AgriInnovation Program Stream B

2017-18 Annual Performance Report

Foxglove aphid biology and management in ornamental greenhouse production systems

Name of Recipient: Canadian Ornamental Horticulture Alliance	
Project Title: Canadian Ornamental Horticulture Research and Innovation Cluster	
Project Number: AIP-CL20	Period Covered by Report: 2017-04-01 to 2018-01-31
Activity #: COHA 15 Name of Activity: Foxglove aphid biology and management in ornamental greenhouse production systems	Principal Investigator: Dr. Rose Buitenhuis

1. Performance Measures. See Annex A for an explanation of each measure.

Innovation Items	Results Achieved	Provide a description (2-3 paragraphs) for each item produced and describe its importance to the target group or sector. Explain any variance between results achieved and targets. Use plain language.
# of new/improved products	Yes (4)	This project demonstrated efficacy against foxglove aphids in greenhouse crops of 3 new biocontrol agents: • Novel predatory mite This mite is a generalist predator, which targets a wide range of pests including foxglove aphids, western flower thrips, echinothrips, spider mite, whitefly and fungus gnats. Further research is focussing on mass rearing techniques. Vineland is currently looking for a commercial partner to commercialize this predator. • Met52 EC biopesticide The EC formulation replaced the granular biopesticide that was originally registered in Canada. The EC formulation is easier to work with and is very effective against foxglove aphids. We will work with the manufacturer of this product to see if the data from this project will help in pursuing registration for floriculture crops. • Pea protein biopesticide This product is still in the experimental phase. This project showed that it has good potential to control foxglove aphids. Data from this project will support further commercial development of this material for use in floriculture crops. Finally, this project improved the use of one existing biocontrol agent: • *Aphidius ervi*: Improved release guidelines include: releases only when foxglove aphids are detected, and providing the parasitoids with supplemental food. This parasitoid is compatible with the

Innovation Items	Results Achieved	Provide a description (2-3 paragraphs) for each item produced and describe its importance to the target group or sector. Explain any variance between results achieved and targets. Use plain language.
		novel predatory mite, and several (bio)pesticides used to control foxglove aphids. These data will significantly improve the success of IPM programs that include this parasitoid.
# of new/improved practices	Yes (1)	IPM strategy: Based on the results obtained from this project, we developed recommendations for a foxglove aphid IPM strategy. We tested those recommendations in commercial greenhouse trials in Québec and Ontario. Growers followed the recommendations with good results, improving their control of foxglove aphids. This strategy will reduce the number of sprays by at least 50%, resulting in economical and environmental benefits. In addition, this strategy is completely compatible with IPM programs for other important pests of greenhouse ornamental crops, like thrips.

Information Items	Results Achieved	**Provide the complete citation for each item. Please see Annex A for examples.**
# of peer reviewed publications	1	La-Spina, M., & Buitenhuis, R. (2017). Which is the best strategy against foxglove aphid? IOBC-WPRS Bulletin, 124, 55–61. Retrieved from https://www.iobc-wprs.org/members/shop_en.cfm?mod_Shop_detail_produkte=170
# of information items	3	- Fact-sheet in English and French for growers explaining the Foxglove aphid IPM strategy - Aphid section on www.greenhouseIPM.org website - Greenhouse Grower Magazine article planned for April Issue
# of information events	5	- Presentation- La Spina, M. IOBC-Integrated control in protected crops, Temperate Climate meeting, Niagara Falls, ON: 06/05/2017 Which is the best strategy against foxglove aphid? - Presentation- La Spina, M. Canadian Greenhouse Conference, Niagara Falls, ON: 10/05/2017. IPM Wars, Episode 1: The Foxglove Menace. - Poster- La Spina, M. 5th International Entomophagous Insects Conference, Kyoto, Japan: 10/19/2017. Side effects and sublethal effects of pesticides and biopesticides on *Aphidius ervi*. - Presentation- La Spina, M. Journée des producteurs en serre, Drummondville, QC: 11/28/2017. La lutte intégrée au puceron de la digitale.

		- Presentation- Buitenhuis, R. Biological control in commercial nurseries, greenhouses, interiorscapes and managed landscapes. University of Maryland Extension. Westminster, MD : 02/01/2018. Success and newest developments in biological control of whitefly and aphids.
		Provide the # of attendees
# of individuals attending information events		- Presentation- IOBC-Integrated control in protected crops, Temperate Climate meeting, Niagara Falls, ON: 06/05/2017 200 attending. - Presentation-Canadian Greenhouse Conference, Niagara Falls, ON: 10/05/2017. 100 attending. - Poster-5th International Entomophagous Insects Conference, Kyoto, Japan: 10/19/2017. 200 attending. - Presentation- Journée des producteurs en serre, Drummondville, QC: 11/28/2017. 150 attending. - Presentation-Biological control in commercial nurseries, greenhouses, interiorscapes and managed landscapes. University of Maryland Extension. Westminster, MD : 02/01/2018. 165 attending.

2. Executive Summary

Key Highlights -

Foxglove aphids are an increasingly problematic pest in various ornamental greenhouse crops. However, commercially available biological control agents seem ineffective against the aphid, leaving growers with no recourse other than to use pesticides. The goal of the project is to provide effective pest management strategies for problem aphid species in greenhouse ornamentals that are compatible with existing biological control systems.

The focus of the project during the third and final year (2017-2018), was to integrate of the different tools developed during years one and two into a complete IPM strategy for foxglove aphids, and to test the recommendations in commercial floriculture greenhouses.

We studied the compatibility of the parasitoid *Aphidius ervi* with three pesticides (Beleaf, Enstar and Endeavour) and two biopesticides (BotaniGard and the Pea protein extract). Emergence rate of sprayed mummies was 90% except for Enstar (30%). Endeavour and Pea protein spray residues did not reduce adult parasitoid survival (16-20 days); BotaniGard and Beleaf slightly reduced survival (10-13 days); adults exposed to Enstar residues died within a few hours of exposure. There were no differences between (bio)pesticides in most of the common aphid and parasitoid behaviours and parasitism with the exception of Enstar, where parasitoids died before they could be tested. This means that if foxglove aphid populations increase beyond the capacity of biological control agents, they can be selectively controlled by the tested (bio)pesticides, except Enstar, which is not compatible with foxglove aphid biocontrol agents.

We further studied the compatibility of *A. ervi* and the novel predatory mite on open greenhouse benches with pepper plants. The novel predatory mite did not interfere with parasitoid efficacy. This confirms previous results from an experiment in small cages. Treatments with *A. ervi* alone and in combination with the novel predatory mite were able to control foxglove aphid. This means that the predatory mite would be a good addition to a foxglove aphid IPM strategy.

Based on these results and the knowledge obtained from the first two years of the project, we developed recommendations for a foxglove aphid IPM strategy. We tested these recommendations under commercial greenhouse conditions, collaborating with growers from Québec (through IQDHO) and Ontario. We also tested the IPM strategy in a full-scale greenhouse experiment at the Vineland Research and Innovation Centre with gerbera. In the greenhouses where the IPM strategy was implemented, numbers of aphids initially increased but were controlled after several *A. ervi* releases. No additional pesticide sprays were necessary, or were limited to a clean-up spray at the end of the crop cycle, resulting in at least a 50% reduction in pesticide use.

We engaged with industry in ON and QC (growers and biocontrol companies) to transfer new technologies and improve profitability and sustainability of floriculture systems through presentations at several industry events, grower visits, a fact sheet and a trade journal article. In addition, we added aphid pages to the website greenhouseIPM.org.

Success Story -

We improved the methods for release of the commercially available parasitoid, *Aphidius ervi*. Previously, growers and consultants did not obtain good efficacy from this parasitoid. We determined that the best time to release *A. ervi* against foxglove aphid was when aphids were found in the crop; previously, wasps were released preventatively. In small and large-scale trials, *A. ervi* controlled aphid populations when used alone or together with a novel predatory mite. No negative interactions (such as intraguild predation) were observed. We also showed high compatibility of *A. ervi* with biopesticides, which will enhance biocontrol of foxglove aphids.

Based on the knowledge generated in this project, we developed recommendations for an IPM strategy against foxglove aphids, which significantly reduces the number of chemical sprays. The IPM strategy will enable growers to respond to emerging aphid pest issues and reduced availability of pesticides (e.g. neonicotinoids). A biological control-based management strategy for foxglove aphids also allows growers to retain the benefits of existing biocontrol strategies against other greenhouse pests (such as thrips) and maintain production of high value, premium crops for domestic and export markets.

3. Objectives/Outcomes (technical language is acceptable for this section)

The goal of this project is to provide effective pest management strategies for problem aphid species in greenhouse ornamentals that are compatible with existing biological control systems.
Below is a summary of activities and results since the last report.

Objective 1. Develop a better understanding of the behaviour and life cycle of aphids and their interactions with natural enemies in greenhouse settings.

- Identify entry routes of foxglove aphids into the greenhouse and indicate where they pass the summer when temperatures are too high for infestations to persist: This year we scouted the surroundings of two greenhouses to verify the presence of foxglove aphids, but none were found. However, outside the greenhouses we found a wide diversity of natural enemies, which might have potential as new biocontrol agents.
- Determine interactions between foxglove aphids and two commercially available biocontrol agents: Completed in year 2.

Objective 2. Investigate a suite of new biocontrol agents (pathogens, predators and/or parasitoids) to identify effective candidate(s) for use in aphid management

- Completed in year 2

Objective 3. Determine the compatibility of candidate biocontrol organisms with existing controls, including natural enemies and insecticides, and devise methods towards their integration into a crop management program.

- Effect of three pesticides (Beleaf, Enstar and Endeavour) and two biopesticides (Botanigard and Pea protein extract) on *Aphidius ervi*: We tested the direct (survival) and indirect (sublethal) effects of these products on foxglove aphid mummies parasitized by *A. ervi* and on *A. ervi* adults. Adult wasps emerged from 90% of the sprayed mummies in all treatments except Enstar (30%). Endeavour and Pea protein spray residues did not reduce adult parasitoid survival (16-20 days); BotaniGard and Beleaf slightly reduced survival (10-13 days). Adults exposed to Enstar residues died within a few hours of exposure. There were no differences between (bio)pesticides in terms of their effects on most of the common aphid and parasitoid behaviours and parasitism with the exception of Enstar, where parasitoids died shortly after exposure. We do not recommend using Enstar in an IPM strategy because it clearly has adverse side-effects on one of the main parasitoids.
- Further studies on the compatibility of *A. ervi* and the novel predatory mite: The interaction between *A. ervi* and the novel predatory mite was tested on open greenhouse benches with pepper plants. The novel predatory mite did not interfere with parasitoid efficacy. This confirms previous results from an experiment in small cages. Treatments with *A. ervi* alone and in combination with the novel predatory mite were able to control foxglove aphid. Both, parasitoid and the novel predatory mite are compatible; once this new predator is commercially available, we would recommend using them in combination.

Objective 4. Assess the efficacy of these approaches on a small, medium and large scale.

- Efficacy of *A. ervi* in research greenhouse trials: We repeated the experiment testing the performance of *A. ervi* on open greenhouse benches at two foxglove aphid densities: low (2 aphids per plant) and high (20 aphids per plant). These treatments represented a preventative and curative scenario. At high aphid densities, parasitoids were able to maintain the aphid

population at the same level, while at low densities parasitoids did not control the aphids and pest populations increased over time, presumably because the parasitoids did not detect low numbers of aphids. The main conclusion of this work is that *A. ervi* does not work effectively when used in a preventative manner and it should be released only when aphids are found.

- Validation of IPM strategy in commercial greenhouses: We asked growers from Quebec (with the collaboration of IQDHO) and Ontario (Niagara region) to follow our recommendations in their commercial greenhouses. We visited all the growers to explain personally the strategy and to collect data from the previous season about foxglove aphid incidence. At the end, we chose two growers in QC and three in ON. Foxglove aphids were observed only in one greenhouse in QC and one in ON. In QC, our collaborators from IQDHO scouted the greenhouse every two weeks, and in ON we evaluated pest populations with the grower. In both greenhouses, growers released *A. ervi* several times and foxglove aphid populations were controlled successfully. Pesticide sprays were reduced by 50%.
- We also tested the IPM strategy in a Vineland greenhouse on a gerbera crop artificially infested with foxglove aphids. We released *A. ervi* over 4 weeks and monitored the aphid population and parasitoid dynamics on the crop weekly. Parasitoid releases successfully kept foxglove aphid under control.

Objective 5. Engage with industry in ON and QC (growers and biocontrol companies) to transfer new technologies and improve profitability and sustainability of floriculture systems.

- Five talks and a poster were presented at various industry and scientific conferences (see section 1).
- We wrote a fact sheet in French and English with the most important recommendations to control foxglove aphids and a trade journal article will be published in April. In addition, we added aphid pages to the website greenhouseIPM.org.

4. Issues

Like last year, foxglove aphids have not been a major pest this year in commercial greenhouses, making the scouting at commercial greenhouses challenging. Still, enough data was collected to determine potential entry points and preferred habitats in commercial greenhouses.

The lack of abundant foxglove aphid infestations also made it challenging to test the IPM strategy in commercial greenhouses. We chose growers with a history of foxglove aphid infestations and found foxglove aphids only in one greenhouse in QC and another in ON. To ensure all deliverables were accomplished by Jan 31st 2018, we designed an additional experiment in a research greenhouse at the Vineland Research and Innovation Centre and successfully tested the IPM strategy in a semi-commercial gerbera crop scenario.

5. Lessons Learned:

Based on the results from this project, we will be able to develop better recommendations for IPM of foxglove aphids in greenhouse ornamentals. Key findings are:

- The developed IPM strategy depends on early detection of foxglove aphids so thorough scouting of the crop is essential.

- It is important to ensure that the released parasitoids will remain in the crop and establish. Therefore, they should only be released when aphids are detected. Adding supplemental food (like honey) can improve adult parasitoid survival.
- Two biopesticides (Met52 EC and pea protein) and one new biocontrol agent (predatory mite) were able to suppress foxglove aphids to low levels. All of them are compatible with the use of *A. ervi* in foxglove aphid biocontrol and should be considered after the release of the parasitoids. These products are in various stages of registration for the Canadian market.
- To obtain unblemished plants at the time of sale, it is possible to spray the crop if necessary, but only with products that are compatible with *A. ervi*: pesticides (Endeavour, Beleaf); biopesticides (Botanigard, Met 52 EC and Pea protein).

6. Future Related Opportunities:

- The potential for adoption of the tools and the IPM strategy developed in this project is high. The results have been presented at several industry events and the strategy validated in multiple greenhouses collaborating with growers and consultants.
- The knowledge developed in this project could be used to develop IPM strategies for other aphid pests.
- Vineland is working on commercializing the novel predatory mite. One of the most important steps to achieve commercialization is to develop an efficient mass rearing system for this mite.
- Registration of Met52 EC and pea protein should be pursued so greenhouse floriculture growers can use these products. Data from this project may help in achieving this.
- There is a lack of indigenous natural enemies for the North American market such as mirid predators, which represent an important part of European IPM strategies against aphids and other pests. Future research should explore this group of natural enemies for potential new biocontrol agents in North America.

NOTE TO READER: This report has been edited from the original for formatting purposes only. There have been no changes made to the information provided by the researcher.