Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

Final Report – 2018 – 2023

Activity title:
Optimizing Delia pest monitoring and management in vegetable brassicas

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Activity Objectives:
The overarching goal of our project is essentially to improve management practices for *Delia* pests of vegetable brassicas in Canada. To reach that goal, we have developed the following five objectives (listed as activities below):

1. Document and compare the relative contribution of different *Delia* species and genetic lines to crop damage in 6 Canadian provinces (BC, ON, QC, NS, PEI, NB)
2. Develop threshold-based models for conventional management of *Delia* pests
3. Document the development, host preferences and reproductive compatibility of two genetic lines (N-line and H-line) of seedcorn maggot (*Delia platura*)
4. Investigate selected soil parameters as oviposition stimulants in two genetic lines of *D. platura*
5. Validate and optimize the sterile insect release method for cabbage maggot (*Delia radicum*).

Research Progress & Results:
Activity 1. We sampled a total of 140 *Brassica* fields across British Columbia, Nova Scotia, Prince Edward Island, Ontario, Québec and New Brunswick in 2019 and 2020. Identification of 9672 *Delia* larvae sampled across the six Canadian provinces suggests that the cabbage maggot (*Delia radicum*) is the most abundant root maggot in the sampled cruciferous crops although the members of the seed maggot complex (*Delia florilega*, *Delia platura* N-line, and *D. platura* H-line) can be found in relatively high numbers, especially in broccoli. Additionally, we were able to confirm the absence of the *D. platura* H-line in the sampled fields of British Columbia. In Québec, peak root maggot abundance in broccoli and radish fields occurred in the last two weeks of June in both 2019 and 2020.

Activity 2. Field surveys were conducted in 12 fields throughout the Fraser Valley; with 2 fields in 2019, 4 fields in 2020, 3 fields in 2021 and 3 fields in 2022. We visited fields at least 5 times prior to harvest and then did an assessment of root damage prior to the grower's harvest of the field in 11 of the 12 fields. Crops included broccoli, rutabaga, Brussels sprouts and cabbage. Fields varied in length and width but were representative of the diversity of field vegetable production practices observed across Canada. Our preliminary results demonstrate that the majority of Delia spp. activity is concentrated around field edges during the field season. This corresponds to higher damage ratings on roots around field edges. These results appear to be most dramatic within the first 50-m of the field perimeter in larger fields.

Activity 3. We compared the mating behavior of the H- and N-lines of *D. platura* and uncovered subtle differences in their behavior, with H-line females being more selective towards the male with which they mate. We also tested the reproductive compatibility of the two lines which revealed that they are asymmetrically reproductively compatible with N-line females readily mating with H-line males but H-line females refusing to mate with N-line males. The offspring that originated from crosses between N-line females and H-line males developed fully from the larval to adult stage. Additionally, we tested the ovipositional preferences of the two lines when subjected to different crops. The results obtained suggest that the two lines differ in their ovipositional behaviors but are attracted to a large variety of crops. When combined, the results from this activity suggest that the two *D. platura* lines are in fact two biological entities which may differ in the behavior and occurrence in different crops. We suggest that agricultural stakeholders pay attention to the line that is causing damage to certain crops as the control measures used for one line may not be as efficient for the other.

Activity 4. We tested the oviposition preference of the H- and N-lines of *D. platura* when subjected to different crop residues. Our experiments clearly indicate that crop debris incorporated in soil, independent of the nature of the debris, significantly stimulate oviposition as well as the simultaneous germination of weed seeds. These effects can be avoided by proper cultural practices: delay of crop seeding in fields with plant debris to allow them to decay for at least 12 to 14 days at 25°C, period during which the effect diminishes gradually. Simultaneous weed seed germination was found to significantly stimulate oviposition. Proper weed control over time to minimize the size of the soil seed bank and the use of false seedbed techniques to stimulate seed germination prior to crop seeding will most likely reduce the risk of high *D. platura* oviposition at time of crop seed germination.

Activity 5. We monitored 63 fields (SIR or control) in QC over a 4-year period mainly in daikon and cauliflower. We demonstrated that the technique was successful in reducing damages caused by *D. radicum* in daikon when compared to the untreated control plots. In cauliflower, when SIR was compared to treated control plots, we observed a higher number of infected plants in the SIR plots. *It is important to note, however, that most of the infected plants were colonized by members of the seed maggot complex rather than the cabbage maggot*. Our results thus suggest that the SIR is efficient at reducing damages caused by the cabbage maggot. Additionally, we have uncovered the conditions that stimulate diapause in the cabbage maggot which allows us to produce and store individuals to be released at our convenience. Although we have not yet reached the optimal conditions for diapause induction, the conditions we have determined to date significantly improve the logistics behind mass production of sterile individuals. We also have further developed an artificial diet for a more efficient production of cabbage maggot individuals. Again, even if the artificial diet is not yet optimal, mass production has been significantly improved. To summarize, we have increased our efficiency in the mass production of sterile cabbage maggot individuals and shown that SIR was successful in reducing damages caused by this species in both daikon and cauliflower.

Key Message(s):

Our project documented the relative proportions of root maggot species causing damage to vegetable brassicas across Canada. Our results showed that the species composition of maggots found feeding on brassicas varied according to crop and locality. The cabbage maggot was the most abundant species but members of the seedcorn maggot complex should not be overlooked, especially in broccoli where they often represented more than 30% of samples larvae. We documented various aspects of the seedcorn maggot's biology thus improving our understanding of this pest and provided recommendations for managing damages caused by root maggots. Finally, we improved the production parameters for producing sterile cabbage maggots and have shown that the sterile insect technique is a promising control method for this important pest species.

Overall benefit to industry:

Activity 1. We uncovered that multiple root maggot species are involved in colonizing *Brassica* plants and while the cabbage maggot is the most abundant across Canada, the members of the seed maggot complex are not to be overlooked, especially in broccoli.

Activity 2. While our results have not been fully analyzed preliminary examination of the data indicates that industry will benefit in two ways. First, growers and crop consultants can streamline pest scouting in large brassica plantings to the field interior, since our data show that field edges always have *Delia spp.* activity. Second, pest scouting in the field interior can help determine if interior sprays are needed for cabbage maggot or if sprays can be concentrated around field edges. This can help reduce the amount of product applied to fields and help growers save money.

Activity 3. This activity revealed that the H- and N- lines of the seedcorn maggot are in fact two biological entities which may cause a difference in the efficiency of different control methods, depending on the line(s) found in a specific field.

Activity 4. We confirmed that the two lines of the seedcorn maggot are attracted to crop residues and that growers should wait between 7 and 14 days between residue incorporation and seeding.

Activity 5. We improved the efficiency of mass production of sterile cabbage maggots by improving the composition of the artificial diet and diapausing conditions. In addition, we demonstrated the efficiency of the sterile insect technique for the cabbage maggot, with the results being especially promising in daikon.

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