Final Plain Language Research Summary - AgriScience Grape & Wine Cluster 2018-2023

Activity: *Development of sustainable management practices for leafhoppers on grapes*

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Leafhoppers are economically important pests of grapes in Canada. Feeding by nymphs and adults causes the death of individual leaf cells that results in reduced photosynthetic activity, depletion of stored carbohydrate, and delayed fruit ripening. Damage varies between regions and locally due to several factors, including production practices (e.g. organic vs. conventional; hybrid versus vinifera), climate, and the abundance of natural enemies. Control is currently achieved largely with applications of broad-spectrum insecticides, but there is growing interest in alternatives that contribute to sustainable or organic production. This final industry report presents findings from the 2018-2023 CGCN-AAFC (CAP program) leafhopper project (#17) that investigated some of the more promising alternative management strategies for leafhopper control. These included 1) identification and biology of Anagrus parasitoids of leafhopper eggs including their alternate summer and winter hosts and involving several sub-objectives, 2) evaluation of the efficacy of new insecticides, 3) assessment of leafhopper antifeedants, and 4) effect of deficit irrigation on leafhopper populations.

As summarized below, significant progress was made on this project in spite of the many delays and difficulties. Some of the notable discoveries/progress include:

- Discovery of a new species of Anagrus egg parasitoid from willow.
- Development of genetic DNA libraries for the identification of Anagrus parasitoids and their leafhopper hosts.
- New tritrophic relationships determined for Anagrus species, their leafhopper hosts, and the leafhopper host plants.
- Characterized effectiveness of foliar oil sprays and the influence of sprayer technology on levels of leafhopper control.
- Determined the female:male sex ratio for A. daanei in BC.
- Identified new insecticides that are highly effective against leafhoppers.
- Identified fungicides and surfactants that effectively deter leafhopper feeding in the laboratory and in the field.
- Successfully modelled leafhopper and scale development in relation to temperature and grape phenology stages.
- Publication of technical bulletins, industry presentations, and updated insect and mite chapter of the BC grape production guide for grapes.

Numerous considerable difficulties were encountered during the conductance of this project, including most importantly the pandemic that resulted in restrictions that hampered research and contact with colleagues and growers. COVID spawned the need to adjust research activities, alter staffing of students, and to change budgets. The heat dome impacted field work in BC over one summer, and there were several staff changes and retirements as well. In spite of these many and serious obstacles, most of the objectives were fully or largely completed. Delays caused a need to conduct additional research over the final year of the project with some data analysis and preparation of reports and papers still to be completed. In all this research has made a significant contribution to our knowledge of Anagrus parasitoids of leafhoppers and their associations with specific leafhopper hosts and the winter and summer plant hosts of those leafhoppers. Molecular sequencing has led to the development of accurate and rapid testing for the identification of many species of Anagrus parasitoids and leafhoppers. A species of Anagrus new to science was identified in BC by the North American expert on the taxon, Dr. S. Triapitsyn. Research has quantified that a whole region of coastal BC is largely devoid of insect pests, including leafhoppers, other than occasional yellowjacket problems affecting ripening fruit. The reason for this absence requires explanation.

Insecticide lab bioassays identified several novel insecticides that are highly effective against leafhoppers, and replicated field spray trials with horticultural oils demonstrated that with good leaf coverage these materials can be very effective for the control of leafhoppers. Contributing also to organic or sustainable production of grapes, laboratory feeding choice test bioassays and field trials found that certain surfactants and the fungicide Sirocco were highly deterrent to leafhopper nymphs and could provide effective control in the field. Initiation of research to model stages of leafhopper population development based on temperature and grape phenology models will help producers to implement various controls as part of a comprehensive leafhopper management program. From previous and current research these measures include timing of early season removal of basal leaves, application of oils or insecticides timed against peak numbers of 1st or 2nd generation nymphs, and optimum timing of surfactants or fungicides that act also as effective leafhopper feeding deterrents.

This project contributed considerably to our knowledge of leafhoppers and their Anagrus parasitoids and the development fine-tuning of techniques and protocols that will contribute to future studies. Molecular diagnostics will help with research on these pests and their most important natural control agents, while the lab protocols developed to accurately evaluate the efficacy of insecticides or the deterrent effects of materials will assist in future studies involving these or other insect pests. Presentations and scientific manuscripts are forthcoming upon completion of diagnostic tests and statistical analyses.