Greenhouse Vegetable Research Activities

The greenhouse vegetable sector has two research activities with the Canadian AgriScience Cluster for Horticulture Cluster 4. These two activities are focused on protecting vegetables against pests and managing disease in tomatoes.

THE CLUSTER 4 GREENHOUSE VEGETABLE RESEARCH ACTIVITIES ARE:

ACTIVITY 9

Developing a systems approach to pest management on greenhouse vegetable crops: mirid predator selection

LEAD RESEARCHER – Roselyne Labbé, research scientist in greenhouse entomology with Agriculture and Agri-Food Canada at the Harrow Research and Development Centre

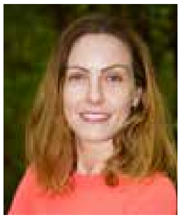
ACTIVITY 10

Novel approaches for the management of tomato brown rugose fruit virus (ToBRFV)

LEAD RESEARCHER – Aiming Wang, research scientist with Agriculture and Agri-Food Canada at the London Research and Development Centre

This project is generously funded through the Canadian AgriScience Cluster for Horticulture 4, in cooperation with Agriculture and Agri-Food Canada's AgriScience Program, a Sustainable Canadian Agricultural Partnership initiative, the Fruit and Vegetable Growers of Canada (FVGC), and industry contributors.

Developing a Systems Approach to Pest Management on Greenhouse Vegetable Crops: Mirid Predator Selection



LEAD RESEARCHER

Roselyne Labbé
Research scientist in greenhouse entomology with Agriculture and Agri-Food Canada at the Harrow Research and Development Centre

To find new integrated pest-management strategies to protect greenhouse vegetable crops, a research team is studying two native North American mirid species: *Dicyphus discrepans* and *Dicyphus famelicus,* and one adventive species, *Nesidiocoris tenuis.*

Over the past winter, the research team started mirid olfactometry assays (smell trials) using a Y-tube olfactometer to test predator responses to western flower thrips and greenhouse whitefly. This test was meant to better understand how mirid species use scent cues to find prey in greenhouse environments. Intraguild predation data from petri dish arena trials and full-plant greenhouse trials was analyzed. Greenhouse movement data was inspected comparing dispersal patterns to pest hotspots. Natural adult emergence trials were started to help explain inter-species predation outcomes. A tomato–sesame drench experiment focusing on egg laying preference was conducted, as well as laboratory tests examining the trade-off between fertility and longevity.

Through greenhouse intraguild predation trials, researchers discovered that N. tenuis is suppressed in tomato–mullein systems when combined with D. famelicus. Movement trials showed N. tenuis had the highest dispersal, followed by *D. famelicus,* while *D. hesperus* rarely moved away from banker plants. Olfactometry assays found *D. hesperus* and *N. tenuis* prefer whitefly-infested plants over clean plants but don't have a preference for thrips-infested plants or when both pests are present. Egg laying studies revealed all species prefer to lay eggs on sesame, except *D. hesperus,* which uses sesame and mullein equally. Drenching sesame alone was found to reduce *N. tenuis* populations than compared to untreated controls.

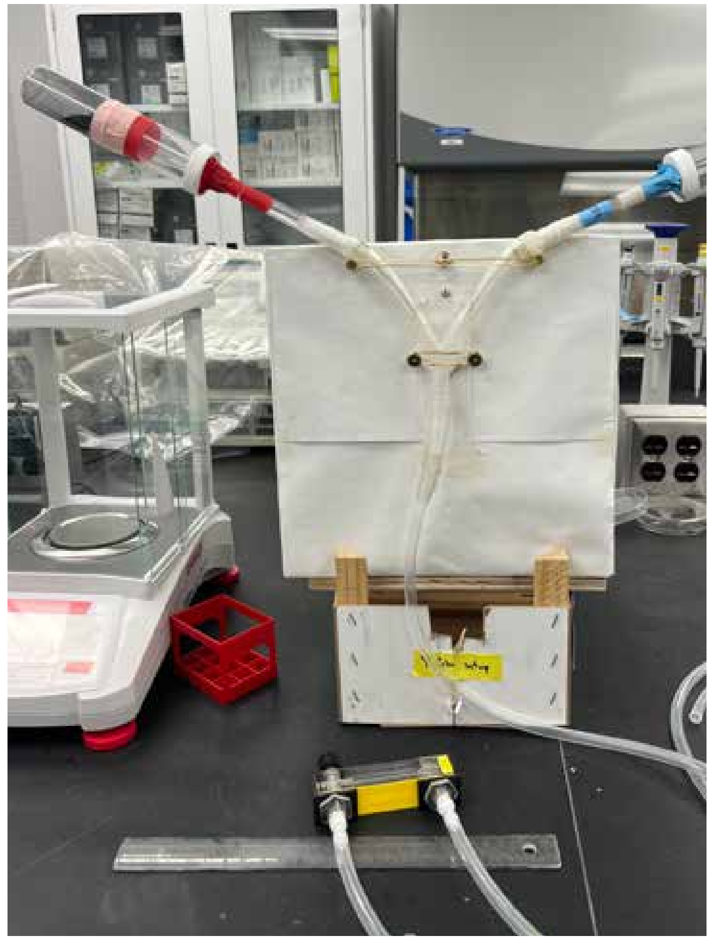
A greenhouse trial of mirid host preferences. Photo: Isabella Nardone

These findings directly impact greenhouse pest management. By understanding inter-species predation dynamics, growers can avoid combinations of biological control agents that may interfere with each other. Movement data is showing growers where to monitor for pests and beneficial insects. The smell test results highlight that mirids are more effective against whitefly than thrips. The strong egg laying preference for sesame and the effects of sesame drenching suggests this plant could be used as a trap crop or oviposition sink to help manage N. tenuis populations.

Throughout the rest of the growing season, the research team will complete the smell test trials with *D. famelicus*, finalize natural mortality trials and analyze all collected data. Microbial control trials targeting *N. tenuis* will happen with light-based experiments started in controlled cabinets as a precursor to larger-scale greenhouse studies. During winter, the researchers plan to finish the remaining smell experiments. They will also work on microbial and lighting studies. Before the research activity is done, the research team wants to develop a theoretical biological-control model comparing organisms with a fast life-history strategy to those with a slow life history.

KEY TAKEAWAYS:

- Through greenhouse intraguild predation trials it has been discovered that *N. tenuis* is suppressed in tomato–mullein systems when combined with *D. famelicus.*
- Movement trials showed *N. tenuis* had the highest dispersal, followed by *D. famelicus*, while *D. hesperus* rarely moved away from banker plants.
- Olfactometry assays (smell trials) found *D. hesperus* and *N. tenuis* prefer whitefly-infested plants over clean plants but don't have a preference for thrips-infested plants or when both pests are present.
- Egg laying studies revealed all species prefer to lay eggs on sesame, except *D. hesperus,* which uses sesame and mullein equally.
- Drenching sesame alone was found to reduce *N. tenuis* populations than compared to untreated controls.



A mirid prey attraction assay. Photo: Isabella Nardone

Novel Approaches for the Management of Tomato Brown Rugose Fruit Virus (ToBRFV)

LEAD RESEARCHER

Aiming Wang
Research scientist with Agriculture and Agri-Food Canada at the London Research and Development Centre

Researchers are working to stop Tomato Brown Rugose Fruit Virus (ToBRFV) from threatening Canadian greenhouse tomatoes and peppers. This research activity has been studying the infection process and working to develop novel genetic resistance to ToBRFV. Promising results have discovered ToBRFV resistance genes and new biocontrol measures to manage ToBRFV.

Researchers have been able to develop novel genetic resistance for ToBRFV in an elite tomato cultivar. This breakthrough was made through generation and screening of a tomato mutant population. The research team is now working to identify the gene responsible for this novel resistance. This will allow for growers to control ToBRFV through genetic resistance. Genetic resistance is environmentally friendly, target-specific and provides reliable protection without additional labour or material costs during the growing season.

The research team has been working to better understand how ToBRFV overcomes Tm-22 broad-spectrum resistance. It was discovered that while ToBRFV can dodge Tm-22 extreme resistance, tomato plants with Tm-22 gene still show partial resistance to ToBRFV. This weakened resistance can be boosted by increasing Tm-22 expression levels. The Tm-22 gene-encoded protein interacts with the ToBRFV-coded movement protein (MP) to trigger resistance pathways. This shows the possibility to restore Tm-22-mediated immunity through gene expression increases.

Weakened ToBRFV strains that can be used for cross-protection against ToBRFV have been developed by the research team. These strains could potentially allow growers to manage ToBRFV using a biocontrol approach.

A tomato plan infected with Tomato Brown Rugose Fruit Virus (ToBRFV). Photo: Aiming Wang

It was also discovered that several seed-borne viruses, particularly ToBRFV and pepino mosaic virus (PepMV), and to a lesser extent southern tomato virus (STV), are prevalent in greenhouse tomatoes in Canada. A mixed infection of ToBRFV and PepMV induces more severe symptoms, often causing crop termination. New research is needed though to develop a protocol to detect tomato seed-borne viruses and understand why the mixed infection of PepMV and ToBRFV causes more severe symptoms.

Over the next year, the research team is planning to focus on generation population mapping and phenotyping. They will complete screening for ToBRFV resistance from the tomato (Roma) mutant population. Functional characterization of host proteins interacting with ToBRFV infection proteins will be started. The researchers plan to characterize long non-coding RNAs associated with ToBRFV pathogenesis and symptom development. They will continue monitoring ToBRFV diversity in Canada by sequencing and analysis of samples collected in major production regions across Canada. The research team plans to start a study to understand why ToBRFV and PepMV mixed-infections cause more severe symptoms.

KEY TAKEAWAYS:

- Researchers have been able to develop novel genetic resistance for ToBRFV in an elite tomato cultivar and are now working to identify the gene responsible for this novel resistance.
- While ToBRFV can dodge Tm-22 extreme resistance, tomato plants with Tm-22 gene still show partial resistance to ToBRFV. This weakened resistance can be boosted by increasing Tm-22 cells.
- Weakened ToBRFV strains that can be used for cross-protection against ToBRFV have been developed by the research team.
- A mixed infection of ToBRFV and PepMV induces severe symptoms, often causing crop termination.

Tomatoes at the markets showing Tomato Brown Rugose Fruit Virus (ToBRFV) symptoms. Photo: Aiming Wang