

Canadian Agri-Science Cluster for Horticulture 3



Update to Industry

2018-2019

<p>Activity title: Evaluating biological control strategies for the tomato leafmining moth (<i>Tuta absoluta</i>), a potential invasive greenhouse pest in Canada</p>
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<p>Names of Collaborators and Institutions: Cara McCreary, Greenhouse integrated pest management specialist, Ontario Ministry of Agriculture Food and Rural Affairs Dr. Sherah VanLaerhoven, University of Windsor, co-director of MSc student working on this project. Nature Conservancy of Canada Thames Talbot Land Trust Parks Canada</p>
<p>Activity Objectives (as per approved workplan):</p> <ol style="list-style-type: none"> 1. Field survey for native natural enemies of the tomato leaf miner, <i>Tuta absoluta</i> (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.
<p>Research Progress to Date:</p> <p>Summary: The tomato leaf miner <i>Tuta absoluta</i>, continues to represent one of the most important arthropod pests of tomato crops around the world. Recently, the pest has spread in its geographic range, including to Haiti as detected in June 2018, meaning it is closer than ever to continental North America (Verheggen and Bertin, 2019). In preparation for a possible introduction into this area, we have begun our investigation of potential natural enemies of this pest that may naturally occur in Canada. In this first project year, we have conducted surveys which have led us to the identification of multiple predatory species, including <i>Phytocoris tibialis</i>, <i>Ilnacora</i> sp. <i>Nabis americanoferus</i> and <i>Nabis roseipennis</i>, which are likely to represent important predators of the tomato leaf miner in North America. Particularly valuable was our success in the establishment of tomato adapted colonies for both <i>Nabis americanoferus</i> and <i>N. roseipennis</i>, belonging to a known genus of</p>

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tomato leaf miner predators. Interestingly, that both predators were isolated from and are now reared on tomato, means that these species are likely to be amenable to the biological control of pests of tomato crops. This is also considered a success since tomato tends to be a difficult crop for natural enemies to establish on. Tomato plants are laden with trichomes, which are difficult for many predators to navigate. In contrast, the predatory hemiptera, including Nabids and Mirids are physically better adapted to tomato, having long legs that allow them to move readily over tomato trichomes. As such, work is now underway to characterize the life histories and functional responses of these two predators, which may serve as the foundation for the development of these species as biological control agents for the tomato leaf miner as well as other crop pests in North America.

Specific progress:

01 - Field survey for native natural enemies of *Tuta absoluta* (predators and parasitoids)

A survey for predatory bugs was initiated in August, 2018, which covered an approximately 200 Km radius across Southern Ontario. Surveyed lands were selected which were closely associated with agricultural and naturalized areas. For these purposes, we obtained research permits allowing us to survey Nature Conservancy Canada (NCC) and Thames Talbot Land Trust (TTLT) properties. Surveys in this reporting period consisted of sampling up to 100 plants per site. Plants were selected which represented known hosts for predatory mirids, including hairy plants such as common mullein, *Verbascum thapsus*, stem hedge nettle, *Stachys albens* and hairy nightshade, *Solanum sarachoides*.

We surveyed areas of the Upper, Central and Lower Big Creek blocks, as well as the Backus block of Nature Conservancy of Canada lands. During these surveys, we found the presence of mirid host plant, *Verbascum thapsus*, as well as plants in the Aster family, which were particularly abundant at Upper Big Creek. There, we found a number of true bugs, including the wee harlequin bug, *Cosmopepla bimaculata*, feeding on mullein, as well as a seed bug, *Nysius niger* within the Osrilinae sub-family. However, these species did not consist of predatory bugs and were not collected for rearing purposes.

We also surveyed the Florian Diamante Nature Reserve, Middle Point Woods, as well as the Richard & Beryl Ivey NCC properties on Pelee Island in August, 2018. In these locations, predominant bug species found consisted of members of the Lygaeidae, as well as of the Coreidae families. While this later family of insects is considered predatory, we did not collect live specimens as these are likely to have a very long life cycle, which may not lend them well to efficient biological control. Of particular interest were insects of the *Ilinae* genus, which we have collected on a mixed patch of mullein and ragweed. This predator is a promising biocontrol agent which we hope to evaluate for its suppression of agricultural pests.

During surveys of the Meadowlilly Road site (TTLT) in London in August 2018, we collected *Phytocoris tibialis* predators, which belongs to the mirinae (Mirini) family. This species, collected from giant ragweed, *Ambrosia trifida*, is certainly a predatory species, and one we hope to collect again from this site in the coming year for further study.

In 2018, we also established tomato plots at the Harrow Research and Development Centre, which have served to attract populations of two Nabid predatory species; *Nabis americanoferus* and *N. roseipennis*. These predators are very relevant and interesting in the context of this study as members of this genus are known to be good predators of a number of crop pests, including the tomato leaf miner. For instance, studies in Europe have shown that *Nabis pseudoferus*, which is a strict zoophagous insect, is able to effectively reduce populations of the tomato leaf minter, *Tuta absoluta* (Cabello et al., 2009). These two species are therefore studied further through life history and functional response assays performed here.

Over the next three project years, further surveys will also be conducted at these as well as new Parks Canada sites in order to gather more detail on the diversity of mirid predator species that may occur at different times of the year.



Working with taxonomist Dr. Schwartz at the Canadian National Collection, we have identified a recurrent occurrence of native *Macrolophus tenuicornis* at Point Pelee National Park and plan to try to collect this species in the coming year. This species represents one of the closest relatives of the mirids, as members of the Bryocorinae, which are known to be highly effective as predators of *Tuta absoluta* in Europe. During our 2018 survey, we also collected samples of microlepidopteran larvae, from which we will continue to study for possible presence of parasitoids associated with these, which may also attack *T. absoluta*.

02 - Establish rearing methods for predators and parasitoids

Colonies of two predator species, *Nabis americanoferus* and *N. roseipennis*, were successfully established during this first project year. Interestingly, these two North American predators were found to be naturally adapted to tomato, which is a considerable benefit towards achieving good establishment of these species as biological control agents on tomato crops. In order to optimize rearing, multiple different setups have been trialed, balancing space and time efficiency while minimizing the effects of interspecific predation.

03 - Define the life history, predatory capacity and biological control potential of new agents on greenhouse crops.

Laboratory studies are ongoing which aim to determine the life history, predatory breadth and functional response of both *Nabis americanoferus* and *N. roseipennis* to common crop pests. Assays are now complete for determining the length of nymphal development for both species. Work is also well underway for identifying the number and diversity of pest prey these predators will consume over time, including of aphids, whiteflies as well as lepidopteran looper pests. Over the course of the next two years, we will plan to assess the feeding capacity of these predators on moth leaf miners. Together, these studies will establish important metrics which would be required for the commercial development of these natural enemy species.

04 - Identify and apply novel molecular tools for identification and monitoring *Tuta absoluta*.

As planned, work associated with this research objective will begin in future project years.

References:

Cabello, T., Gallego Granados, J. R., Fernandez-Maldonado, F., Soler, A., Beltran, D., Parra, A and Vila, E. 2009. The damsel bug *Nabis pseudoferus* (Hem.: Nabidae) as a new biological control agent of the South American Tomato Pinworm, *Tuta absoluta* (Lep.: Gelechiidae), in tomato crops of Spain. Bulletin IOBC/WPRS. 49. 219-223.

Verheggen, F., Fontus, R. B., 2019. First record of *Tuta absoluta* in Haiti. Entomologia Generalis, 38(4), 349-353.

https://www.schweizerbart.de/papers/entomologia/detail/38/90620/First_record_of_Tuta_absoluta_in_Haiti?af=crossref

Extension Activities (presentations to growers, articles, poster presentations, etc.):

Over the course of this first project year, we have produced two associated reports:

Labbe, R. and Mlynarek, J. 2019. Evaluating biological control strategies for the tomato leafmining moth (*Tuta absoluta*), a potential invasive greenhouse pest. Report to the Nature Conservancy of Canada. Jan 30, 2019

Mlynarek, J. and Labbé, R. 2019. Survey of potential natural enemies of the tomato leafmining moth (*Tuta absoluta*) at Thames Talbot Land Trust sites. Report submitted to the Thames Talbot Land Trust on March 27, 2019.

Early Outcomes (if any) or Challenges:

The variable nature of surveys means that it is impossible to certainly know where and when arthropod predators will be located. We rely on previously published literature as to understanding the seasonal and host plant dynamics of predatory species, but sometimes these are not where we would expect them to be. In addition, there is a certain degree of difficulty in establishing colonies of predators, with either too few individuals or limited knowledge available to satisfy their diverse environmental necessities. This has certainly been a challenge for rearing the many predatory mirid species we have collected in the context of this project. With this however, we have also experienced some considerable success.

In addition to the identification of a number of predatory species that may be effective in the control of the tomato leaf miner, we have now successfully established colonies for two hemipteran predator species, *Nabis americanoferus* and *Nabis roseipennis*. These insects, both discovered in tomato field crops, are now being reared on this host plant so that they may be well adapted to biological control of pests on this crop. We have also now completed studies of the developmental time of individuals of these species and will begin this summer, to work with a highly qualified person, Master's student, Andrew Laflair, whom will continue survey work, lab trials and greenhouse studies to characterize the predatory capacity as well as host plant distribution of these two Nabid species.

Key Message(s):

The tomato leaf miner represents a major threat to Canadian agricultural productivity. With the considerable limitation that conventional agents represent to the management of this pest, this work is important in identifying alternative agents that are both compatible with existing biocontrol strategies as well as work well to minimize financial losses attributed to invasive crop pests including the tomato leaf miner.

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