Summerland Research & Development Centre
Wine Grape Research

Leafhopper Research at SuRDC: Select Results from the 2018-2023 CGCN/AAFC Growing Forward Project

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Project Background

Development of Sustainable Management Practices for Leafhoppers on Grapes (T. Lowery Project Lead) was funded by AAFC and the wine grape industry through the CGCN proposal *Fostering Sustainable Growth of the Canadian Grape and Wine Sector*, 2018-2023. Despite several major difficulties (COVID-19, 2021 heat dome, staffing changes), this article outlines some of the significant findings from research conducted at the Summerland Research and Development Centre (SuRDC).

Assessment of Insecticides for Leafhopper Management

Access to new products more suitable for integrated pest management and organic production would benefit the grape industry. Lab-based insecticide efficacy trials involving 7 insecticides and 5 fungicides applied to leaf disks of grapes at 1x, ½x, and ¼x field rates were used to assess toxicity to Virginia creeper leafhopper (VCL) nymphs. Efficacy of select materials was also assessed in replicated field spray trials conducted in collaboration with Dave Nield (Minor Use Coordinator, SuRDC).

Small Virginia creeper leafhopper (VCL) nymph used in lab insecticide efficacy and feeding choice test trials.

Results - **Bexar**™ (tolfenpyrad, Nichino Amer.) at all rates resulted in 100% mortality after 48 hrs, as also occurred with the organic standard **PyGanic**™ Crop Protection 1.4 EC (natural pyrethrum, Valent Canada Inc.). **Bexar** was found to be equally effective under field conditions with the field rate reducing leafhopper numbers ~99%. The remaining 1% were all newly emerged nymphs. Lab results with the insect growth regulator **Centaur**™ (buprofezin, Nichino Amer.) was not quite as efficacious, but further work to support its registration for the control of leafhoppers on grapes is warranted due to its reportedly minimal effect on beneficial insects, including *Anagrus* parasitoids of leafhopper eggs. Reflecting that it disrupts molting, mortality rates increased from 16% after 1 day to 90% after 4 days. At their request, the **Centaur** data has been provided to the manufacturer in support of possible registration. The remaining insecticides were not as effective (<65% mortality) or their registration is currently not possible

Results for the fungicide **Sirocco**™ (potassium bicarbonate, AEF Global Inc.) were surprising. The highest test rate, equivalent to twice the fungicide rate, resulted in nearly 98% nymph mortality, versus 8% for the control. Further research is required to determine the mode of action and if the activity is related to the formulants or the potassium bicarbonate. Although not a controlled experiment, two unintended sprays of **Sirocco** to the vineyard research blocks at SuRDC in the summer of 2022 reduced numbers of 2nd generation VCL nymphs to such an extent that a planned spray trial that included that same material had to be cancelled. None of the Marrone Bio-Innovations fungicides (**Grandevo, MBI-206, MBI-306**), some with reported insecticidal activity, or **KMS** (BASF), resulted in significant mortality rates.

- The bioassay method involving treated grape leaf disks placed within small Petri dishes held in crispers produced results for insecticide toxicities roughly equivalent to those from the replicated field spray trials. This laboratory method allows for rapid and reliable assessment of new test materials year-round.
- **Bexar** and **Centaur** should be pursued for registration, while further work, including replicated field spray trials, is required to verify the toxicity of **Sirocco**.
- Lab and field results did not indicate that VCL has developed resistance to **Pyganic**. Baseline toxicities are needed for the western grape leafhopper (WGL), which has developed resistance to many insecticides.

Assessment of Horticultural Oils

Three replicated field spray trials were conducted with horticultural oils applied in a similar manner but with different sprayer types. Treatments applied in 2021 at SuRDC using a spray gun consisted of 1% and 2% **PureSpray Green**™ Spray Oil 13E (99% mineral oil, Intelligro), 2% **Vegol**™ (96% canola oil, Neudorff N.A.) and a water only control in a volume of ~1,500 L/ha. Treatments in 2022 at two sites consisted of 1% **PureSpray Green**, 2% **Vegol**, and water only as a control. Treatments applied in collaboration with H. Buchler utilized an air-assist sprayer; treatments at SuRDC in collaboration with D. Nield were applied using a tower sprayer.

Air-assisted sprayer, high volume spray, and timing against small nymphs optimizes control of leafhoppers with oil. (Photo: H. Buchler)

<u>Results – </u>Use of the spray gun resulted in uneven spray coverage with the undersides of leaves only lightly and/or unevenly covered. As a result, 1% and 2% **PureSpray Green** only reduced nymph counts by 34% and 48%, respectively, compared to the water spray. In comparison, sprays of 1% **PureSpray Green** using the tower sprayer or air-assist sprayer reduced nymph counts 52% and 58%, respectively. **Vegol** applied at 2% was consistently more effective than 1% **PureSpray Green** with nymph counts reduced 66%, 71%, and 81% with use of the spray gun, tower sprayer and air-assisted sprayer, respectively, relative to the water control.

- Reflecting the need for thorough coverage, control of leafhoppers with horticultural oils was best achieved with the use of an air-assist sprayer and high spray volume.
- 2% **Vegol** consistently performed better than 1% **PureSpray Green**; effective control with either material would require a 2nd spray application.

- Effectiveness of **PureSpray Green** might be enhanced with the addition of an adjuvant, but the resulting level of control and possible phytotoxicity will need to be determined.

Evaluation of Leafhopper Feeding Deterrents

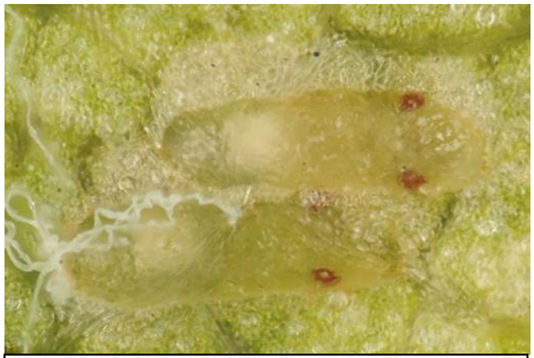
Feeding choice test bioassays conducted previously in the Lowery lab have shown that certain organosilicone surfactants and strobilurin fungicides are highly effective deterrents. In field spray trials, leafhopper numbers were reduced significantly with proper timing and spray coverage. Here we report on the latest results from choice tests that included formulated plant essential oils, additional fungicides and surfactants, as well as miscellaneous vineyard materials. Deterrent action was determined over 10-fold serial dilutions from the approximate field rate.

Results – Consistent with previous results, all 4 organosilicone surfactants had a strong negative effect on VCL feeding, with **Widespread Max**™ (Loveland Products) exerting the strongest effect. Both non-organosilicone surfactants had little effect on leafhopper feeding. Included because of reports of possible antifeedant or toxic effects, the biopesticide **Grandevo**™ was only slightly deterrent. Five of the six formulated plant essential oils or plant extracts included in this study showed modest negative effects on VCL feeding, with **EcoExempt**™ (EcoSMART Technologies, Inc.), a formulation of rosemary and peppermint oil, being the strongest with ~80% fewer nymphs found on leaf disks treated with it compared to numbers on the untreated leaf disks. Additional work would be required to determine if the effect was due to the plant oils or the formulants. Only 2 of 7 miscellaneous vineyard materials proved to be deterrent, with **Sirocco** fungicide being the only material other than the organosilicone surfactants to have a very strong negative effect on VCL feeding.

- Organosilicone surfactants appear to be universally deterrent to VCL and may be responsible for the activity of some formulated spray materials (e.g. **Sirocco**).
- **Sirocco** fungicide was very deterrent in choice tests and inadvertently shown to effectively reduce VCL and WGL numbers in the field. The Canadian **Sirocco** label lists it as suitable for organic production of grapes, but growers need to verify this with their organization.
- Deterrent activities need to be verified in replicated field spray trials.

Enhanced Knowledge of *Anagrus* Parasitoids of Leafhopper Eggs

With help from Dr. S. Triapitsyn (UC Riverside) we have learned a great deal about *Anagrus* parasitic wasps of leafhopper eggs in BC. *Anagrus erythroneurae* that parasitizes eggs of the WGL utilizes eggs of other leafhopper species on a number of common plant species during the summer and winter, making it an effective control agent. *Anagrus daanei* that parasitizes eggs of the VCL is less effective and we know little about its alternate winter and summer hosts. Research in the Okanagan Valley focussed on collection of *Anagrus* wasps and their leafhopper hosts from dormant woody plants in spring and from herbaceous plants in summer. Parasitoids and leafhoppers were also collected from dormant roses in spring and from grapevines and Virginia creeper vines during the growing season to determine if a 3rd *Anagrus* species, *A. tretiakovae*, that parasitizes both WGL and VCL was now present in BC.



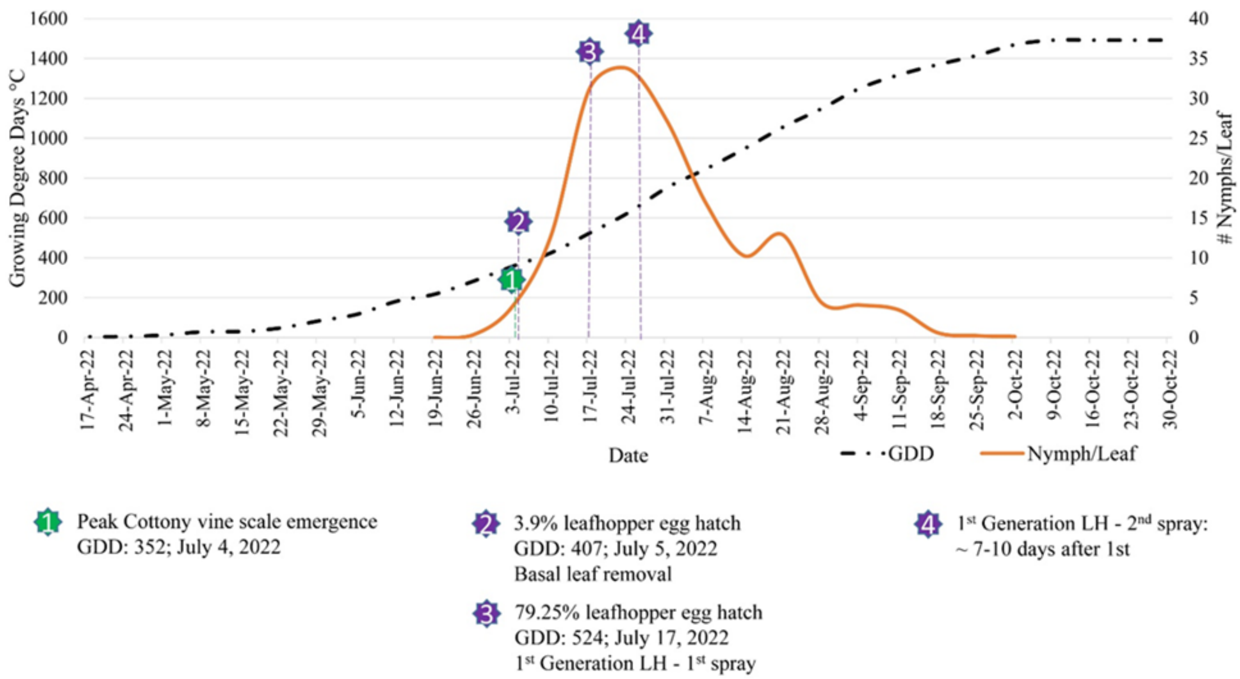
Not yet darkened Anagrus daanei parasitoid wasps developing in Virginia creeper leafhopper eggs. Note the white fat body and visible pair of red eyes.

Results – While a large number of *Anagrus* were collected, including a new species from dormant willow, we did not collect *A. tretiakovae.* It is likely to eventually migrate to BC from southern WA, where it was found recently, or it could be considered for importation from eastern Canada. Widespread mapping of VCL populations and measures of parasitism on grapes and Virginia creeper at 3 sites with unexpectedly low VCL populations revealed that low numbers at one site was due to changes in vineyard production practices. High rates of parasitism of VCL eggs by *A. daanei*, particularly early in the season, and low VCL numbers at the remaining two sites indicated that eggs of a leafhopper wintering on organic cherry and/or apple are rare winter hosts for *A. daanei*. Future research could help verify this discovery and identify the leafhopper host species. It is hoped that this knowledge might be used to enhance parasitism of VCL on grapes with culture of certain beneficial plant species.

Research within this project conducted independently by Dr. P. Abram (AAFC Agassiz) found that leafhopper pests of grapes were absent from Fraser Valley vineyards. A number of leafhopper and *Anagrus* specimens collected in BC (by Lowery and Abram) and in ON (by Dr. J. Renkema, AAFC Vineland) remain to be identified (by Dr. Tara Gariepy, AAFC London) using molecular diagnostic methods. Combined with the taxonomic expertise of Dr. S. Triapitsyn, the molecular diagnostics will help clarify *Anagrus*-leafhopper host relationships.

Forecasting/Modelling Grape Pest Populations.

The objective of this research was to link leafhopper population development to temperature recordings, grape phenology stages, and flowering of possible indicator plant species in order to develop models to improve timing of physical (e.g. basal leaf removal) and chemical control measures. Weekly, or twice weekly during critical times, numbers of VCL and WGL eggs and nymphs per leaf were assessed on 10



1 2 Chardonnay growth stage at peak cottony vine scale emergence (GDD: 352; July 4, 2022); and 3.9% leafhopper egg hatch (GDD: 407; July 5, 2022) for timing of basal leaf removal.

4 Chardonnay growth stage at peak numbers of 1st generation leafhopper nymphs; July 24, 2022, ~650 GDD

fully expanded leaves from a vine located near each of the four temperature recorders. Growing degree day (GDD) models were calculated using the traditional method with a base of 10°C.

Results – Numbers of leafhopper eggs peaked in the Chardonnay block on June 24th corresponding with the 1st record of two newly hatched (neonate) leafhopper nymphs. Reflecting the cool, wet spring of 2022, monitoring suggested that removal of basal leaves to reduce leafhopper numbers would have begun about July 5th when ~4% of leafhopper eggs had hatched; nymph counts at that time averaged 5.4/leaf and GDD_{10} measured 407. Demonstrating the utility of modelling and forecasting, removal of basal leaves based on these dates would have triggered this action approximately 2.5 weeks later than had been determined for a previous leaf-removal study in the Kelowna area when early season conditions had been warmer. Monitoring and modelling during 2022 suggested a spray date for 1st generation leafhopper nymphs of July 17 (524 GDD) when nearly 80% of eggs had hatched. The peak in 1st generation nymph counts of more than 50/leaf was recorded between July 19-26. Likely due to the action of the fungicide **Sirocco** outlined earlier, numbers of nymphs of the 2nd generation were very low and a 2nd generation peak was almost entirely lacking even though no insecticides had been applied. An approximate spray date occurred sometime after September 4th (>1251 GDD).

This initial modelling has shown that action dates for leafhoppers, such as early season removal of basal leaves and the 1st spray for leafhopper control, will also contribute to the management of scale pests. Photographic records relating grape phenology stages to particular control activities will also assist growers with timing of control events. This monitoring and modelling study is planned to continue as a component of the upcoming 2023-2028 CGCN AAFC-GF project. Future work to include other cultivars and locations over multiple years is required to improve the accuracy of the GDD model.

Summary

Our research identified several insecticides that are effective against leafhoppers on grapes in BC and it quantified the degree of control that might be expected when applying horticultural oils using different types of sprayers. In addition to organosilicone surfactants, we have shown that certain fungicides (e.g. Sirocco) effectively deter leafhopper feeding. Preliminary temperature-based models of seasonal leafhopper population growth were produced that will, with refinement, help provide accurate timing for various control measures (e.g. insecticide applications). This project contributed considerably to our knowledge of leafhoppers and their *Anagrus* parasitoids and the development and 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 enemies, 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 pests.

Outputs

Due to COVID-19 and other unavoidable disruptions, some studies were completed later than planned and certain articles and papers remain to be completed. Some of the presentations and factsheet articles related to this project include:

- Horticultural Oils for Grape Pest Management, T. Lowery; industry newsletter article, Aug. 2022, posted on the CGCN, BCGGA, and SuRDC websites.
- Utility of Oils in Grape Pest Management, T. Lowery; oral presentation, Ont. Fruit & Veg. Conv., Feb. 2022.
- Organic Leafhopper Management, T. Lowery; oral presentation and panel discussion BCWGC Webinar, Dec. 2021.
- BC Coastal Grape Production and the Threat of Invasive Pests, T. Lowery: oral presentation to WIGA, Mar. 2021.

- Sustainable Management of Leafhopper Pests of Grapevines, T. Lowery; oral presentation and web posting, Feb. 2021, CCOVI Lecture Series.
- Management of Grape Leafhoppers: it's a lot about timing, T. Lowery; industry newsletter article, Jan. 2021, posted on BCWGC, BCGGA, and CGCN websites (4 pgs., 8 photos).
- Options for Organic Insect Management in Vineyards, T. Lowery; Un-Conventional Thinking Workshop (OMAF) 2021: Adapting to a Changing Tree Fruit and Grape Landscape.
- Leafhopper Research Update: Adding to the Toolkit, T. Lowery; Growers Supply Annual Conference, Feb. 2020.
- Insect and Mite Pests of Grape, T. Lowery. Chapter 5.3, in Best Practices Guide for Grapes for British Columbia Growers 2020. Posted on the BCWGC and BCGG websites. 32 pages.
- The Entomology of Vineyards in Canada. Vincent, C., D.T. Lowery and J.-P. Parent. Nov. 2018. Can. Entomol. 150: 697–715. https://doi.org/10.4039/tce.2018.55

Acknowledgements

We thank the BCWGC and GGO for funding provided through the CGCN-AAFC GF3 program. We're indebted to the many collaborating Okanagan growers who allowed us use of their vineyards, and H. Buchler in particular for assistance conducting a field spray trial. In addition to the Research Associates mentioned above we thank Naomi DeLury, Mairi Robertson and numerous student assistants. We also thank the Field Services Crew for assistance maintaining the SuRDC vineyards.

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This report and other SuRDC Wine Grape Research newsletters and information can be accessed at: https://drive.google.com/drive/folders/1NBg5f6qXfyfzM82ZeKgR-364