020 to increase the colony in Quebec and further develop Ontario colony.

2020 Progress:

Field trials are being completed as per planned in Quebec (CEROM) however, due to COVID-19 survey sites in Ontario (Guelph) are being limited. It is the hope that survey sites in 2021 will be increased to compensate for this deficiency in 2020.

Investigation of Critical Tissue Sulfur Concentration and Nitrogen to Sulfur Ratio for Optimizing Canola Production in Eastern Canada

Principal Investigator: Bao-Luo Ma, AAFC, Ottawa Research and Development Centre

The best way to improve N fertilizer use efficiency (NUE) in canola is to adopt a nutrient balance approach, which considers the synergistic and antagonistic interactions between macro- and micro-nutrients that occur in soils and plants (*Fageria*, 2001). If crop growth is limited by an excess or deficiency of another essential nutrient, focusing on the crop response to N fertilizer inputs alone is unlikely to improve N fertilizer use efficiency (*Subedi* and *Ma*, 2009). Hidden hunger for micronutrients (*Gao* and *Ma*, 2015) and unbalanced nutrient supply (*Ma* et al., 2017) are the main causes of low N fertilizer use efficiency. Canola is expected to be sensitive to S concentrations in plant tissue, as S is an essential component of the amino acids cystine, cysteine, and methionine, and oilseed crops in the Brassiceae family require larger amounts of S than small grain cereal crops (*Nuttall* et al., 1987; *Grant* and *Baily*, 1993). For example, canola seed has a narrow N:S ratio of 6:1, compared to 16:1 in harvested wheat grain. On the other side, soil S source has been dramatically reduced in the past decades likely due to (i) reduction from atmospheric deposition with the effective control of air pollution, (ii) reduction in S content in phosphorus (P) fertilizers; and (iii) wide growth of high S demand crops and/or larger S removal with increasing crop yields (IPNI, 2016). Currently, there is a lack of knowledge on the appropriate S concentrations at early growth stages to be used as a diagnosis tool for S deficiency correction and N:S ratios at maturity to assess a balanced strategy of N and S nutrition being met. The proposed study is to address these issues.

This is a 4-year nitrogen x sulfur experiment with canola that was conducted at two fields with different soil characteristics at 2 sites in Eastern Ontario. The objectives of this study are to:

1) Identify the ranges of canola plant S concentrations and N:S ratios at various growth stages and at maturity.
2) Determine the critical S concentration and N:S ratio at early growth stages in relation to canola yield and NUE.
3) Develop a site-specific S recommendation rate for enhanced nutrient use efficiency and canola yield.

Experimentation is being conducted at two locations in Eastern Ontario: The Central Experimental Farm in Ottawa, ON and MacDonald College of McGill University. At both locations, the experiment was planted in two fields with different soil characteristics. Ottawa sites are sandy clay loam and sandy clay, while MacDonald College sites are CHICOT sandy loam and Rosalie clay.
Measurements include the following parameters: phenology; leaf chlorophyll and biomass measurements; plant heights; harvest index, yield, and moisture measurements; plant/grain nitrogen and sulfur concentrations; grain oil and protein measurements; and multiple soil samplings.

Results to Date:

2019 was an extremely challenging year at both sites due to a cool wet spring that made it difficult to work the land, fertilize and plant early. Planting occurred about 2 weeks later than normal. Compaction from tractor tires also caused a problem with plants in the tracks being shorter than the other plants in the plots. July had very little precipitation with hotter than normal temperatures. In July, the ground was so dry, soil sampling was difficult. Ste-Anne-de-Bellevue had a similar spring and summer.

Phenological Progression

At the Ottawa clay site only, the plots with high N rates and no sulfur, had plants in these plots that exhibited signs of sulfur deficiency early on in their growth. By the rosette stage, leaves were beginning to cup and the leaf edges turned purple (Figure 1). These plants were much slower to develop than the plants in the other plots. They flowered much later, and the flowers were a very pale yellow. Many of the flowers did not produce seed pods, leaving the plants with very few pods (Figure 2). The Ottawa clay site was the only site that exhibited these signs of sulfur deficiency.

Figure 1: Cupping and purpling of the leaves

Figure 2: Few pods formed by maturity

Soil Nitrate and Sulfate Levels

For all sites and each growth stage, soil nitrate significantly increased with increasing amounts of N fertilizer.

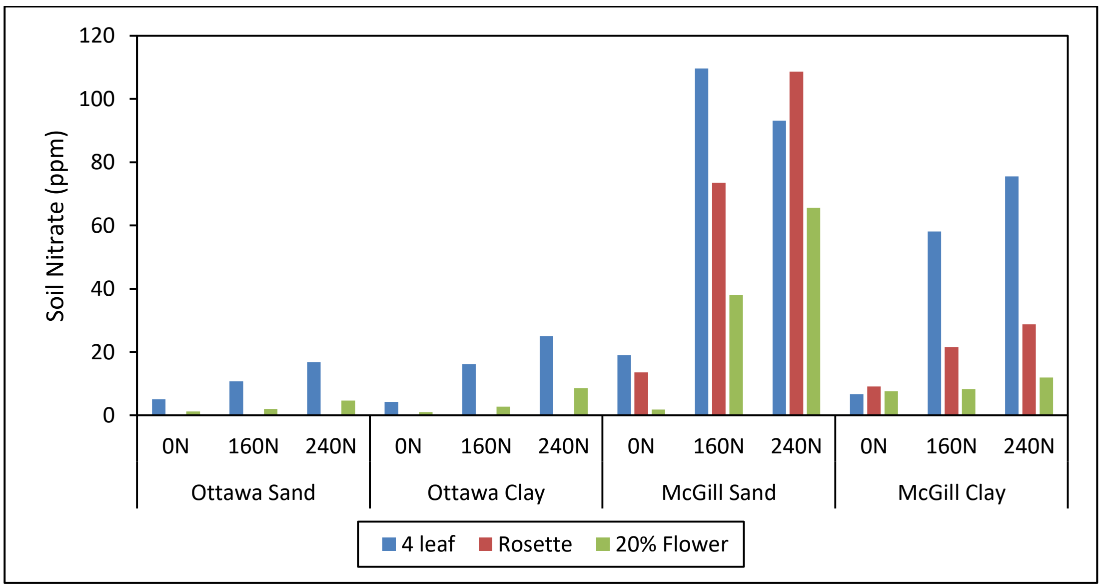


Figure 3: Soil Nitrate levels for the clay and sand sites of Ottawa and McGill in 2019

There was no significant N x S interaction effect on soil available sulfate at any of the sites and growth stages. However at the Ottawa clay site only, even though the N x S interaction was not significant, by 20% flowering the available soil sulfate levels were much lower in the 160 N and 240 N plots with no S, compared to all the other treatments and even lower than in the plots with no N or S (Figure 4). More work needs to be done to determine why this is happening at this clay site and not the other 3 sites. But excessive amounts of nitrates have been known to reduce the uptake of available sulfate. It should be noted that only at the Ottawa clay site did the addition of N have a slightly significant effect on soil available sulfur, causing it to lower with increasing applied nitrogen.

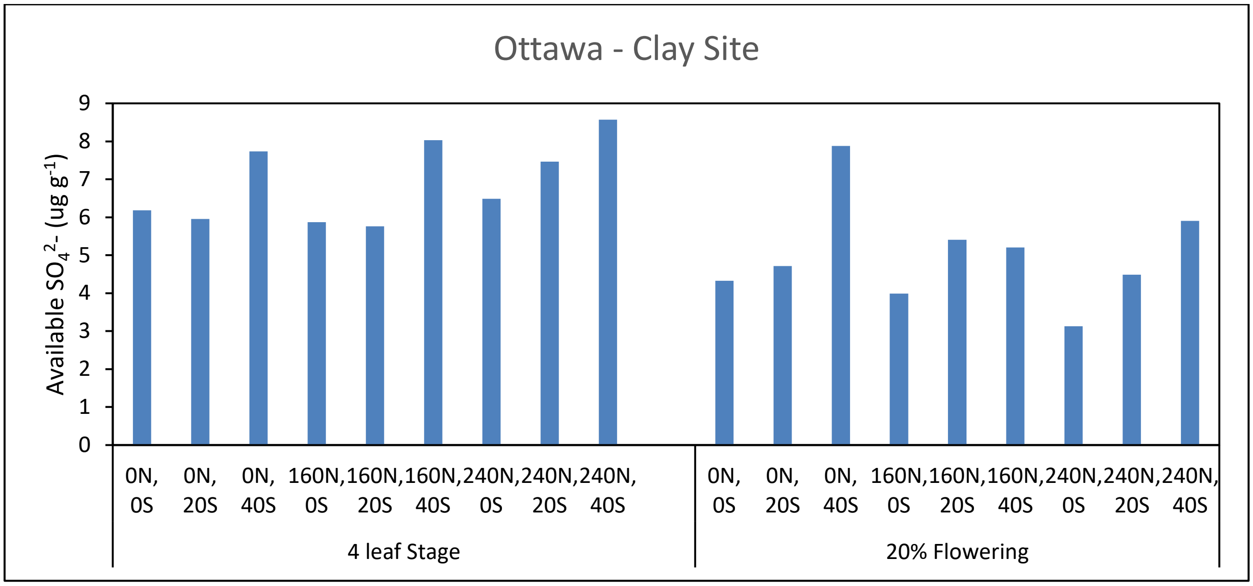


Figure 4: Soil available sulfate (SO_4^{2-}) at the clay site in Ottawa in 2019.

Final Yields

At all sites, yields responded positively to increasing amounts of preplant N fertilizer with the 0 N plots have significantly the lowest yields and in most cases (except the Ottawa clay site), the 160 and 240 N plots having the highest yields. Only at the Ottawa clay site did the application of preplant sulfate have a positive effect on yields, with the 0 S plots have significantly the lowest yields and the 30 and 40 S plots having the highest yields. This site was also the only site that had a significant nitrogen x sulfur interaction on yields (≤.001), with the plots that received no N or S having the lowest yields and yields increasing with increasing N and S. However, the plots with high N rates (160 and 240) and no sulfur, had the poorest yields, even worse than those of the 0 N plots. These are the same plots where the plants showed signs of S deficiency (purple and cupped leaves, were less green, took longer to develop, flowered later, and produced few and small seed pods). The Ottawa clay site was the only site that exhibited these signs of sulfur deficiency. These plots also had the lowest soil sulfate levels by the 20% flowering (Figure 4).

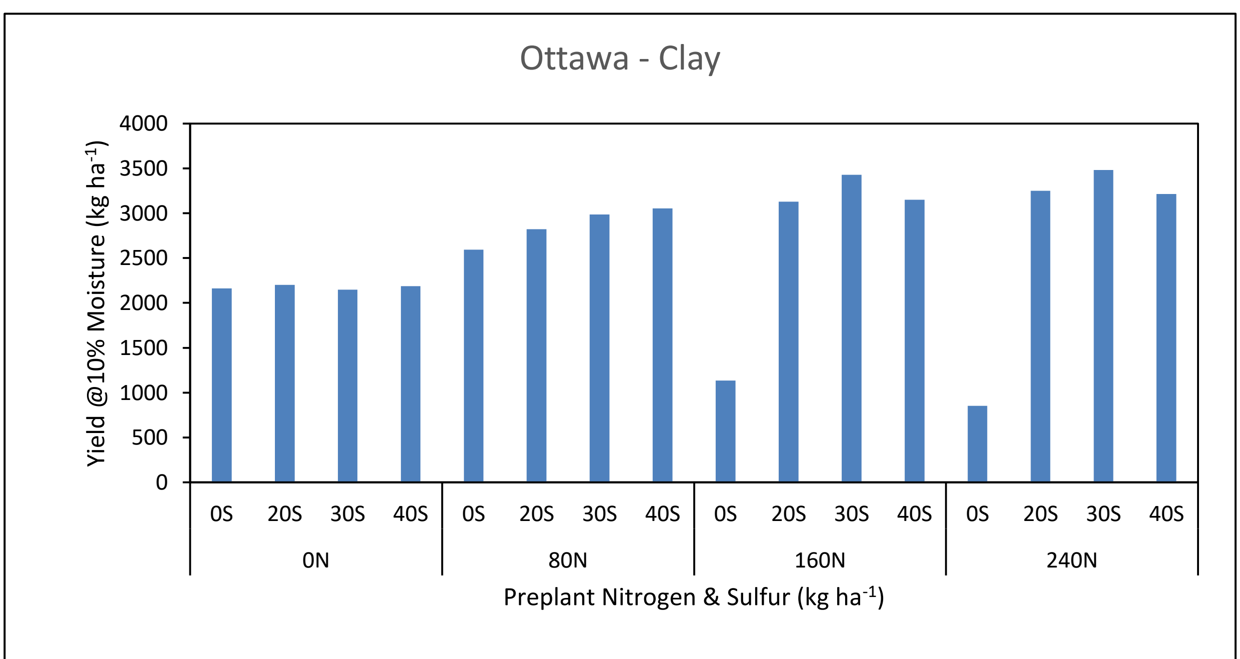


Figure 5: The effect of nitrogen x sulfur interaction on canola yields at the clay site in Ottawa in 2019.

Branches, Pods, seeds per pod and Thousand Seed Weight

At all sites branches, pods, and seeds per pod increased in numbers with increasing nitrogen levels, sometimes significantly. In all cases the plots that received the least amount of nitrogen had the least number of branches, pods, and seeds. In most cases the plots that received 240 kg ha^{-1} preplant, had the most branches, pods, and seeds. Thousand seed weight decreased significantly with increasing preplant applied N.

Sulfur did not have any effect on number pods or seeds per pod at any site. However, the addition of sulfur did have a significant effect on number of branches per plant. For 3 of the 4 sites, branching increased significantly with increasing amounts of preplant S. The Ottawa clay site is the only site that had a very significant nitrogen x sulfur interaction on number of seeds per pod. Figure 6 shows that number of seeds per pod were greatly reduced in two treatments: 160N, 0S and 240N, 0S, corresponding to the significantly lower yields also found in those two treatments.

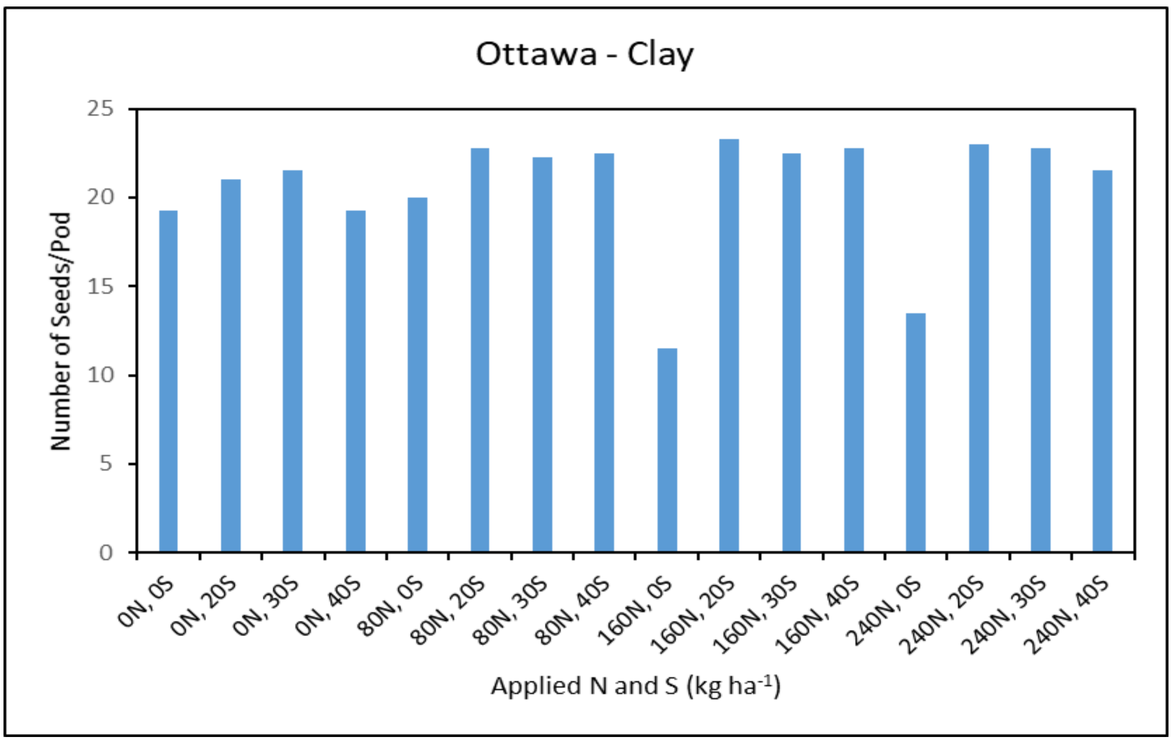


Figure 6: Nitrogen x sulfur interaction effect on number of seeds/pod at the Ottawa clay site in 2019.

Oil and Protein

Increasing preplant nitrogen significantly increased seed protein concentration, but significantly decreased oil concentration ($p \leq .001$) (Table 10A & B). In all cases, the plots that received 240 kg N ha^{-1} had the highest seed protein concentration but the lowest seed oil concentration. Plants from the 0 N plots had seed with the lowest protein concentration but highest oil concentration of all the treatments.

Table 10 A & B. Nitrogen effect on (A) seed oil and (B) seed protein concentrations (%) at all sites. Means with different letters in the same column are significantly different at the .001 ** level.

A) Oil

Applied N (kg ha^{-1})	Ottawa Sand	Ottawa Clay	McGill Sand	McGill Clay
0	44.7 a **	46.4 a **	53.3 a **	52.9 a **
80	44.2 b	46.2 a	51.4 b	52.4 a
160	43.8 c	44.9 b	50.3 c	50.0 b
240	43.8 c	44.3 b	50.0 c	49.1 c

B) Protein

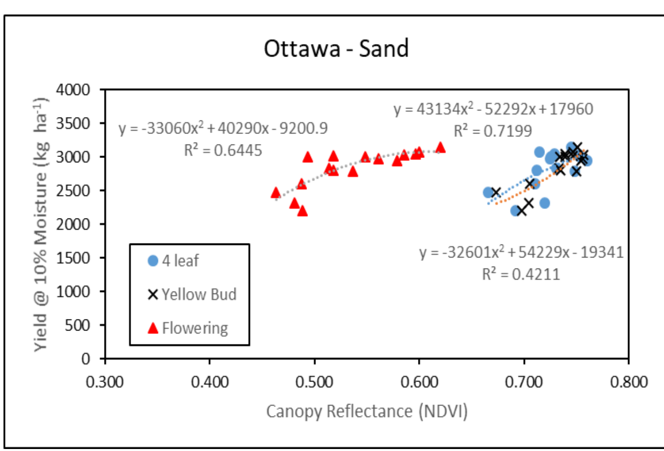
Applied N (kg ha^{-1})	Ottawa Sand	Ottawa Clay	McGill Sand	McGill Clay
0	22.6 c **	20.9 c **	14.8 c **	15.0 c **
80	23.2 b	21.3 c	16.6 b	14.4 c
160	23.7 a	22.5 b	17.4 a	17.0 b
240	23.7 a	23.1 a	17.8 a	18.0 a

For three of the sites (not including the Ottawa clay site) correlation analysis shows that yield is negatively correlated with seed oil and positively correlated with seed protein.

Canopy Reflectance (NDVI)

Canopy reflectance measurements determining plant greenness, were taken by Greenseeker several times during the growing season at the Ottawa location only. From the 4 leaf stage to 20% flowering, greenseeker could detect that the plants in the 0 N plots were significantly less green than all the other plants, NDVI readings significantly increased with increasing amounts of preplant urea added to the soil.
The addition of sulfur had no effect on plant greenness.

There is a very strong positive correlation between NDVI readings and yield based on the Pearson's coefficient analysis and regression analysis (Figure 7). However at the clay site in Ottawa at 20% flowering, there was a negative correlation between yield and Greenseeker, probably due to the fact that the plants in the 0 S plots with 160 and 240 kg N ha^{-1} were so far behind in development (therefore greener at that stage) compared to plants in the other treatments (Figure 7).



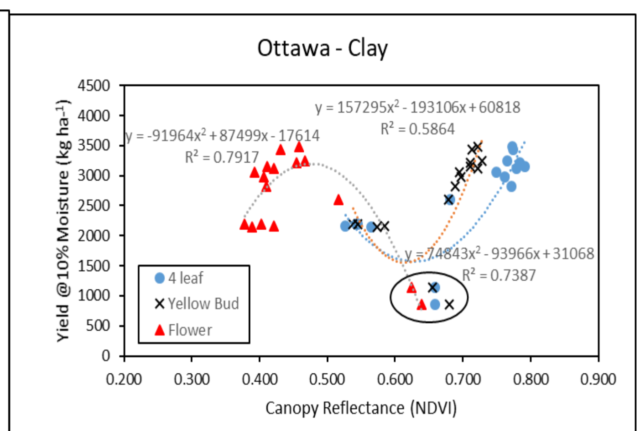


Figure 7: Regression analysis of yield as a function of canopy reflectance at three different growth stages at the Ottawa sand and clay sites. The circled points refer to the plots with no sulfur and 160 and 240 kg N ha^{-1}

Leaf Chlorophyll Readings

SPAD readings from the SPAD-502 leaf chlorophyll metre were taken in Ottawa and in St-Anne-de-Bellevue. Readings were taken from the 4-leaf stage (GS14) to 20% flowering. It was not until the yellow bud stage (BBCH 59) in Ottawa where SPAD could detect leaf chlorophyll differences, with SPAD readings significantly increased with increasing preplant N rates. At McGill, SPAD could significantly detect leaf greenness differences between N treatments at the 4-leaf stage.

There was a very strong correlation between SPAD readings and final yields at the Ottawa sand site and the McGill sand and clay sites based on Pearson's correlation and regression analysis. Note that the Ottawa clay site at 20% flowering did not show any correlation between SPAD and yield.

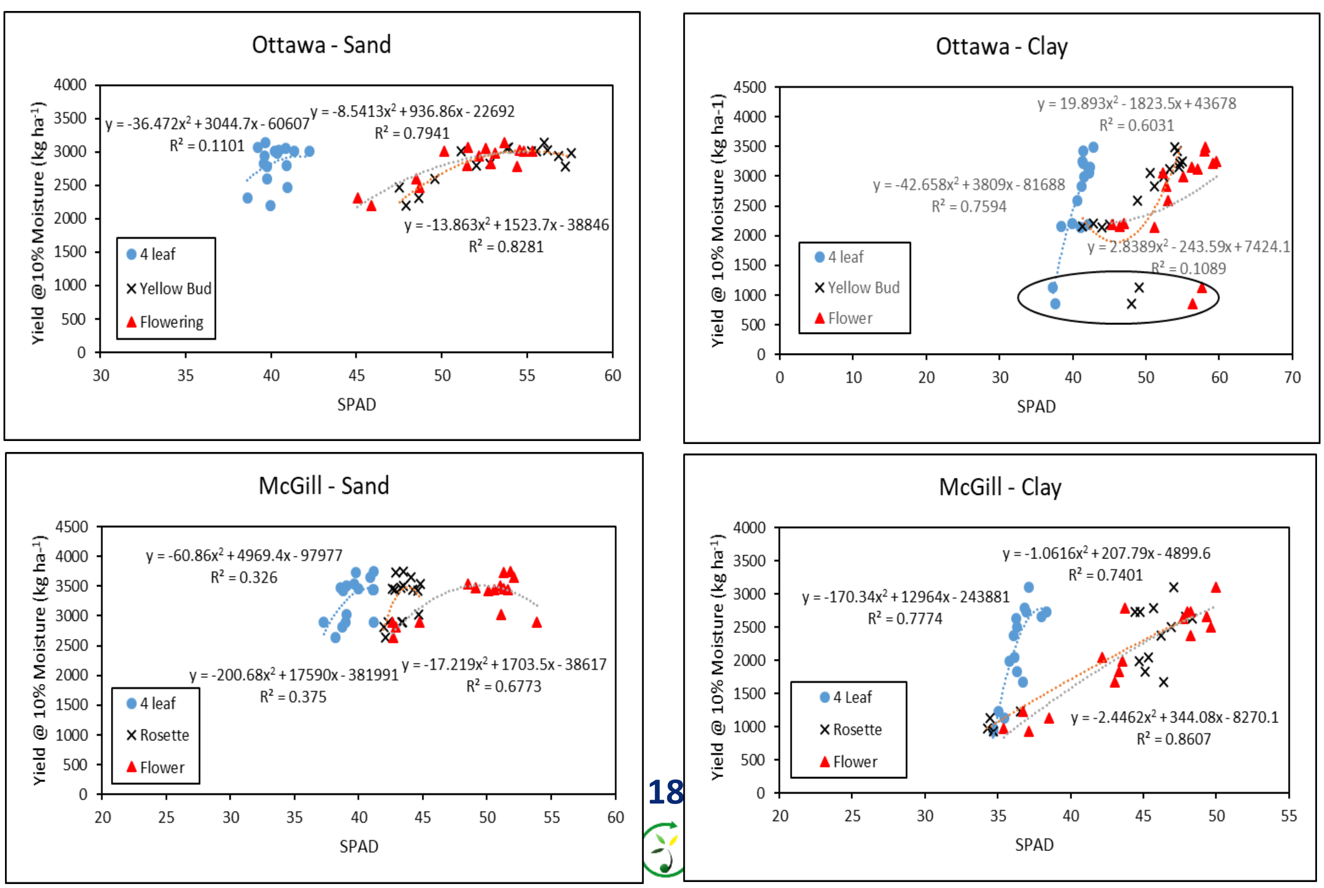


Figure 9: Regression analysis comparing yield with SPAD taken at different growth stages at Ottawa and Ste-Anne-de-Bellevue at their sand and clay sites in 2019. The circled points at the Ottawa clay site refer to the plots with no sulfur and 160 and 240 kg N ha^{-1}.

2020 Progress:

AAFC field trial activities in Ottawa are being partially completed (approximately 40%), with all fields planted but restricted data collection. McGill site trials are being conducted as planned.

Environmental and Economic Impact of Canola in Potato Rotation in Eastern Canada

Principal Investigator: Aaron Mills, AAFC-Charlottetown

The previous ECODA cropping systems project evaluated 10 different rotations that were approved by industry collaborators. These rotations were conducted over a period of three years and provided information regarding the effects of the presence of canola, soybean, and corn, in a rotation with potatoes. The project also generated information on the influence of crop diversity within each of the cropping systems. The previous project work showed that sequential planting of soybean and canola showed the highest percentage of culls in the potato crop of all rotations. The highest overall potato yields were observed in the corn/canola rotation. We collected limited information on soil nutrient and soil health status including nematode population dynamics and phospholipid fatty acid profiles. These measurements showed that higher mycorrhizae numbers were observed in rotations containing forage, forage mixes and grains; plant parasitic nematodes showed slightly higher numbers in the corn-canola rotation and were lowest in the corn soybean rotation when averaged over the three years. When broken down by year, it is clear that certain rotations resulted in an increase in plant parasitic nematode numbers such as canola-canola, barley-forage, and canola-wheat, however these numbers did not appear to correlate negatively with potato yield.
Building on previous ECODA research, cropping sequence and crop identity influence potato quality and yield. Plant diversity appears to be an important aspect of cropping system productivity. Nematode population dynamics showed a complexity associated with plant diversity but did not have a direct influence on yield; PLFA bioindicators were positively associated with the presence of forages within the cropping system. Taken together, it was clear that further research should include a greater focus on plant diversity, a deeper understanding of soil nutrient dynamics, and more focus on understanding soil health parameters including soil mycorrhizae and microbial biomass and how these factors affect the profitability and sustainability of each cropping system.

The current cropping system study is evaluating different management practices that can improve both the sustainability and profitability of potato rotations with the following objectives:

1. Agronomy: cover crop compatibility for each cropping system; effects of fall plow vs. winter cover crop; yield components and agronomic metrics of all crops in all rotations; disease effects on all crops including potato

2. Nutrient management : N credits from different cover crops ; N use efficiency; Soil enzyme activities associated with C, N, and P cycling
3. Soil health: nutrient ratio in the whole soil and microbial biomass; soil aggregate stability and particulate organic matter during potato phase; effects of brassicas on mycorrhizal colonization of subsequent crops; evaluate mycorrhizal inoculant application to improve potato yield and quality

This cropping system study strategy applied the use of overseeding and underseeding to provide winter cover crops to reduce erosion and nitrogen leaching through the winter. Therefore, as a split within the design, one half of each plot was plowed in the fall to leave the soil exposed; the other half of the field was plowed in the spring. With the project being a continuation of the previous funding cycle, 2017 and 2018 were the first and the second year of the three-year potato rotation. The 2019 growing season will be the potato phase (Figure 1).

	2017		2018		2019	2020		2021		2022
Rotaton	**Main crop**	**Cover crop**	**Main crop**	**Cover crop**	**Main crop**	**Main crop**	**Cover crop**	**Main crop**	**Cover crop**	**Main crop**
1	barley	red clover u/s	red clover	red clover	potato	barley	red clover u/s	red clover	red clover	potato
2	canola/pea	winter wheat	winter wheat	red clover	potato	canola/pea	winter wheat	winter wheat	red clover	potato
3	soybean	ryegrass o/s	corn	ryegrass o/s	potato	soybean	ryegrass o/s	corn	ryegrass o/s	potato
4	canola	cereal rye	pea	cereal rye	potato	canola	cereal rye	pea	cereal rye	potato
5	canola	red clover	corn	ryegrass o/s	potato	canola	red clover	corn	ryegrass o/s	potato
6	soybean	mustard	corn	ryegrass o/s	potato	soybean	mustard	corn	ryegrass o/s	potato
7	pea	cereal rye	canola	cereal rye	potato	pea	cereal rye	canola	cereal rye	potato
8	corn	ryegrass o/s	canola	cereal rye	potato	corn	ryegrass o/s	canola	cereal rye	potato
9	canola	winter wheat	winter wheat	red clover o/s	potato	canola	winter wheat	winter wheat	red clover o/s	potato
10	pea	winter wheat	winter wheat	red clover o/s	potato	pea	winter wheat	winter wheat	red clover o/s	potato

o/s = overseeded
u/s = underseeded

Figure 1: Cropping systems implemented in the present study.

Results to Date:

The 2018 rotation crops were planted, harvested, and all relevant crop and soil sampling were performed as required. Data collected included agronomic measurements of seed and biomass yield, seed quality, soil nutrients, soil nematode populations and phospholipid fatty acid (PLFA) profiles to measure the status of soil microbial functional groups. The 2018 season experienced issues with the productivity of the corn plots as well as the canola plots. Several canola plots were affected by birds which resulted in a significantly lower seed yield (and all corn plots were affected by both birds and raccoons (crop loss situation). In 2017, the first round of fall tillage occurred following the growing season. The implementation of this tillage regime saw significant differences between the seed and biomass yields observed during the 2018 growing season. Generally, most yields were lower in the plots that were spring tilled (or not tilled in the fall in the case of winter wheat). Although these differences were observed with winter wheat, there were no impacts of fall vs. spring tillage on pea crop seed or biomass yield (Figures 2 and 3).

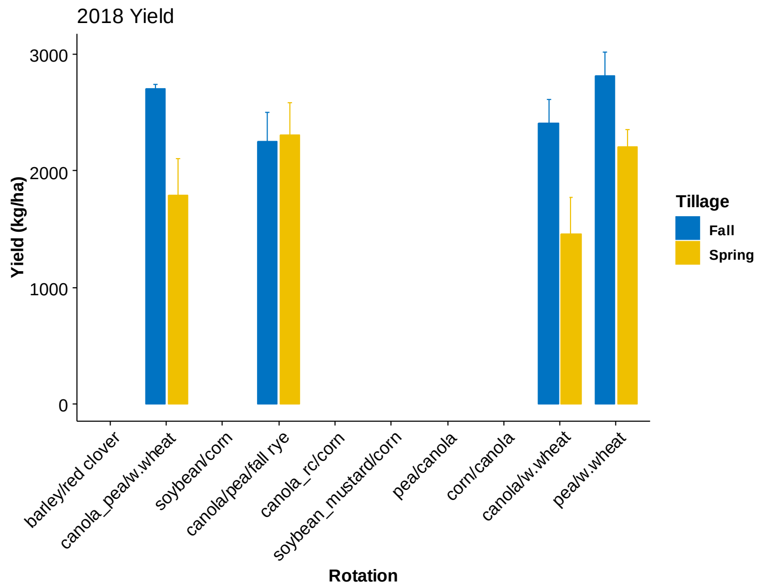


Figure 2: Total seed yield for each rotation for the 2018 growing season. The absence of bars in each figure indicates either a non-seed crop (i.e. clover) or a crop loss situation

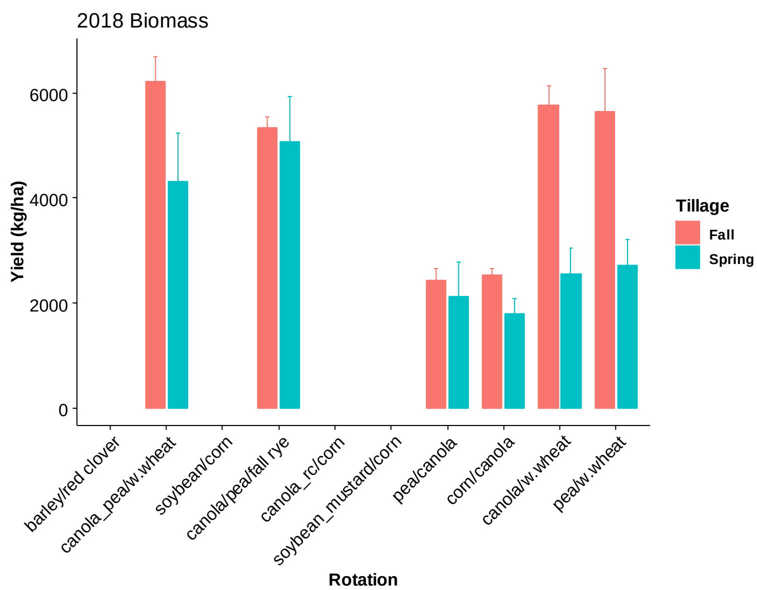


Figure 3: Total dry matter for 2018. The absence of bars indicates a crop loss for corn where data were not collected; red clover biomass was recorded separately and are not reported.

Although the 2019 potato crop year had a prolific weed issue, cursory analysis of the potato yield at the end of the first phase of this project (2019) showed interesting trends. Overall, potato yield was higher in treatments that used fall plowing over spring plowing; there appeared to be a higher potato yield in treatments following corn or canola (Figure 4).

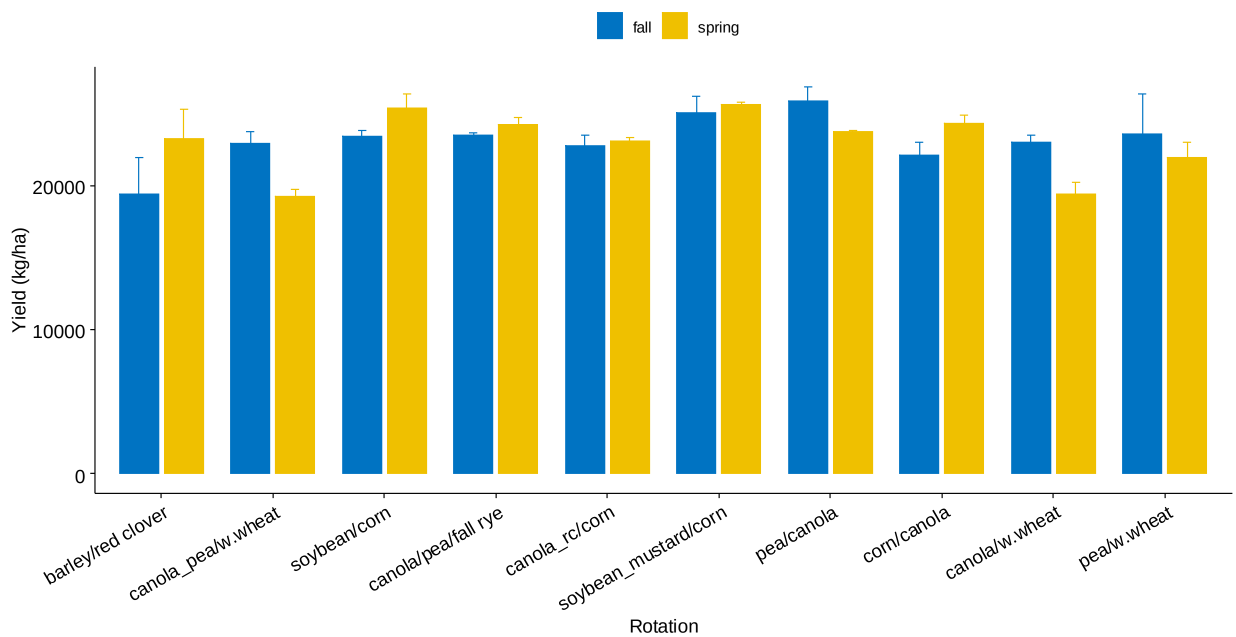


Figure 4: Potato yield (2019) in various cropping systems.

Both nematode community analysis and PLFA has been completed up to 2018. The data will be integrated into the potato yield and quality analysis once the 2019 data has been recorded, which has been delayed due to COVID.

2020 Progress:

2020 field trials being conducted as planned, with corn being replaced with other field crops in rotation due to challenges experienced in earlier years.

SOYBEAN REPORT

There are 5 soybean research activities being conducted under the current ECODA CAP program in collaboration with Sevita Genetics. Three of these projects are being conducted by Sevita researchers aimed at developing commercially viable, IP, non-GM soy varieties with the following target characteristics: high oleic, low linolenic, low palmitic oil composition; high methionine and lysine; high protein soybean line for aquaculture feed. The remaining 2 projects are being conducted by AAFC researchers Malcolm Morrison and Elroy Cober who are screening and developing soybean varieties for moisture stress and nitrogen fixation as well as incorporation of strong seed coat, good germination, and root quality.

All projects have progressed with good results thus far and continue this season with little interruption due to COVID-19.

NOVEL CROPS REPORT

Enhancing Profits and Sustainability in potato rotations using brown mustard (brassica juncea) for soil health and export grain production

Principal Investigators: Steve Howatt, Atlantic AgriTech Inc. / Dr. Aaron Mills AAFC Charlottetown PEI

Due to considerable and rapid expansion of wireworm and the increase in the prevalence of potato early dying complex (EDC), growers have been increasingly interested in the use of biofumigant crops as part of the potato production system. Brown mustard (*Brassica juncea*) has seen the greatest increase in acres as growers attempt to capitalize on the bio fumigation properties of this plant. Although some studies have shown bio fumigation to be an effective alternative approach to pest control, brown mustard seed is expensive and the specific management of this crop as a biofumigant may be detrimental to soil structure. For example, when managed as a biofumigant, the use of secondary and tertiary tillage to incorporate brown mustard plants into the soil results in additional field passes and physical disturbance that would not have normally happened. The purpose of this project is to evaluate whether biofumigant effects of brown mustard can be realized if the plant is managed in ways other than through secondary tillage. This would include the use of flail mowing, or potentially harvesting the mustard seed as a cash crop.

Quantification of the level of reduction of wireworm damage in potato and overall return per acre following establishment of brown mustard (Brassica Juncea) for grain harvest versus plow-down in an Eastern Canadian potato rotation.

To achieve this objective there would be 3 sub-objectives:

a) Determine if there is a significant positive effect of mustard residues on wireworm reduction and subsequent potato tuber yield and quality, if mustard is permitted to mature for grain export as compared to mustard being incorporated as a green plow-down.

b) Create predictive model of yield and economic return for a potato rotation with mustard that is cropped for grain harvest or for plow-down.

c) Quantify the economic and environmental return of a rotation with a mustard grain harvest as compared to the traditional mustard plough-down.

This work will be conducted both on private grower-cooperator sites as well as a site conducted by AAFC researchers at the Harrington Research Station.

Each year in Years 1-4 of the project, four field sites will be chosen for establishment of brown mustard management strips, for a target of 24 site-years for evaluation over the 5-year project. All fields selected will be in rotation with potatoes and will be coming out of a grain, oilseed, or forage crop for establishment with mustard (*B. Juncea*) and potatoes to follow. Three, approximately equal sized field-scale plots (strips) will be established in each field to compare: 1) mustard allowed to mature for grain harvest, 2) mustard plowed down at peak flowering prior to full seed development, and 3) a check treatment of spring cereal (barley, wheat, oats or mixed grain). Each of the three plots will be divided into four separate sections from which replicate samples will be collected. All plots and sections will be accurately marked, and GPS mapped for accurate identification in the following year for surveying of potato quality.

Results to Date:

This trial has been significantly challenged due to an inability to line up adequate grower cooperators. In the first year, 2018, although some field sites were established, little was achieved in terms of results. In 2018, Season 1 mustard field sites were established at 3 locations in PEI and 1 location in New Brunswick. All fields selected were in rotation with potatoes and coming out of a grain, oilseed, or forage crop for establishment with mustard (*B. Juncea*) and potatoes to follow.
One composite pre-plant soil sample was collected from across all areas of each plot (3 composite samples per field) for analysis for nematodes and verticillium. Samples were not collected for other baseline indicators, but this will be done in spring 2019. General crop observations and crop stand counts were taken in five, 1 m^2 quadrants placed randomly throughout each of the four sections of each plot at approximately 3 weeks after emergence. Mustard biomass plots were mowed down at peak flowering, prior to seed development, and incorporated using disc harrow. Plots to be harvested for mustard seed were harvested at maturity, or when approximately 95% has turned colour and firm or approximately 8% moisture. Plot yields were determined by harvesting the plot area with commercial combine.

Although significant effort was put into identifying cooperators to establish new mustard strips, no successful Season 1 mustard field sites were established in PEI in 2019 due to lack of cooperating growers and grower mismanagement of plots. Two sites were initially established, however insurmountable issues will prevent either site from being followed through to the potato season in 2020.

In terms of mustard impact on potato quality, two PEI mustard sites and one NB mustard site that had been established in 2018 were followed through to the 2019 potato crop. Following is a list of activity completed with regards to the Season 2 (potato) crop evaluations: soil samples were taken from each of the four sections of each plot established in Year 1 (mustard planting year) of the trial, resulting in four individual soil samples per plot and 12 samples for the field; samples were analyzed for nematode and verticillium levels as well as for OM and other soil health indicators. Only one composite sample per strip was collected from the NB site in the potato year.

Table 1. ECODA – Visser Verticillium and Nematode Data

	16-Jul-19		16-Jul-19		16-Jul-19		16-Jul-19	
	V. dahliae		V. albo-atrum		Root Lesion		Other	
Soybean	2.4	a	0.4	a	1107	a	20459	a
Mustard – Plow Down	2.5	a	0.1	a	2948	a	28184	a
Mustard – Seed Harvest	2.4	a	0.3	a	1158	a	24256	a

Table 2. ECODA – Webster Verticillium and Nematode Data

	16-Jul-19		16-Jul-19		16-Jul-19		16-Jul-19	
	V. dahliae		V. albo-atrum		Root Lesion		Other	
Barley	2.4	a	0.5	a	4866	a	23258	a
Mustard – Plow Down	2.5	a	0.5	a	5884	a	15653	a
Mustard – Seed Harvest	2.4	a	0.8	a	2946	a	21239	a

No statistically significant differences (P=0.05) were observed in verticillium levels (0-3) or nematode numbers at either of the PEI sites in the potato year.

Following is a summary of the soil health data from analyses conducted at DAL-AC. No statistics were run on this data.

Table 3. ECODA – Visser (PEI) Soil Health Data*

	Total Carbon (%)		Active Carbon (mg kg $^{-1}$)		Water Stable Aggregates (%)	
Soybean	1.11		248.8		28.26	
Mustard – Plow Down	1.17		284.5		31.03	
Mustard – Seed Harvest	1.09		286.5		27.64	

*Data is average of 4 samples taken per plot

Table 4. ECODA – Webster (PEI) Soil Health Data*

	Total Carbon (%)		Active Carbon (mg kg $^{-1}$)		ACE Protein (ug/mL)		Water Stable Aggregates (%)	
Barley	1.27		326.2		5.56		47.32	
Mustard – Plow Down	1.14		301.6		5.00		46.50	
Mustard – Seed Harvest	1.54		374.1		5.55		45.79	

*Data is average of 4 samples taken per plot

Table 5. ECODA – Anderson (NB) Soil Health Data**

	Total Carbon (%)		Active Carbon (mg kg $^{-1}$)		Water Stable Aggregates (%)	
Oats	2.35		382.0		53.43	
Hemp	2.37		387.0		36.90	
Mustard	2.31		382.0		44.50	

*Data is based on one composite sample per plot

Four random 3 m length strips were evaluated for potato stand counts, vigor and general crop health and recorded from random areas of each section of each plot throughout growing season, at two timings. No differences were observed in visible observations between strips at any site.

At harvest, a single, 3-metre test strip was harvested from random areas within each of the four subsections of each main plot, recording number of plants dug per 3-metre strip. Potatoes from within each test strip were bagged and removed from the field for grading and assessment. Samples were graded according to appropriate processing contract payout criteria and assessed for other soil borne disease levels (scab, *Rhizoctonia*, etc), specific gravity and wireworm damage.

Table 6a. ECODA – Visser (PEI) Site Potato Yield Data

	28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19
	# Plants		# Tubers Total		# Tubers/Plant		% < 2”		% 2”-10 oz		% > 10 oz		% Knobs
Soybean	10.5	a	69.0	a	6.7	a	23.6	a	68.9	a	6.2	a	1.4
Mustard – Plow Down	12.3	a	67.3	a	5.5	a	29.3	a	61.5	a	8.7	a	0.5
Mustard – Seed Harvest	11.5	a	69.3	a	6.1	a	30.8	a	61.8	a	6.8	a	0.7

Harvested area was average of 4 samples, each consisting of 1 row of potatoes (0.914 m wide) and 3 m long.

Table 6b. ECODA – Visser (PEI) Site Potato Yield Data

	28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19	
	Avg Tuber Wt (oz)		% Tubers with WW damage		% Tubers with Scab		Total Yield (cwt/acre)		Marketable Yield (cwt/acre)		Specific Gravity	
Soybean	5.01	a	39.0	a	8.9	a	314.2	a	278.4	a	1.077	a
Mustard – Plow Down	4.96	a	38.1	a	5.8	a	307.7	a	270.3	a	1.076	a
Mustard – Seed Harvest	4.81	a	56.3	a	10.5	a	307.7	a	266.2	a	1.078	a

Harvested area was average of 4 samples, each consisting of 1 row of potatoes (0.914 m wide) and 3 m long.

No significant differences were observed in total or marketable yields for any tuber size category at the Visser site. Similarly, no significant differences were observed in wireworm or cab levels between the strips.

Table 7a. ECODA – Webster (PEI) Site Potato Yield Data

	28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19
	# Plants		# Tubers Total		# Tubers/Plant		% < 2”		% 2”-10 oz		% > 10 oz		% Knobs
Barley	7.3	a	79.8	a	11.0	a	25.8	a	68.3	a	5.6	a	0.4
Mustard – Plow Down	7.5	a	89.3	a	11.8	a	29.9	a	66.2	a	3.9	a	0.0
Mustard – Seed Harvest	8.5	a	83.0	a	9.9	a	28.3	a	62.8	a	7.9	a	1.1

Harvested area was average of 4 samples, each consisting of 1 row of potatoes (0.914 m wide) and 3 m long.

Table 7b. ECODA – Webster (PEI) Site Potato Yield Data

	28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19		28-Oct-19	
	Avg Tuber Wt (oz)		% Tubers with WW damage		% Tubers with Scab		Total Yield (cwt/acre)		Marketable Yield (cwt/acre)		Specific Gravity	
Barley	4.55	a	9.3	a	3.9	a	330.5	a	289.8	a	1.075	a
Mustard – Plow Down	4.35	a	6.4	a	4.3	a	337.0	a	283.3	a	1.073	a
Mustard – Seed Harvest	4.65	a	18.2	a	15.9	a	350.9	a	300.4	a	1.075	a

Harvested area was average of 4 samples, each consisting of 1 row of potatoes (0.914 m wide) and 3 m long.

No significant differences were observed in total or marketable yields for any tuber size category at the Webster site. Similarly, no significant differences were observed in wireworm or cab levels between the strips.

Table 8a. ECODA – Anderson (NB) Site Potato Yield Data

	# Plants	# Tubers Total	# Tubers/Plant	% Small	% Medium	% > 10 oz	% Knobs
Oats	9.5	64.2	6.4	3.7	89.6	6.7	
Hemp	10.3	62.0	6.1	3.9	85.8	10.2	
Mustard	9.0	71.0	6.6	6.6	86.8	6.6	

Table 8b. ECODA – Anderson (NB) Site Potato Yield Data

	Avg Tuber Wt (oz)	% Tubers with WW damage	% Tubers with Scab	Total Yield (cwt/acre)	Marketable Yield (cwt/acre)	Specific Gravity
Oats	5.53	0.0	0.0	287.9	274.1	1.081
Hemp	5.69	0.0	0.0	320.1	306.6	1.078
Mustard	5.07	0.0	0.0	264.5	246.1	1.085

AAFC Research Site

Brown mustard acres on PEI have gone from less than 500 to 15000 over the period of five years. This increase in the amount of brassica crops combined with the lack of treated seed and the reluctance of farmers to apply insecticide to a "cover crop" has resulted in a tremendous spike in flea beetle populations. As a result, all plot experiments in 2018 for this project were destroyed. The initial planting happened in early June, was destroyed three weeks later. The project was then immediately replanted, and the combination of drought conditions and the second emergence of flea beetles was enough to result in another crop loss. A third attempt to implement this project consisted of mowing plots out of an existing mustard field. However this final attempt to save the project happened so late in the season that the data gained from the soil and tissue samples were useless when they could not be taken under the context of phenological sampling to quantify glucosinulate production in the plant tissue. In 2019 season there were once again issues with flea beetles early on. This required insecticide to be applied to the plots. This is now part of the regular management practice.

Samples were collected throughout the 2019 growing season, flash frozen in liquid nitrogen and stored at -80C. Plant tissues (above ground, below ground) and soil samples were processed separately, during plant phenological development and in response to agronomic treatments, totaling ~250 samples.

13 different analytical standards representing the most reported glucosinolates were sourced for quantitative analysis.

Optimized extraction and analytical instrument separations are currently being developed.

A summer student (May-Aug 2020) was sourced to assist in bulk sample prep, however, this was cancelled due to COVID-19 and therefore data was not available.

2020 Progress:

On-farm coordination and data collection has been taken over by Steve Watts with some assistance provided by Ryan Barrett and the PEI Potato Board to set up new cooperators for the 2020 season. 3 season 1 mustard field sites have been established in PEI and 2 in New Brunswick. The season 2 potato fields in New Brunswick have been soil sampled and lab analysis completed.

Improving soil health and land-use efficiency through intercrops with pulses

Principal Investigator: Dr. Claude Caldwell, Dalhousie University / Dr. Aaron Mills, AAFC Charlottetown PEI

The projected outcome for this activity is a recommended pea intercrop that delivers a LER of greater than one, and therefore a higher return per acre versus a single crop, for producers in Eastern Canada for a single rotation year. This recommendation will also be based on high market potential and export value as well as improved soil health over the entire rotation of our agricultural lands. Development of a new intercropping production system in Atlantic Canada that incorporates two high value crops and improves the overall sustainability of the agricultural rotation in the region meets multiple AAFC and CAP priorities including innovative research for the improvement of support for minor and emerging commodities, increased efforts in value added commodities, and opening of new opportunities in export markets and trade. This proposed system will also support major commodity sectors by providing locally produced value-added feed ingredients to our livestock and aquaculture industries as well as support healthy sustainable rotations for potato farmers in the region.

The goal of this research is to determine variation in intercrop performance of two brassica species with peas evaluating soil health and LER as determinants for performance. To achieve this objective there are 3 sub-objectives:

a) Determine the effect of brassica: pulse intercrops on soil health.
b) Evaluate the relative benefits of B. juncea (brown mustard) and C. sativa (camelina) as companion crops for peas.
c) Determine the best intercrop ratio to obtain optimum Land Equivalent Ratio (LER) for oil, protein and per hectare profitability.

There are two sections of work being completed for this study, one being led by Dr. Caldwell with three field sites in Hartland, NB and Truro, NS, chosen for variation in soil type and climate condition. The other section of work conducted by AAFC at the Harrington Research Station in PEI. Small plot experimentation designed to evaluate the response of two brassica species camelina (C.sativa) and mustard (B.Juncea) intercropped with peas. Control plots of each crop were established at recommended rates and seeded at different rates when intercropped. The plots were seeded by first drill seeding the peas and then followed by the brassica species seeded on top either drilled in rows between peas or via broadcast seeding. Intercrop treatments received nitrogen fertility at a rate of 60 kg N ha^{-1}, while pea-only plots will receive 20 kg N ha^{-1} and brassica plots will receive nitrogen at 100 kg N ha^{-1}.

Results to Date:

2019 was the first year of study for these trials, unfortunately these experiments at all sites were terminated during the early flowering stage of the pea crop when it became obvious that there had been a serious mistake in the chosen pea cultivar. The intended pea cultivar was a semi-dwarf, semi-leafless grain type that matched closely the growth habit of the test brassicas. Unfortunately, the pea variety that was mistakenly planted was a vigorous, leafy, forage type. This pea quickly outcompeted the brassicas making it a completely unsuitable intercrop choice. All sites had put considerable effort and expense into establishing this experiment but, in the end, no useful data on this experiment was collected.

2020 Progress:

Truro (Dalhousie University) site moved to Annapolis Valley due to COVID closure of campus but is progressing well at this site. However, initial observations lead us to believe that mustard has overgrown peas in most plots. Charlottetown (Harrington) site was established and data collection pending.

Evaluation of diverse camelina germplasm to enhance profits and sustainability in Eastern Canadian rotations

Principal Investigator: Dr. Claude Caldwell, Dalhousie University

Camelina sativa is a rediscovered oilseed with unique characteristics for human consumption, animal feed and use in the production of biofuels. Recent experimentation has led to its registration both for human use and at low levels in animal feed. There is a need to identify improved varieties with specific characteristics for identified markets and to develop rotations in which camelina can provide both in economic and environmental benefit.

The primary objective of this research is to identify top performing camelina varieties for Eastern Canada for both soil enhancement as well as maximization of return in rotation. To achieve this objective, we have set 5 sub-objectives:

a) Determine what varieties, when introduced into Eastern Canada best meet targeted market standards/demands (FA profile, protein, antinutritional, seed size, etc.), specifically feed and high value oil markets.
b) Assess if producers can use a short season (< 80 day), high quality camelina type to follow winter wheat and produce a double crop economically and sustainably.
c) Evaluate if improved camelina lines from the EU outperform the present camelina cultivars in Canada and improve the profitability of the camelina value-chain both in feed and the human food market.
d) Determine bio fumigation effectiveness of a long season (160 day), high glucosinolate lines of camelina as a plough-down in a potato rotation.

e) Evaluate how a potato rotation with camelina for seed compare to the traditional mustard plough-down both in economic and environmental terms.

Results to Date:

Agronomic data:

At the Kentville site, there were no significant effects of variety on yield, thousand kernel weight, or stand count. However, there was significant variation in terms of test weight, lodging, and downy mildew incidence. Two of the tested lines had significantly higher test weights than the check variety. This site experienced significant lodging: the check variety lodged the most, while 2 others were identified as best. All lines experienced some level of downy mildew incidence but only one line had significantly more disease than the check.

At the Truro site, there were no significant effects of variety on yield. However, there was significant variation in terms of test weight, thousand kernel weight and stand count. At this site there was no significant lodging or downy mildew incidence. One line had a significantly lower test weight and thousand kernel weight than the check; the others were not significantly different. In terms of stand establishment, only one tested line had a lower stand count.

Seed quality data:

2019 data showed the interactive effect of cultivar and location on protein and oil levels. This evaluation clearly demonstrated the inverse relationship between protein and oil content. However, it also showed the effect of location on varieties. The varieties segregate in terms of protein and oil production in varying amounts according to location. This data also showed expression of variety and location effects on fatty acid composition. This is very preliminary data and must be followed up with more locations and more years to pin down the best, most stable variety.

Overall, 2019 was a very difficult season for these trials due to extreme weather conditions, including late seeding and a very wet fall. However, there is some good data in terms of differentiation of varieties and optimism in terms of double cropping as a viable option in the Annapolis Valley. We have been able to obtain earlier land for 2020 planting for the germplasm evaluation. In addition, we shall be looking at doing our double cropping experiments after winter barley so that camelina planting can occur immediately after the earlier winter barley harvest. This work is being done in cooperation with a very interested malt barley producer. The next 2 years of testing will be very important to respond to the increasing interest in this crop.

2020 Progress:

A single site was established in Annapolis Valley due to COVID closure of Dalhousie campus. Initial observations have shown a similar incidence of downy mildew as previously seen in 2019.

2020 COMMENCEMENT TRIALS

On Farm Agronomic evaluation of Industrial Hemp Varieties for Yield and Quality

2020 Progress:

This project has been delayed due to AAFC screening of hemp varieties, which were preemptive to on-farm evaluations, not being completed. The hope is this will be able to be conducted in year 4 and/or 5 of CAP program.

Nutritional value and functionalities of non-genetically modified oilseeds for application in aquaculture feeds

2020 Progress:

This project is to commence in late 2020, early 2021 when sufficient seed volumes of preferred, stable variety is available.