

PROJECT DETAILS

- **Title:** Enhanced modelling of swede midge population dynamics in North America
- **Funders:** Alberta Canola and SaskCanola
- **Research program:** Canola Agronomic Research Program
- **Principal investigator:** Rebecca Hallett
- **Collaborators/additional investigators:** Jenny Liu, Owen Olfert, Jonathan Newman, Boyd Mori
- **Year completed:** 2019

Final report

Completed activities

1. Recruit graduate student. Summer 2016.
 - a. Completed. Jenny Liu, MSc student commenced program in Sep 2016.
2. Conducted experiments determining temperature-dependent rates of development for eggs, larvae, adults.
3. Collect weather data for all sites and years for which we have pheromone trapping data.
 - a. Completed. Southern Ontario canola grower sites, 2013–2016 and Elora Research Station, 2003–2016.
 - b. Completed. Northern Ontario sites, 2012–2015.
 - c. Completed. Saskatchewan sites, 2007–2016.
4. Training of graduate student on Dymex v4 software package. Fall 2016.
Completed. Jenny Liu attended Dymex training (delivered by R. Weiss), AAFC
 - a. Saskatoon Research Centre. 24–28 October 2016.
 - b. Rebecca Hallett also visited the research centre 25–26 October for meetings with collaborators.
5. Graduate student coursework, thesis proposal, literature review. Fall 2016–Winter 2017.
 - a. Literature review completed December 2016.
 - b. Coursework completed April 2017.
6. Assessed accuracy of MidgEmerge model in predicting adult population peaks. Winter 2017.
 - a. Ran original MidgEmerge model for all parameterization sites and years.
 - b. Examined model performance with respect to prediction of spring emergence of overwintered generation first.
 - c. Model altered and identified necessary improvements.

7. Developed new population dynamics model with additional life history & mortality parameters.
 - a. Incorporated revised life history parameters related to diapause entry and termination (from published studies), temperature-dependent development and mortality rates (from lab and field studies), and mortality factors (from literature and/or data collected by others in Hallett lab). Fall 2018.
8. Establish field cage studies to validate lab-derived development and mortality rates. This activity, planned for 2017, was removed as lab-derived data is more useful for model than field cage studies in determining effects of environmental parameters on insect development.
9. Presented at each of the following conferences in Summer–Fall 2017: International Pest Risk Research Group Annual Meeting (Best Student Presentation); the Annual Meeting of the Entomological Society of Canada in Winnipeg, Manitoba (Best Poster Award); and the Ontario Pest Management Conference.
10. Validated new model using population data from validation sites and years.
 - a. Assessed performance of model in matching observed population dynamics in long-standing areas of infestation (e.g., Elora, southern Ontario).
 - b. Assessed performance of model in matching observed population dynamics in northern Ontario (Timiskaming, ON).
11. Elucidate life history differences in swede midge populations in different regions of invasion (i.e., populations in Eastern vs Western Canada).
 - o The midge that is widespread in Western Canada has been identified as a new *Contarinia* sp., rather than the swede midge, and therefore this activity is no longer relevant and has been removed.
12. Potential continuation of Ontario field cage studies to investigate life history parameters, if needed. Summer 2018. Activity discontinued as per #8.
13. Presented at each of the following conferences in Fall 2018: Annual Meeting of the Entomological Society of Ontario, Ontario Pest Management Conference, Joint Annual Meeting of the Entomological Societies of America and Canada (won President’s Prize for Best Oral Presentation).
14. Elucidate environmental conditions under which swede midge can reach economically damaging populations and become an economic pest in a new area of invasion.
 - o The updated MidgEmerge model was used to compare data from a region with very high populations (i.e., outbreak conditions, Timiskaming, ON) with that of lower populations (i.e., non-outbreak conditions, southern Ontario), for climatic similarities and differences that may help to identify factors contributing to high population growth and severe economic impacts.

- Other factors (e.g. crop rotation) contributing to outbreaks have been identified.

16. Thesis writing, manuscript writing, and thesis defense.

- Thesis writing and thesis defense was completed in April 2019.
- One manuscript has been published in the Journal of Economic Entomology, and 2 more are in preparation.

Challenges

Activity removed action due to insufficient data and/or time constraints:

Additional activities to enhance utility of model for integrated pest management purposes may be added, depending upon progress with previous activities and time remaining in program. Potential additional activities include:

- Run multi-year scenarios to examine impact of different proportions of canola in the landscape on swede midge populations. This information could be used to predict optimum rotation to maintain swede midge populations below manageable levels in northern Ontario.
- Incorporation of mortality by parasitoids into model to assess the required parasitoid population densities and parasitism rates of parasitoids.
- Possible investigation of the cumulative average growth index (obtained from Dymex model) from first record to economic damage in initial area of invasion and comparison with cumulative average growth indices in areas of subsequent economic damage (e.g., northern Ontario, Quebec, Vermont) and in new areas of invasion (Saskatchewan, Manitoba, Alberta).

Significant Accomplishments

- Made significant revisions to and completed the MidgEmerge II model
- Completed and submitted MSc thesis and successfully defended
- Published 1st research paper on swede midge temperature-dependent development in Ontario in Journal of Economic Entomology
- 2nd research paper on MidgEmergell model is completed and in final editing stages. It will be submitted to the Bulletin of Entomological Research
- Completed the introduction, methods, and results for 3rd research paper on swede midge outbreak in new areas of introduction; completed assessment of model performance for northern Ontario midge populations and elucidated environmental conditions under which swede midge will reach economically damaging populations