Title: BC Cranberry Variety Assessment 2020 Progress Report

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Prepared for: BC Cranberry Growers Associate and BC Cranberry Research Farm Society

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Key Findings:

- There is considerable difference between some varieties in terms of important phenology milestones such as bud break, bloom and out-of-bloom (fruit set). For example, Mullica Queen is one of the earliest varieties to come out of dormancy, bloom and begin fruit set. In contrast, Haines is one of the latest varieties to meet these same milestones. Because a number of important management practices are timed for phenology - specifically frost protection, fungicide applications and insecticide applications for cranberry fruitworm – growers should be aware of the relative timing of these events for different varieties
- 6-year average estimated yield data indicate that the top three released varieties are: Vasanna, Crimson Queen, and Welker – all with 350 or more barrels/acre on average from 2015 to 2020. RS11 is an unreleased variety from the Rutgers breeding program that has potential for late harvest and a 6-year estimated average of 382 barrels/acre. The top performing variety from the Valley Corp. breeding program was Valley King with 284 barrels/acre over the six years.
- In terms of fruit quality, all released varieties from both breeding programs and RS11 from Rutgers met the minimum criteria for firmness and % of white fruit in 2020. However, it is important for growers to note that our firmness values were based on hand-harvested fruit, and that commercially harvested fruit, especially through wet pick, would have lower firmness scores. RS11 continues to show characteristics, specifically delayed reddening of fruit, that make it a good candidate for late harvest

Introduction:

The BC Cranberry Research Farm (BCCRF) provides a unique opportunity to evaluate newly developed cranberry varieties under the specific growing conditions of south western BC. While there are many microclimatic differences across the cranberry production areas in BC (e.g. Agassiz to Delta to Pemberton on the mainland, Campbell River to Ladysmith on Vancouver Island), performance of new varieties in Delta BC, is still more relevant than in Oregon, Washington or eastern North America.

In the first few years (2015 to 2018) of data collection efforts were primarily focused on documenting differences in yield amongst recently released (Crimson Queen, Mullica Queen, Demoranville, BG), newly released (Valley King, Midnight series, Haines and Welker) and unreleased varieties (e.g. RS99-9-25). The result of the work at the BCCRF and other field sites across North America has resulted in the recent release of RS99-9-25 as Vasanna, by Rutgers University. Additionally, the variety RS98-11 has shown to be a promising candidate for late harvest and larger scale plots are being planted at the BCCRF.

Yield however is only one characteristic of a cranberry variety that is important to understand. In order to optimize performance a variety must be managed for growth and pests. Many management steps are tied to the phenology of the cranberry plant. For example, fungicide applications for fruit rot protection are tied to %bloom, insecticide applications for cranberry fruitworm are tied to %out-of-bloom and monitoring data. Our data, from the past several years, show trends in bloom phenology that indicate differences across varieties that remain consistent from year-to-year – e.g. Crimson Queen is one of the earliest to bloom and Haines is one of the last to bloom (Fig. 1). Thus, the different varieties may require different timings for phenology related management activities. In highbush blueberries, the differences in bloom and fruiting across the different varieties grown in the Fraser Valley are well established and helpful to growers in managing activities such as pollination and pest management.

The objectives of the 2020 field season at the BCCCRF were as follows

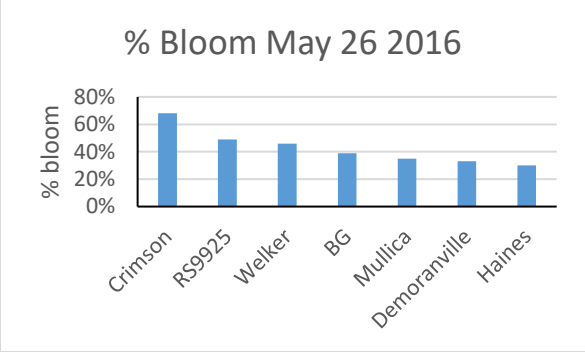
1. Document differences in bud phenology (dormant to bloom) for released and some numbered cranberry varieties,

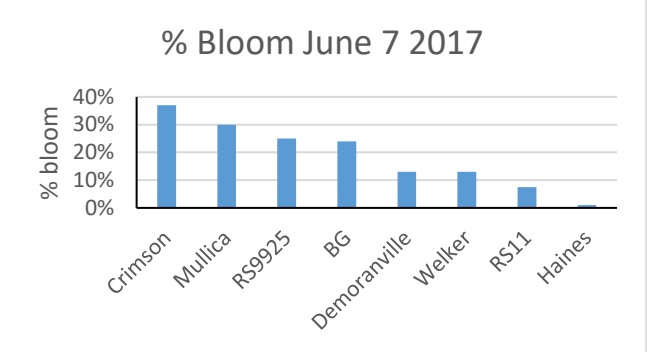
2. Document differences in bloom and out-of-bloom phenology for released and some numbered cranberry varieties

3. Document yield differences in released and numbered varieties grown at the BCCRF

4. Document differences in berry characteristics (% poor, Firmness, colour) and potential incentive payments for released and some numbered cranberry varieties (this objective is done in collaboration with Ocean Spray Canada)

This progress report provides a summary of Objectives 1, 2, and 3 for Bog 1 only.





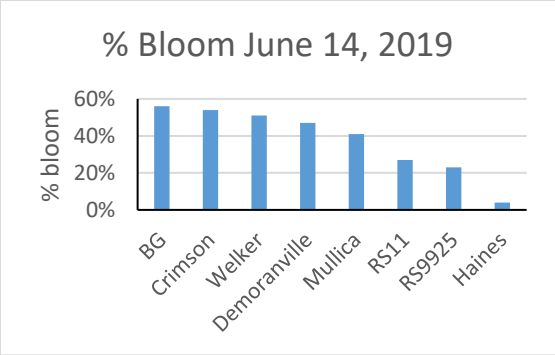


Figure 1. Bloom phenology of select cranberry varieties at the BC Cranberry research farm over three different years: 2016 (top left), 2017 (top right) and2019 (bottom).

Methods:

Objective 1 and 2 (Phenology): Phenology was assessed from dormancy through to fruit stages (pinhead) in both Bog 1 and Bog 2. Bud phenology was assessed six times in Bog 1 the spring of 2020 – March 28, April 14, April 22, May 12, May 26 and June 9. Bloom and out-of-bloom phenology were assessed three times in Bog 1 – June 25, July 2, and July 21.

In Bog 1, phenology was assessed by stopping at three random locations and determining the bud stage (using Fig. 1 from Workmaster and Palta, 2006) on 10 uprights/location. Similarly, bloom and out-of-bloom were assessed from three random locations and the number of (pods, flowers and pinhead fruit were counted on 10 uprights/location). Bloom and out-of-bloom were calculated using established formulae.

$$\% \text{ Bloom} = \frac{\text{Total \# of flowers}}{\text{Total \# flowers and unopened flower pods}} \times 100\%$$

$$\% \text{ Out-of-Bloom} = \frac{\text{Total \# of pinheads and berries}}{\text{Total \# pinheads, berries, flowers and unopened flower pods}} \times 100\%$$

(Source: University of Maine - https://extension.umaine.edu/cranberries/grower-services/calculating-out-of-bloom/)

Objective 3 (Yield): We continue to harvest cranberries at the BCCRF using methods established in 2015 and used consistently for the past six years. Specifically, yield data were collected following the protocols developed and reported on in previous reports (see 2016 Final Report). In Field 1, square-foot quadrats were placed randomly within the centre of the plot – within 2-m of the sprinkler line, ensuring that the location had 100% cranberry cover and no weeds. In Field 2, square-foot quadrats were placed randomly within the centre of the plot, 1-m from the edge. Berries were collected from Field 1 on two dates: September 22 and prior to harvest on October 6. For Field 1, berries were collected from three square-foot samples. Berries were

collected from Field 2 on September 22 to 24. Because variety trial plots are much smaller in Field 2 only two square-foot samples were collected/plot. However, in Field 2 there are two replicates for each variety, so a total of four square-foot samples/variety. We collected a select number of varieties from the Rutgers 2013 planting, all of the Valley Corporation plantings, and all of the Rutgers 2015 and 216 planting.

Objective 4 (Berry Characteristics): To assess berry characteristics a 1kg sample of berries is hand-harvested and delivered to the Ocean Spray fruit quality lab (Richmond, BC). To measure firmness a sample of berries is placed on the FirmTech machine which compresses individual berries by 1 mm and records the amount of gram force that was necessary to complete that compression – results are then presented in g/mm for the entire sample. Colour is measured using the DigiEye machine which converts images to coloured pixels and provides the % of berries in five different colour categories: Class 1 are the whitest fruit and Class 5 are the darkest red.

Results and Discussion:

Objective 1 (Bud Phenology): In the early part of the spring as cranberry buds break dormancy they are vulnerable to frost damage that can negatively impact yield for the current growing season. As buds develop they become increasingly more sensitive to cold temperatures (Demoranville 1998). For example, as Stevens moves from dormancy (tight bud) to cabbage head to roughneck frost tolerances decreases from 20^{o}F to 30^{o}F or -6.7^{o}C to -1.1^{o}C. Crimson Queen, Mullica Queen and Welker were the earliest varieties to move from dormancy (tight bud) to bud swell between around mid-April. Thus, these variety would in theory be more susceptible to frost damage in April than those that are still dormant. However, impact of cold temperatures on cranberry buds has been shown to be very complicated and bud phenology is only a part of the story (Workmaster and Palta, 2006). For example, cranberry buds have been shown to vary in theory response to cold stress both within the tight bud stage and between tight bud and bud swell (Workmaster and Palta, 2006). Further, without the detailed information for each of the new varieties (e.g. see Demoranville 1998) tailored management recommendations for each variety are unlikely. However, growers could still use the information from Figure 2 (repeated over several years) to understand which of their varieties needs frost protection the earliest. By June 9, the earliest blooms were observed in Mullica Queen, Crimson Queen, Welker, BG and Vasanna. Consistent with previous work we observed that Haines was the latest to bloom among these seven varieties assessed in Bog 1 (Bog 1).

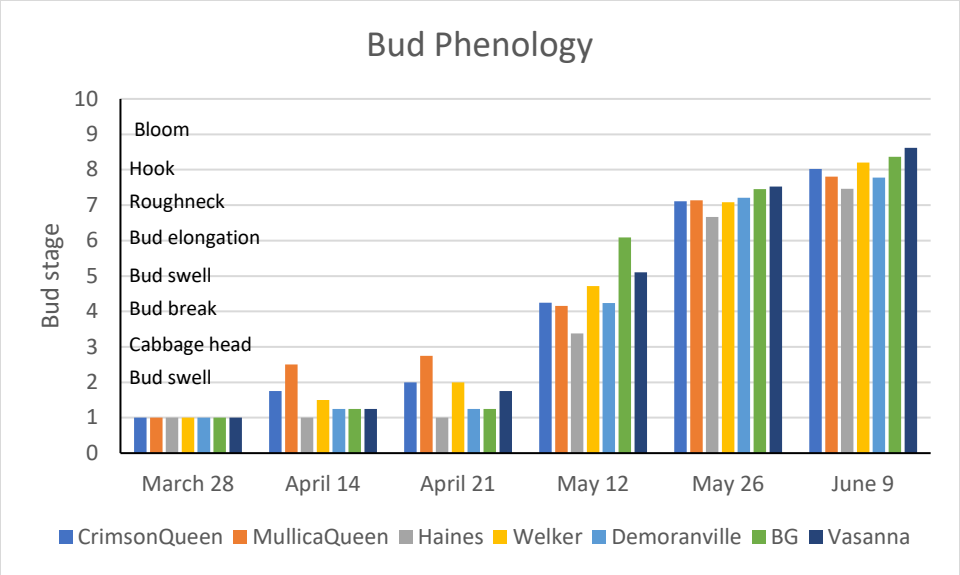


Figure 2. Bud phenology of seven cranberry varieties grown at the BC Cranberry Research Farm, Delta BC in 2020. Bars represent the mean of 30 uprights/variety/sampling date. Bud stages are based on Figure 1 in Workmaster and Palta (2006).

Objective 2 (Bloom and out-of-bloom): By late June only one of the varieties (Haines) was not at 50% bloom (Fig. 3). Early fruit set had started by the very end of June beginning of July for all varieties (Fig 3). The timing of bloom and fruit set has been shown to be critical for proper fungicide applications, since most fruit rot fungi infect during bloom and early fruit set (Oudemans *et al.* 1998). The varieties Crimson Queen and Haines have reliably been the earliest and latest to bloom, respectively. In contrast, the other varieties seem have different relative timings for bloom from year-to-year. For example, the variety Vasanna (formerly RS99-9-25) was one of the last to bloom in 2019 (Fig. 1) but one of the earliest in 2020 (Fig. 2) and it will be important for growers to monitor the timing of bloom in fields with those varieties.

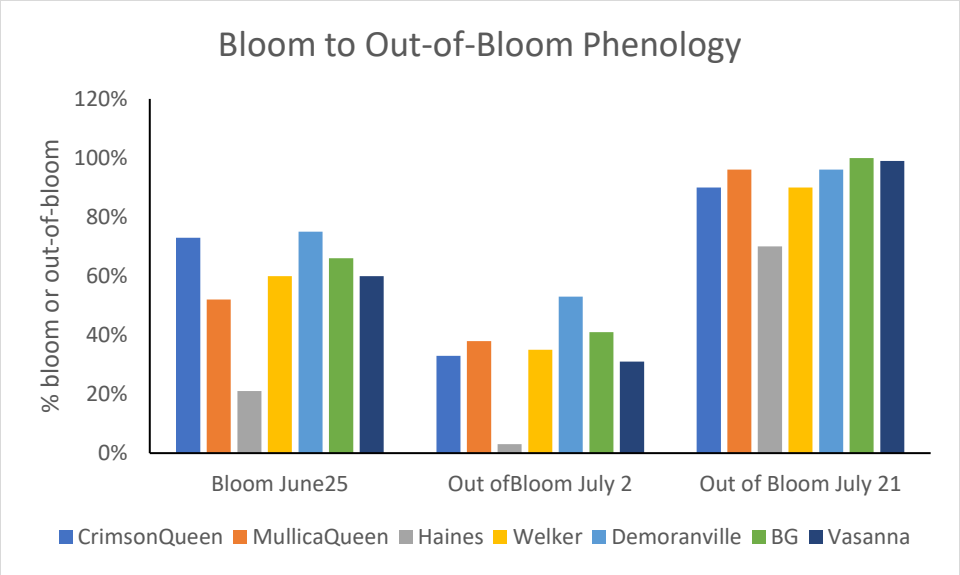


Figure 3. Comparison of bloom (June 25) and out-of-bloom status of seven cranberry varieties grown at the BC cranberry research farm. Each bar is the mean of 30 uprights for each variety.

Objective 3 (Yield): The highest yielding Field 1 variety in 2020 was Crimson Queen (Table 1), with an average estimated yield of 493 barrels of marketable cranberries/acre. The only other varieties to have an estimated marketable yield over 400 barrels/acre were Vasanna and RS-11 (Table 1). Haines and Mullica Queen had similar yields as in 2019 and Welker had much lower yields in 2019 than in 2020 (Table 1). The 2020 foliar nutrient analysis revealed that all varieties from Field 1 had tissue N% values that were below the normal of 0.90 (see Table 2 in Davenport, Demoranville, Hart and Roper, 2000) (Fig. 4). With the exception of Mullica Queen, we observed that lower yielding varieties had lower foliar N% values (Fig. 4). The response of the new cranberry varieties to nitrogen application rates and timings has not been explored, for BC growing conditions, to our knowledge. However, previous work with older varieties shows that response to nitrogen fertilizer can vary not just in response to rate of application but also application timing and with confounding effects of soil/location (e.g. Fig. 7 in Davenport, Demoranville, Hart and Roper, 2000).

As cranberries is a long term crop, what is perhaps more relevant than the yield in any given year is the average yield over time. We now have 6 years of estimated yield data and six varieties have average estimated yields over 300 barrels/acre: Crimson Queen, Mullica Queen, Welker, Haines, Vasanna, and RS11 (Table 1). The top performing variety from the Valley Corp. program is Valley King which has a 6-year average of 284 barrels/acre (Table 1). Our data does not take into account fees and costs for purchasing from the different breeding programs. Growers however should be factoring in these costs when making long-term decisions about variety selection.

Table 1. Estimated average barrels/acre for 6 years for released and numbered varieties from the Rutgers and Valley Corp breeding programs (values are the mean of 3 samples, from Field 1, 4 samples from Field 2, and from the late September harvest in each year)

Variety (and Field)	2015	2016	2017	2018	2019*	2020*	6-Year Average
Crimson Queen (Field 1)	335.52	382.37	308.44	559.23	231.47	493.85	385.15
Mullica Queen (Field 1)	153.14	420.81	265.57	586.18	245.81	244.67	319.36
Demoranville (Field 1)	171.82	350.38	172.3	425.91	236.00	368.99	287.57
Welker (Field 1)	611.53	211.07	331.75	393.95	428.47	243.31	370.01
Haines (Field 1)	508.53	300.26	208.43	441.95	311.57	336.31	351.18
Vasanna (Field 1)	473.18	457.53	532.48	410.46	311.66	442.60	437.99
RS-11 (Field 2)	459.82	394.43	302.20	378.7	334.31	423.20	382.11
BG (Field 1)	115.79	330.09	203.59	378.13	171.83	380.72	263.36
Valley King (Field 2)	260.36	242.45	393.69	226.41	260.36	320.86	284.02
Pilgrim King (Field 2)	141.63	180.74	214.61	186.50	141.63	265.59	188.45

* Average barrels/acre estimate in all years is based on marketable weight – minimum size based on Ocean Spray Cranberries criteria. Minimum size for 2015 to 2018 = 9/32” or above; for 2019 and 2020 = ½” or larger.

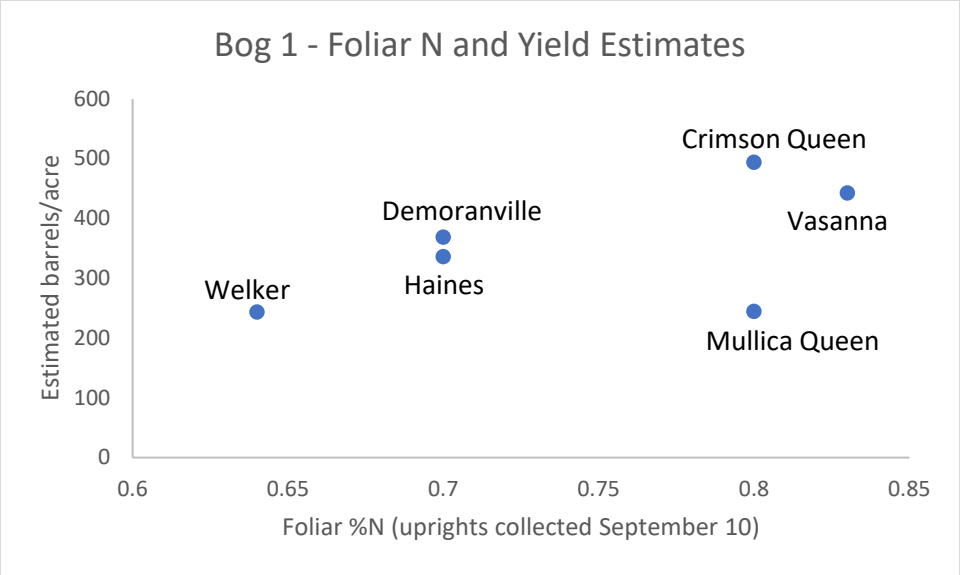


Figure 4. Relationships between foliar %N from uprights collected on September 10 and estimated average yield based on square foot berry samples (average of 3) harvested on September 22, 2020.

Objective 4 (Berry Characteristics): Berry characteristics have become increasingly important for cranberry producers, primarily because the main processor – Ocean Spray – has incentive payments for fruit meeting certain criteria in terms of firmness and colour. All of the named varieties from both the Rutgers and Valley Corp program were above the minimal firmness criteria of 450 g/mm in both 2019 and 2020 (Fig. 5). Based on the samples submitted to the lab all varieties would be eligible for the max incentive of $1.00/barrel. It should be noted that the samples submitted to Ocean Spray from the cranberry research farm are hand harvested, and thus not exposed to the mechanical process of harvest. Thus growers should the values in Fig. 5 as the potential of each variety. In addition to firmness another important berry characteristic is colour. In 2020, Ocean Spray moved away from using TAcy (totally anthocyanin) as a measure of colour to colour % based system using a machine called a DigiEye. The baseline that Ocean Spray has developed is no more than 15% of fruit in the Class 1 category – which is essentially white fruit with minimal colour development. None of the September 2020 harvest exceeded 15% white fruit (Fig. 6), however it is interesting to observe that the variety with the largest amount of white fruit in September was RS11. RS11 has consistently been late to colour and is a potential candidate for late harvest – e.g. late October through to November. The Rutgers breeding program is currently considering releasing RS11 commercially specifically for BC, WA and OR production.

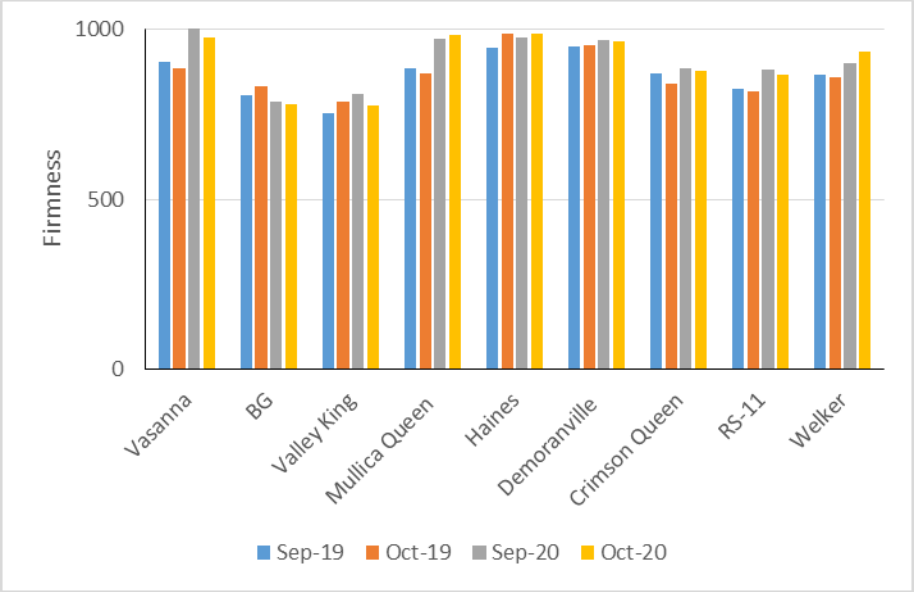


Figure 5. Firmness (g/mm) scores for fruit collected in September and October 2019 and 2020, for 9 different cranberry varieties grown at the BC Cranberry Research Farm in Delta, BC. All fruit were hand harvested.

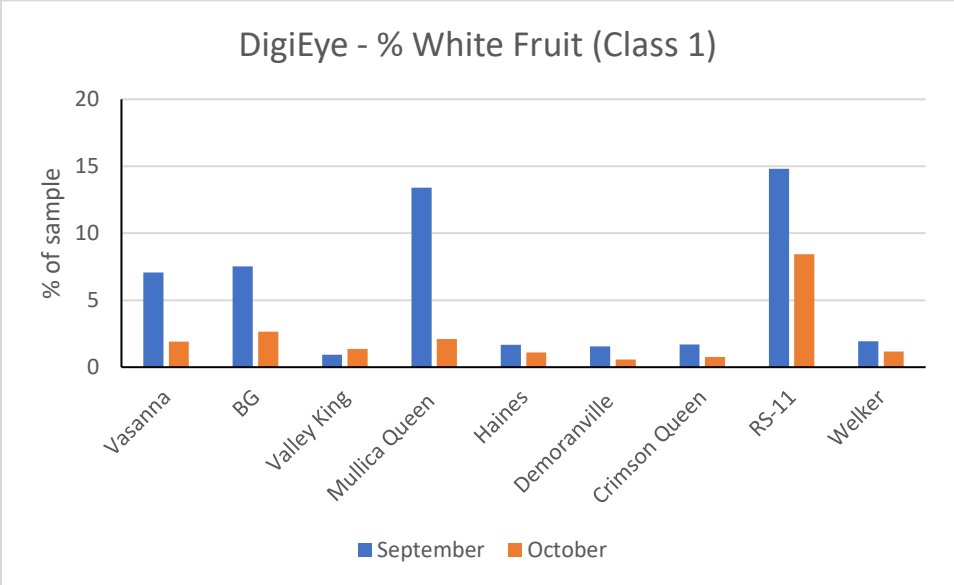


Figure 6. Amount of class 1 (White fruit) harvested in September and October, 2020 for 9 different cranberry varieties grown at the BC Cranberry Research Farm in Delta, BC. All fruit were hand harvested.

Suggested Next Steps

Based on the past 6-years of harvest data from the BC Cranberry Research we propose the following next steps for the next 3 to 6 year period

- Continue to collect yield data in the same manner since 2015
- Add regular phenology data collection to the yearly assessment, with particular attention paid to early season (to bloom), and out of bloom timing
- Examine canopy characteristics of the different varieties focusing on the released varieties that are most commonly grown
- Add new plantings of Mullica Queen, Crimson Queen, Haines, Welker, Vasanna in 2021-2022 – as this will allow for a comparison of canopy characteristics for a variety across different ages (e.g. 2013, 2015, 2016, and 2022 plantings)
- Explore fertilizer response of the different varieties (this may include some greenhouse trials to isolate the fertilizer response from interactions in the soil)

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