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

Activity: *Grapevine Virus Diseases and Virus Vector Control*

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Objectives

1. Expand knowledge on the prevalence and distribution of grapevine leafroll-associated virus (GLRaV) and red blotch virus (GRBV) in Ontario vineyards, the provenance of infected materials and the estimated economic impact of virus infection.
2. Investigate the relationship between genotype, symptomology and origin of Grapevine Pinot Gris Virus, especially for Canadian isolates.
3. Determine whether GRBV and GLRaV infections spread within vineyards and to adjacent vineyards.
4. Document the effect of GLRaV and GRBV alone and in combination on vine cold hardiness, vigour, fruitfulness, yield and fruit and wine quality in different growing season. Study production practices (irrigation, fertilization, crop thinning, pruning) that may enhance fruit quality in GLRaV and GRBV infected vines. Determine minimum thresholds of GLRaV and GRBV infected vines that can impact wine quality.
5. Monitor vineyards and surrounding areas for vectors of GRBV and evaluate the ability of potential vector species to transmit GRBV under greenhouse conditions.
6. Develop strategies to manage vectors of GLRaVs and GRBV using conventional pesticides and beneficial insect species as biological control agents.
7. Develop best management practices for grapevine leafroll and red blotch diseases for Ontario.

Methodology

Expand knowledge of prevalence of grapevine viruses - Genotype, symptomology and origin of Grapevine Pinot Gris Virus

- We obtained 21 vines from 3 grape growing regions of Canada (13 samples from Ontario, 7 from British Columbia and 1 from Nova Scotia that were previously

confirmed by PCR to be infected with GPGV. Total RNA was extracted from the leaf samples and sequenced with Illumina-Miseq in January 2021. The virome data was analyzed in September 2021 and some additional sequencing was done in April 2022 to obtain full-genome sequences of 25 GPGV isolates. Phylogenetic analysis was carried out for full-genomes of 68 GPGV isolates sourced from data banks as well as from other provinces in Canada. Funding for all the HTS testing came from Genome Canada through the project [code 189GRP] entitled “CLEan plAnt extractioN SEquencing Diagnostics (CLEANSED) for Clean Grapevines in Canada".

Spread of GLRV and GRBV

- Petiole samples were collected in 2022 from individual vines in the Chardonnay block that was sampled in 2018-2020 (Chardonnay). Since there was no GRBV detected in the Cabernet franc block that originally included, sampling switched to a Pinot noir block in 2021 and 2022. The Vidal block that was sampled 2018-2021 was not included in 2022 due to poor fungal disease management, making it impossible to find healthy leaves to sample. Samples were submitted to CCOVI lab for testing for GLRV-3 and GRBV.

Effects of infection on vine health and fruit and wine quality

- Fruit was collected from individual vines with GLRaV-3, GRBV and GLRaV-3+GRBV as well as virus free vines at 3 sites (Chardonnay, Pinot noir and Vidal). Yield, cluster number, weight per cluster and average berry weight were determined. Soluble solids, pH and titratable acidity were determined on juice for each vine. Duplicate micro-ferments were conducted with fruit from individual vines. Fermentation kinetics were monitored until MLA was complete. Wine quality parameters (Brix, free and total SO2, malic acid, acetic acid in all wines and anthocyanins and phenolics in Pinot noir and hydroxycinnamic acids in Chardonnay and Vidal) were determined. Vines infected with GLRaV, GRBV and GLRaV+GRBV as well as virus-free vines were sampled monthly at 3 vineyards (Chardonnay, Pinot noir and Vidal) starting in November in 2021 and December in 2022 to determine the effects of solo and combined infections on bud cold hardiness. Vine vigour was evaluated by pruning weights.

Virus transmission

- Mealybug and scale were monitored at 4 sites with double-sided tape and trunk counts throughout the growing season to confirm the development of mealybug.

Spread of GRBV and GPGV

- Forty sentinel vines that were confirmed free of GRBV and GPGV by both high throughput sequencing (HTS) and endpoint polymerase chained reaction (PCR) were introduced to two vineyards (one organic and one conventional) that were heavily infected with both GRBV and GPGV. Four months post-introduction, the sentinel vines were relocated to a phytotron. The HTS result 15 months post-introduction revealed widespread infection with grapevine Pinot gris virus (GPGV) among the

sentinel vines but did not detect any GRBV. The possibility of an alternative viral reservoir was assessed by testing the most abundant row-middle plants (Medicago sativa, Trifolium repens, Cirsium arvense and Taraxacum officinale), perennial plants in border areas (Fraxinus americana, Ulmus americana, Rhamnus cathartica and Vitis spp.).

Strategies to manage vectors

- Timing of mealybug sprays was determined by developmental stage of the insect.
- The planthopper, Melanoliarus, and buffalo treehopper (Stictocephala bisonia) were collected adjacent to vineyards in the Niagara region and exposed to insecticides (Aceta, Admire, Sivanto Prime, Closer, Pounce) registered for leafhoppers in grapes on grape leaves in Petri-dishes.

Develop best management practices

A questionnaire was conducted with Ontario vineyards to determine:

- If they experienced a change in vine yield and/or sugars associated with virus infection in an affected block,
- If changes occurred, the degree of change if measured or estimated and
- If viticultural practices changed in the affected block in response to the virus infection.

The economic analysis sought to determine which strategies were economically optimal. Simulations were performed to determine the threshold at which point a grower would decide to move from one control strategy to the next as it was more economically optimal. The decision point is met once the current cost of treatment over the life of the vineyard meets or exceeds the costs of next control strategy.