Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

Final Report – 2018 – 2023

Activity title: Evaluating biological control strategies for the tomato leafmining moth (*Tuta absoluta*), a potential invasive greenhouse pest in Canada

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Activity Objectives:
1. Field survey for native natural enemies of the tomato leaf miner, *Tuta absoluta* (predators and parasitoids).
2. Establish rearing methods for predators and parasitoids.
3. Define the life history, predatory capacity and biological control potential of new agents on greenhouse crops.
4. Identify and apply novel molecular tools for identification and monitoring of the tomato leaf miner.

Research Progress & Results:
Importation of non-native biocontrol agents is increasingly restricted owing primarily to concerns about non-target effects by introduced species. Generalist hemipteran predators have great potential and proven efficacy as commercial biocontrols, as they consume a diversity of arthropod pests and many persist on a broad array of host plants. Their ability to establish on tomato and other solanaceous plants makes them particularly suited for pest control on high value greenhouse crops, and their long stylet allows them to prey on leaf mining pests such as the globally invasive tomato pest *Phthorimaea* (*Tuta*) *absoluta*.

Objective 1. We conducted surveys across Ontario, Canada (20 sites covering an 800 km area between 2018 and 2020) to identify predatory hemipteran species that could be easily maintained in lab cultures, adapt well to greenhouse crops, and demonstrate good biocontrol potential for a diversity of arthropod pests. Over 3000 specimens were collected representing at least 50 hemipteran species, 15 of which are expected to have some biocontrol potential.

Objective 2. Among the predators collected, we successfully established colonies and rearing methods for three nabid species (*Nabis americoferus*, *N. roseipennis*, and *Hoplistocelis palescens*) in 2019 and three mirid predators (*Dicyphus discrepans*, *Dicyphus famelicus*, and *Macrolophus tenuicornis*) in 2021.

Objective 3. Colonies of *N. americoferus*, *D. discrepans*, and *D. famelicus* (Figure 1) were robust enough to complete a thorough characterization of their life history (development time, longevity, and fecundity on tomato as a host plant) as well as their predatory capacity against lepidopterans and other greenhouse pests (whitefly, aphids, or two spotted spider mites) in laboratory and greenhouse assays. We confirmed that *N. americoferus*, *D. discrepans*, and *D. famelicus* can successfully complete their development on tomato as a host plant, requiring approximately 29, 42 and 45 days, respectively when reared at 24°C and 16 h daylength. Under these conditions, females of these three species produced an average of 43 nymphs, 69 eggs, and 101 eggs, respectively.

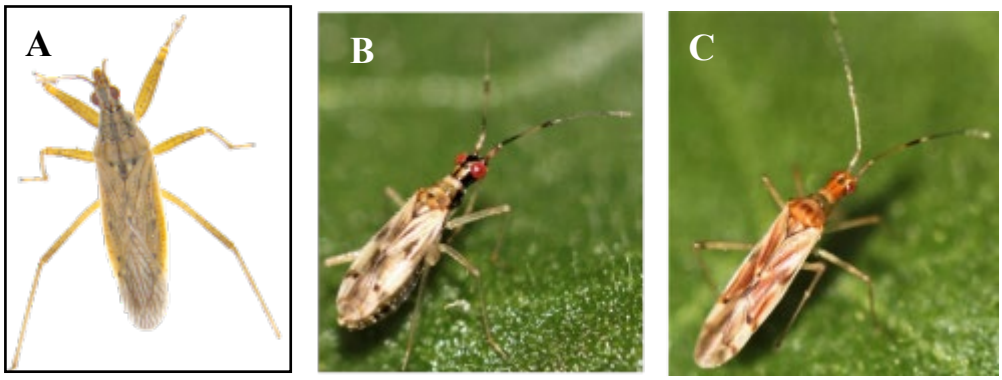

Figure 1. Native Canadian hemipteran predators characterised in this study: *Nabis americoferus* (A); *Dicyphus discrepans* (B); *Dicyphus famelicus* (C).

To assess predatory capacity against lepidopteran pests, we used the flour moth *Ephestia kuehniella* as well as the cabbage looper moth, *Trichoplusia ni* as models and proxys for *T. absoluta*. *Nabis americoferus, D. famelicus,* and *D. discrepans* consumed an average of 56, 54, and 43 flour moth eggs per day, respectively. Given that the average flour moth egg (1.27 mg) weighs nearly double that of a *P. absoluta* egg (0.67 mg), *N. americoferus* could potentially consume the equivalent of over 100 *P. absoluta* eggs per day, while the mirids could consume 80. Adults of *N. americoferus* also ate an average of 38 and 56 T. ni eggs and 1st instar larvae per day, respectively. In contrast, mirids ate far fewer *T. ni* larvae over the same time period: 2.1 for *D. discrepans* and 4.6 for *D. famelicus*. This difference can be attributed to the fact that *N. americoferus* is an ambush predator that effectively captures and feeds on rapidly moving prey.

Concerning predation of other greenhouse pests, *D. disrcrepans* and *D. famelicus* could successfully control whitefly on greenhouse tomato, but only ate 9 and 13 immature whiteflies per day, respectively. This was slightly less than what we measured for *D. hesperus*–a close relative and a commercially available biocontrol agent in Canada–which can consume 15 whitefly per day. Overall, the three *Dicyphus* species appeared to prefer green peach aphid (*Myzus persicae*) and consumed comparable numbers of these pests (between 22 and 27 per day). Work is ongoing to evaluate the capacity for these predators to consume additional pests.

Objective 4. Due to a recent publication of a real-time PCR assay for the identification of *T. absoluta*, we had refocused this objective to DNA barcode and database native predatory hemipterans collected in our surveys. All representative morphospecies of the predatory hemipterans collected in our field surveys have been identified by a specialized taxonomist. We have also optimized hemipteran barcoding primer sets for these species, and have largely completed sequencing of the specimens to generate a more robust public database of these hemipterans in Canada. We expect to complete the final quality control and databasing of all sequences within the coming months.

Key Message(s):

This research has served to identify, establish colonies of, and examine the predatory capacities for new and native candidate biological control agents in Canada. As over 90% of biological control agents currently used in Canadian greenhouses are not native, this research is a very positive step forward to changing the landscape for applied and sustainable pest management here. Also, given that a major focus of this research was to elucidate the potential for novel generalist biocontrol agents, it is quite likely that such agents could serve as the basis for comprehensive biocontrol programs that concurrently target a wide variety of pest species.

Of the over 50 unique hemipterans collected in surveys through this project, we have had success in colony establishment for some key species including ambush predators *Nabis americoferus*, *Nabis roseipennis*, and *Hoplistocelis pallescens* mirid predators *Dicyphus famelicus, Dicyphus discrepans,* and *Macrolophus tenuicornis*. Our DNA barcoding work will also help to improve the molecular identification tools available when developing additional native predatory hemipterans as biocontrols in future.

We have further characterized the life histories and predatory capacities of *N. americoferus, D. famelicus,* and *D. discrepans* through both controlled environment and greenhouse trials. Our results confirm the considerable potential for these predators to contribute to the biocontrol of lepidopteran, aphid, whitefly, thrips, and even spider mite pests.

Overall benefit to industry:

This research lays the groundwork for completely new biocontrol programs to protect greenhouse crops in Canada. Such programs will be based on early crop establishment of native generalist biocontrol agents on suitable host plants, which can immediately act to reduce pressure imposed by invading crop pests. Once established on a crop, agents such as *D. famelicus, D. discrepans,* and *N. americoferus* can suppress a diversity of crop pests in a continuous way throughout a given crop cycle, without the need for additional, costly introductions of these predator species.

This research has also led to a new opportunity for our research group to continue to improve on these biocontrol species through application of selective breeding processes, which we hope to pursue in near future in collaboration with the Fruit and Vegetable Growers of Canada and Biobest Canada (FVGC -ASC-17 Hort Cluster 4: Activity 13A). Through this private-public partnership, we hope to facilitate the commercial availability of such biocontrol organisms in Canada in very near future.

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