BC Report to the NCCC 212 committee on small fruit and viticulture – 2021

Blueberry:

Objective 1:

Blueberry germplasm and variety development

Dr. Michael Dossett, BC Berry Cultivar Development Inc.

Dissemination of results:

Results disseminated to PNW berry growers through at online research review and regional winter meetings.

Plans for next reporting period:

Harvest 2014, 2015 and 2017 yield trials, evaluation of 2016, 2017, and 2018 crosses

Overall, blueberries suffered fewer impacts from the June heat dome than raspberries (though there were some genotypes and locations that were hit hard). BC 14-40-158 continued to look very good – in spite of having poor pollination this year, it was still amongst the highest yielding for the year as well as cumulatively over the last 3 years. BC 14-40-14 also had a very strong showing in both the 2015 planting and the 2017 planting, with one of the highest yields of the season. It is about a week later and slightly firmer than BC 14-40-158, but somewhat less vigorous and expected to be lower yielding than it's sibling over time. BC 14-42-47 also stood out for its yield and fruit quality. It is in the early-mid season, similar in timing to 'Draper'. All three of these are being propagated for grower trial, along with BC 18-18-154 which has firm, jumbo-sized berries in the mid-late (~'Cargo') season. BC 18-68-34 which has firm Jumbo-sized berries in the early-mid season, and BC 18-39-56 which has medium-sized crunchy firm berries in the mid-late season are new additions to the trial propagation list this year. We expect to have some trial plants ready for fall 2022, with more targeted for September 2023.

Projects mapping traits in a 'Legacy' x 'Cargo' mapping population as well as in collaboration with NCSU on the 'Reveille' x 'Arlen' mapping population are underway, but plants are establishing and there is nothing to report at this time.

Objective 2:

Project 1. Developing a decision support system for mitigating fruit rot diseases of berries

Dr. Rishi Burlakoti, Research Scientist, Agassiz Research and Development Centre (ARDC), Agriculture and Agri-Food Canada (AAFC)

Development of fruit rot forecasting models continued in 2021 via collection of meteorological data from on-site weather stations installed in Agassiz and Clearbrook. Field trials (one each for raspberry and blueberry) were continued through the 2021 field season in Agassiz to compare model-based and calendar-based fungicide spray treatments. Fruit samples were harvested each week and fruit rots were assessed from these field trials. In a separate trial, green-fruit *Botrytis* infection and fruit rot at the time of harvest were assessed from early-, mid-, and late-season varieties of blueberry. Fruit samples of multiple varieties of blueberry and raspberry (including selections from the BC Berry Breeding Program) from Clearbrook and Agassiz were assessed for fruit rots. In addition, blueberry samples from growers' fields from diverse regions (Chilliwack, Sumas Prairie, Abbotsford, Langley, Matsqui, Delta, Surrey, and Maple Ridge etc.) were collected and fruit rots were assessed.

Project 2. Integrating host resistance and alternatives to copper-based products for sustainable management of bacterial blight

Dr. Rishi Burlakoti, Research Scientist, Agassiz Research and Development Centre (ARDC), Agriculture and Agri-Food Canada (AAFC)

Blueberry cultivars at Agassiz Research Center were monitored periodically to assess bacterial blight incidence. In addition, blueberry germplasms and cultivars from BC Berry Breeding plots were also monitored to assess the disease incidence in the spring and summer months in 2021. *Pseudomonas syringae* isolates collected over multiple years (2018-2020) were revived regularly from the long-term storage for maintenance. Using molecular tools, representative isolates of *P. syringae* were characterized and genomic study of these isolates are in progress. Several disease screening techniques (detached leaf assay, floral bud inoculation and whole plant assays) were also evaluated in laboratory and greenhouse using multiple pathogen strains inoculating in multiple varieties of blueberry (such as 'Draper', 'Duke', 'Chandler'). Results of this objective was presented at the 2021 Tri-Society Annual Virtual meeting (Canadian Phytopathological Society, Canadian Society of Agronomy, and Canadian Society of Horticultural Sciences) and an abstract was published in Canadian Journal of Plant Pathology.

Project 3. Monitoring of arthropod pests in raspberry and blueberry germplasm

Dr. Michelle Franklin and Dr. Paul Abram, Research Scientists, Agassiz Research and Development Centre (ARDC), Agriculture and Agri-Food Canada (AAFC)

This project aims to determine the relative susceptibility of new blueberry and raspberry cultivars and selections from the BC Berry Breeding Program to arthropod pests of concern. In 2021, we continued to collect data on the susceptibility of new breeding selections to aphids, mites, leafrollers, and gall midges. Arising from this work, aphids are being collected from blueberries with the goal of aiding a collaborating taxonomic specialist with species identification within the *Ericaphis* species complex. This taxonomic work is important given that aphids can serve as a vector of blueberry scorch virus. We included light trapping collections of lepidopterans in our survey throughout the season to gain further information on the species composition of leafrollers and other caterpillars at two research sites. These specimens will be pinned and identified based on morphology and molecular barcoding methods. The newly established strawberry blossom weevil was first observed in strawberry fields in mid-April in the Fraser Valley of BC. Adult weevils were not observed in new raspberry selections during our surveys; however, further information will be collected via visual surveys of aborted buds. A paper is now published in "The Canadian Entomologist" on the establishment of the strawberry blossom weevil in BC.

Project 3. Improving establishment of blueberry and raspberry with non-traditional crop inputs

Dr. Eric Gerbrandt, Plant Scientist, Sky Blue Horticulture Ltd.

For blueberry and raspberry, the objective of this project is to enhance crop establishment, yield and fruit quality through comparison of drench applications of four classes of alternative crop inputs (i.e., high P fertilizer, phosphites, humic acids and kelp extracts). Following pilot trials using potted plants, large replicated-field trials were established for blueberry and raspberry in 2017 and 2018, respectively. In 2021, a large-scale blueberry planting (180 five-plant plots) continued to be treated with experimental combinations of alternative crop inputs and a third year of harvest is nearly complete as the 2021 field season comes to an end. In addition to total fruit yield, average fruit weight and firmness during five weeks of cooler storage was assessed for each experimental plot. Soil, leaf tissue, and fruit tissue samples were also collected from each plot.

While the raspberry field trial was terminated at the end of 2020, evaluation of the impact of foliar alternative crop inputs was initiated in 2021 for both raspberry and blueberry. Fields used for these studies included single fields of 'Duke', 'Reka', and 'Draper' blueberry as well as 'Meeker', 'Chemainus', and 'Rudi' raspberry. Four replications of six- and 15-plant plots (for blueberry and raspberry, respectively) were used to compare an untreated control against kelp, phosphite, and kelp + phosphite foliar applications made at three times during early fruit development. Fruit samples were collected at the time of first harvest for blueberry and at three times during the fruiting

season for raspberry (only for 'Chemainus' as the heat dome caused substantial fruit damage to the other two fields). As for the established blueberry field planting, fruit size and quality were evaluated using clamshells of fruit collected from each plot.

Project 4. Mitigating cultivar-specific physiological challenges in new blueberry cultivars – Part I

Dr. Eric Gerbrandt, Plant Scientist, Sky Blue Horticulture Ltd.

This project is aimed at characterizing the heritability of Green Fruit Drop (GFD) in advanced selections in the BC Berry Breeding Program with the long-term goal of developing molecular markers to screen for this physiological disorder. To address the issue of GFD in 'Draper' blueberry (and other cultivars and breeding selections with 'Draper' in their pedigree), a four-year region-wide survey of leaf and fruit nutrient allocation was completed in 2020. This work was presented in 2021 at the International Vaccinium Symposium.

Also relating to GFD, a second year of foliar calcium trials were conducted in 2021 to adapt field management practices developed for 'Draper' to genotypes that have 'Draper' as a parent and that also suffer from GFD under the climatic conditions in British Columbia: Valor™ and BC 14-40-158.

Project 5. Ecological Pest management for Spotted Wing Drosophila

Dr. Juli Carrillo, Assistant Professor, University of British Columbia

With support from the blueberry, raspberry and strawberry industries, this project is aimed at developing alternative methods of SWD control to reduce regional pressure and reliance on chemical tools. This includes the evaluation of intercropping options to repel SWD, developing better attractants for lures and traps and the establishment of effective biological control species in the region.

Project 6. Evaluating mass trapping as a tool for non-chemical spotted wing drosophila management

Allyson Mittelstaedt, Soft Fruits IPM Supervisor and Assistant Research Coordinator, E.S. Cropconsult Ltd.

The objective of this project is to evaluate mass trapping as an option for reducing SWD pressure in conventional and organic settings. From 2019-2021, this study was conducted in fields of 'Draper', 'Bluecrop' and 'Liberty', and final analyses are currently underway.

Project 7. Non-Chemical Vole Control in Berry Fields

Sofi Hindmarch, Project Coordinator, Fraser Valley Conservancy

The objective of this project is to assess the effectiveness of a non-chemical option for killing voles. The project is using a commercial trap that has a self-resetting and has a bolt-action kill mechanism with the potential to reduce impacts on non-target wildlife as compared to rodenticides. To improve efficacy of this trial, trap design is being re-evaluated and development of a pheromone-based lure is in progress.

Project 8. Evaluation of spray-induced gene silencing of blueberry scorch and shock viruses as a method to reduce virus number and symptoms of infected blueberry plants

Dr. Jim Mattsson, Associate Professor, Simon Fraser University

The objective of this project is to design a biopesticide that can be used to prevent the spread of economically important blueberry viruses. The approach is to sequence the genetic code of the virus and then design RNA sequences that can inhibit replication of the virus when sprayed on the plant – spray-induced genomic silencing (SIGS).

Project 9. Controlling Blueberry Fruit Development using Plant Growth Regulators

Dr. Charitha Jayasinghege, Research Scientist, Agriculture and Agri-Food Canada

The objective of this upcoming project is to use plant growth regulators to de-blossom new plantings as well as delay the ripening season for various blueberry cultivars to shift the harvest window. This project was temporarily placed on hold due to COVID in 2020 but was resumed in 2021. Preliminary experiments were conducted on existing trial plots, and additional plants are being established in large pots for future experimentation.

Project 10. Development of Molecular Diagnostics for Plant-Parasitic Nematodes in BC

Dr. Tom Forge, Research Scientist, Agriculture and Agri-Food Canada

This project is aimed at development of a lab method for detecting nematodes in soil and root samples, filling a gap in diagnostic capacity for the local industry. This project was temporarily placed on hold due to COVID but was resumed in spring of 2021 as part of a collaborative effort with researchers at the BC Ministry of Agriculture, Food and Fisheries as well as Kwantlen Polytechnic University.

Project 11. Genomics-based identification and development of diagnostic methods for detection of novel virus disease in BC blueberry farm and nursery industries

Dr. Jim Mattson, Associate Professor, Simon Fraser University; Dr. Eric Gerbrandt, British Columbia Blueberry Council

The project aims to identify one or more unknown viral pathogens or viral strains of known viruses causing disease in highbush blueberry fields in British Columbia (BC) and to develop a diagnostic method for rapid and affordable testing. The novel pathogens/strains cause symptoms similar to those of known strains of two economically damaging viral diseases of blueberry, blueberry shock virus (BlShV) and scorch virus (BlScV). Around 18% of diseased plants surveyed in 2020 tested negative for both viruses using the routine enzyme-linked immunosorbent assay (ELISA) test as well as the more sensitive Polymerase Chain Reaction (PCR) test. Moreover, PCR results for these plants show negative results for the broader Carla and Ilar virus genuses to which BlScV and BlShV belong. In this project, large-scale DNA sequencing is being used to identify viral pathogens found in the BlScV- and BlShV-negative plants. Gene(s) encoding surface proteins will be cloned and recombinant protein used to produce antibodies. In turn, antibodies will be used to develop ELISA tests that can be used for rapid and affordable identification of the novel pathogen(s)/strain(s). The ability to identify the novel pathogen(s)/strain(s) will be essential to understanding disease progression and allowing blueberry growers to make informed management decisions.

Project 12. Effects of Host, Pathogen, and Environmental Factors on Increased Incidence of European Foulbrood in Honey Bee Colonies Pollinating Blueberries in BC

Dr. Sarah Wood, University of Saskatchewan

This project is focused on determining the effects of common pesticides on bee susceptibility to European foulbrood (EFB) disease and assessing ways to improve bee nutrition and health. In 2020 and 2021, *in vivo* models were used to assess the impact of fungicides and the blueberry pollen diet on susceptibility to EFB as well as the effect of *Melissococcus plutonius* strain pathogenicity on severity of EFB disease.

Objective 3:

Project 1. Mitigating cultivar-specific physiological challenges in new blueberry cultivars – Part II:

Dr. Eric Gerbrandt, Plant Scientist, Sky Blue Horticulture Ltd.

Building on work to assess fruit quality opportunities in new cultivars of blueberry, ‘Cargo’, ‘Last Call’, and ‘Calypso’ from 2018-2020, a new experiment was established in 2021 to focus on the latter of these three cultivars. This experiment was designed to determine the impact of harvest timing for ‘Calypso’ using six field sites across the Fraser Valley. Three replications and a split plot experimental design were used to assess three

different timings (main plots) for initial fruit harvest with two different lengths of cycle-back for second harvest (split plots). Data collection included determining total fruit yield, average fruit weight, and shelf-life during cooler storage (i.e., weight loss, firmness). First year results will be presented at the Lower Mainland Horticultural Improvement Association's Annual Grower Short-Course in January of 2022.

Project 2. Assessing Harvest and Postharvest Fruit Quality in Blueberry:

Dr. Simone Castellarin and Dr. Anubhav Pratap Singh, University of British Columbia

The objectives of this project are to assess fruit quality of current blueberry cultivars as well as advanced selections from the BC breeding program at harvest and at various times postharvest during cooler storage. This will permit the determination of biochemical constituents of fruit quality and how they change over time. This project also includes evaluation and development of postharvest treatments and advanced packaging materials for their ability to improve shelf-life will be used to improve shipping range for industry standard cultivars. In 2019 and 2020, fruit samples of selections from the breeding program as well as standard cultivars from commercial fields were provided to this research group for the first year of this study. Continuing in 2021, there is a team of graduate and post-doctoral researchers working on various projects to elucidate the biochemical basis for fruit quality and develop post-harvest storage methods to extend fresh market shelf life.

Objective 4:

Project 1. Implementing Integrated Pest Management Practices on Small-Scale Farms

Marjolaine Dessureault, Research Director, ES Cropconsult Ltd.

Working with blueberry, raspberry and strawberry growers, this project's objective is to develop IPM training materials for small-scale fruit and vegetable growers to handle shifts in pest pressure due to climate change and to improve region control. A short-list of target pests was identified this season and will be used to develop grower education materials in the next year. A short-list of target pests was identified in 2019. In 2020, this project developed IPM management guides for 14 different pests. In 2021, these IPM guides were "test run" with commercial growers to fine-tune their content.

Project 2. Demonstrating Reduced Nitrogen Fertilizer Rates across Commercial Blueberry and Raspberry Fields in the Fraser Valley

Dr. Eric Gerbrandt, Sky Blue Horticulture Ltd.

Blueberry and raspberry growers often apply more nitrogen (N) to their fields in British Columbia's Fraser Valley. As an effort to extend trial work conducted on research sites to the commercial context, a network of on-farm demonstration trials was

established in 2017. The network included seventeen blueberry fields (seven 'Duke', five 'Bluecrop', two 'Draper', two 'Elliott', and one 'Reka') and five raspberry fields (three 'Meeker', one 'Chemainus', and one Wake™Field). Baseline analyses of several yield components as well as leaf tissue and soil analyses were taken in 2017 prior to implementation of single "reduced" N rate blocks for comparison to adjacent "full" N rate blocks based on the grower's historical management practices. From 2018-2021, extensive data were collected on various yield components as well as annual leaf tissue analyses and soil sampling to determine post-harvest nitrate. In early years, no negative impacts on plant performance were observed while leaf tissue N remained within recommended parameters and post-harvest nitrate was reduced. Results from the final year of this demonstration trial network are being analyzed to extend to industry.

Raspberry:

Objective 1:

Project 1. Raspberry germplasm and variety development

Dr. Michael Dossett, BC Berry Cultivar Development Inc.

Dissemination of results:

Results disseminated to PNW berry growers through at online research review and regional winter meetings.

Plans for next reporting period:

Harvest 2019 and 2020 yield trials, evaluation of 2018 and 2019 crosses

Overall, it was a difficult year for raspberry evaluations. Many fields came through winter with some degree of vascular injury, and a warm dry spring put stress on plants early and did not offer much time for lateral development. Overall, the season was significantly warmer and drier than normal causing stress to the plants. On top of this, three days of extreme heat in late June, where temperatures reached 111°F at the Clearbrook station on June 27 and June 28, did considerable damage to the raspberry crop in production. For the remainder of the season, quality was very good, but fruit were small. Because of the adverse effects of the extreme heat and its differential impacts on selections related to ripening phenology, we emphasized fruit quality and ratings of vigor and crop load in evaluations over measurements of yield. Standouts this year included BC 1855.14, BC 1543.53, BC 15-53-15. We are estimating to have approximately 13k plants of different selections going out for grower trial next spring. Just over 100 new selections were made in 2021.

Ongoing projects developing/validating fingerprinting tools (in collaboration with Nahla Bassil and Michael Hardigan, USDA-ARS), studying heritability and correlations between yield, yield components, and fruit phenology, as well mapping aphid and RBDV resistance and a major color QTL have nothing new to report this year and will be reported on in 2022.

Objective 2:

Project 1. Managing berry root health through pathogens characterization, developing screening methods, and exploring good management options

Dr. Rishi Burlakoti, Research Scientist, Agassiz Research and Development Centre (ARDC), Agriculture and Agri-Food Canada (AAFC)

Field trials were continued in the 2021 field season to evaluate different fungicide products and timings of application for managing the raspberry root rot complex. Assessment of the root rot and wilting complex (RRWC), as well as recording of other relevant data, took place in the summer months and will continue into the fall. To understand the epidemiology of the RRWC in fields, we periodically monitored raspberry plants, assessing RRWC symptoms and collecting pathogen samples. Significant progress was made in characterization of the causal agents (i.e., different species of *Phytophthora*) of the RRWC using samples that had been collected over multiple years. Several screening methods (e.g., whole plant and detached tissue assays) were compared in the greenhouse, and reliable assays for screening raspberry germplasm and varieties were developed. In addition, diversity of pathogenicity and virulence, for representative strains of *Phytophthora* spp. (n = 20) collected from diverse locations, were assessed using greenhouse experiments. Results were presented at the 2021 Tri-Society Annual Virtual meeting (Canadian Phytopathological Society, Canadian Society of Agronomy, and Canadian Society of Horticultural Sciences), and an abstract was published in Canadian Journal of Plant Pathology.

Project 2. Management of soil-borne pests and diseases in raspberry and strawberry

Dr. Eric Gerbrandt, Plant Scientist, Sky Blue Horticulture Ltd.

This project seeks to improve management tools for soil-borne pests and diseases, especially nematodes and Phytophthora root rot, to increase fruit yield and quality in raspberry and strawberry. In 2020, a new set of field trials was initiated in raspberry and strawberry to compare the effects of three different pest control products for their effects of plant parasitic nematodes and plant growth responses to soil-borne disease pressure. Replicated trials were established in a commercial WakeHaven™ raspberry planting and a strawberry planting of 'Albion' and BC 10-2-1. In addition to comparing products, the raspberry trial includes a comparison of application methods (drench versus drip) for one new nematicide product and application timing (spring versus fall) for another. Prior to nematicide applications, soil nematode populations were determined for each plot. Subsequently, plots were treated with nematicides in the spring and fall in 2020 and 2021. Soil and root nematode populations were assessed after spring and fall applications in 2020, before and after spring nematicide applications in 2021, and then again after fall applications in 2021. Fruit yield and average berry weight were determined via mechanical and manual harvest of raspberry and strawberry, respectively. A final year of continued treatments, nematode population assessments, and collection of fruit yield data will be conducted in 2022.

Project 3. Developing a decision support system for mitigating fruit rot diseases of berries

Dr. Rishi Burlakoti, Research Scientist, Agassiz Research and Development Centre (ARDC), Agriculture and Agri-Food Canada (AAFC)

See ***Blueberry: Objective 2: Project 1***

Project 4. Monitoring of arthropod pests in raspberry and blueberry germplasm

Dr. Michelle Franklin, Research Scientist, Agassiz Research and Development Centre (ARDC), Agriculture and Agri-Food Canada (AAFC)

See ***Blueberry: Objective 2: Project 3***

Project 5. Improving establishment of blueberry and raspberry with non-traditional crop inputs:

Dr. Eric Gerbrandt, Plant Scientist, Sky Blue Horticulture Ltd.

See ***Blueberry: Objective 2: Project 4***

Project 6. Ecological Pest management for Spotted Wing Drosophila

Dr. Juli Carrillo, Assistant Professor, University of British Columbia

See ***Blueberry: Objective 2: Project 6***

Project 7. Development of Molecular Diagnostics for Plant-Parasitic Nematodes in BC

Dr. Tom Forge, Research Scientist, Agriculture and Agri-Food Canada

See ***Blueberry: Objective 2: Project 11***

Objective 4:

Project 1. Implementing Integrated Pest Management Practices on Small-Scale Farms

Marjolaine Dessureault, Research Director, ES Cropconsult Ltd.

See ***Blueberry: Objective 3: Project 1***

Project 2. Demonstrating Reduced Nitrogen Fertilizer Rates across Commercial Blueberry and Raspberry Fields in the Fraser Valley

Dr. Eric Gerbrandt, Sky Blue Horticulture Ltd.

See ***Blueberry: Objective 4: Project 2***

Strawberry:

Objective 1:

Project 1. Strawberry germplasm and variety development

Dr. Michael Dossett, BC Berry Cultivar Development, Inc.

Dissemination of results:

Results disseminated to PNW berry growers through at online research review and regional winter meetings.

Plans for next reporting period:

Harvest 2021 yield trial planting and evaluate seedlings from 2021 crosses

After a two-year hiatus, the breeding program performed strawberry crosses again in 2021, so we will have some seedlings to evaluate next year. Our 2020 yield trial was planted very late – a victim of AAFC's COVID shutdown putting us far behind schedule for field work. The late planting resulted in high mortality of the bare root plants in the trial, which probably suffered from an excessive period of cooler storage. Survival and establishment of plug and 4" plants in the trial, by contrast, was very good. As a result of this, we couldn't make good yield comparisons for a lot of the material – particularly short day plants from the Kentville program. BC 10-2-1 performed strongly and had excellent quality through the season. It out-yielded 'Albion' in our plots, though by a smaller margin than in 2020. Fruit of BC 10-2-1 had excellent firmness and flavor that compared favorably with 'Albion' in our evaluations.

Objective 2:

Project 1. Ecological Pest management for Spotted Wing Drosophila

Dr. Juli Carrillo, Assistant Professor, University of British Columbia

See ***Blueberry: Objective 2: Project 5.***

Project 2. Development of Molecular Diagnostics for Plant-Parasitic Nematodes in BC

Dr. Tom Forge, Research Scientist, Agriculture and Agri-Food Canada

See ***Blueberry: Objective 2: Project 10.***

Project 3. Management of soil-borne pests and diseases in raspberry and strawberry

Dr. Eric Gerbrandt, Plant Scientist, Sky Blue Horticulture Ltd.

See ***Raspberry: Objective 2: Project 2.***

Objective 4:

Project 1. Implementing Integrated Pest Management Practices on Small-Scale Farms

Marjolaine Dessureault, Research Director, ES Cropconsult Ltd.

See ***Blueberry: Objective 4: Project 1.***