Activities at the Cranberry Research Farm: April 1 to November 26, 2016

FINAL REPORT-2016

Prepared for: Cranberry Research Farm (Grant Keefer and Todd May) and Cranberry Commission and Research Committee

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Objectives: The objectives of the third field season at the BC Cranberry Research Farm were to continue to document the phenology, growth, management and yield of the various cranberry varieties from the Rutgers University (New Jersey) and Valley Corporation (Wisconsin) breeding programs. Additional opportunities for research and extension at the farm were also explored via two demonstration trials examining fungicides for fruit rot control (Bog 1) and nematodes for cranberry girdler control (Bog 4).

Activities: To achieve these objectives regular site visits were made to the research farm throughout the 2016 growing season (Table 1 and 2). Weekly site visits were also made by the E.S. Cropconsult crew for pest management monitoring. In Bog 4, we also began a demonstration trial for girdler control (Table 3).

Table 1. Summary of activities in Bog 1 (Planted with released and numbered varieties from the Rutgers University breeding program).

Date	Type of Activities	Specific information collected
April 15	Data collection	Phenology – bud development
May 12	Data collection	% Bloom
May 26	Data collection	% Bloom
June 4	Data collection	% Out of bloom
June 24	Data collection	% Out of bloom
August 22	Berry collection	Yield
August 26	Sample collection	Foliage collection for foliar nutrient analysis
August 27	Data collection	Over Growth
September 2	Sample collection	Soil collection for nutrient analysis
September 22	Berry Collection	Yield
September 29	Sample collection	Brix, TACY, ABS, Firmness
October 4 and 5	Berry Collection	Fungicide Trial Berry Harvest for Rot and Yield

October 11	Berry Collection	Harvest of berries following flooding and beating

Table 2. Summary of activities in Bog 2 (Planted with released and numbered varieties from Rutgers University and Valley Corporation breeding programs).

Date	Type of Activities	Specific information collected
May 6	Data collection	Bloom presence and absence
May 19	Data collection	% bloom
May 26 and 27	Planting	Fruit rot resistant varieties from Rutgers University breeding program
June 24	Data collection	Crop phenology
July 9	Data collection	Tip worm cupping, berry reddening, overgrowth
August 27	Data collection	% overgrowth
September 2	Sample collection	Soil collection for nutrient analysis
September 27 and 29	Berry collection	Yield assessment

Table 3. Summary of activities in Bog 4 (Planted with locally-sourced Stevens in 201X).

Date	Type of Activities
May 27	Girdler pheromone trap lines set up in Bogs 3 and 4
July 14	Plots laid out (each plot is 150 m2)
July 21	Girdler adults and eggs added to plots
August 2	Nematode Application
August 2 to 8	Sprinklers run to keep soil moist and support nematodes
September 2	Soil collection for nutrient analysis

Standard Operating Procedure Development

In 2016 we continued to develop Standard Operating Procedures (S.O.P.) for the various data collection activities at the farm. These SOPs are being developed so that data are be collected in a similar manner in subsequent years. In 2016 we finalized protocols for recording bud phenology, calculating % bloom and out-of-bloom, and assessing fruit quality post-flooding.

A. Bud Phenology

Terminology used to describe cranberry bud phenology was based on the descriptions and drawings in Workmaster and Palta 2006 (Figure 1 therein). In Bog 1, bud phenology was determined by walking through the middle of the plot, stopping at five random intervals, and observing buds in a 25X25 cm quadrat for 30 seconds. The stages of all the buds observed during the time interval was recorded. For Bog 2, the process was similar but with only two random stops in the approximate centre of each

plot. Dominant phenological stage(s) observed consistently across the random stops are then presented (see Findings to Date). If no stage is clearly dominant then the range of stages starting from least developed to most developed (as per Workmaster and Palta 2006) are presented.

B. Bloom and Out-of-Bloom Calculations

Bloom was determined by selecting flowering uprights that were growing along a transect running through the middle of each plot. In Bog 1, we took 7 samples of 10 random flowering uprights/plot and in Bog 2 we took 2 samples of 10 random flowering uprights/plot. We calculated % bloom using the following formula

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

% Out-of-bloom was determined by selecting random flowering/fruiting uprights that were growing along a transect running through the middle of each plot. In Bog 1, we took 7 samples of 10 random flowering/fruiting uprights/plot and in Bog 2 we took 2 to 5 samples of 10 random flowering/fruiting uprights/plot. We used the following formula to determine % out-of-bloom

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

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C. Yield and Quality Assessment Pre-Flooding

The first step in yield assessment is to determine the dates for collection. Bog 1 has had multiple collection dates/year occurring approximately around the 20th of August and September in 2015 and 2016, and then with an additional collection as close to the week of flooding as possible. Bog 2 has only had a single harvest and this has happened around the 27th to 29th of September. A major goal of the variety trials is to determine fruit quality. Thus it is important to ensure that once berries begin to size that there is minimal walking on the plots.

1) Collect fruit from 1 foot square – using a metal quadrat with solid sides and legs

2) Collect ALL fruit from 1 foot square into labelled PAPER bag, i.e. ensure you collect right down to soil level and not just surface fruit. (NB: Paper bag supplier used in 2015 to 2016 - Bulldog

3) Collect from three spots in Bog 1 (for first collection toss a ring into the plot from the pathway. Work between the North and South sprinklers of each plot and at **least 3 m** from East and West edges. This will mark the three random spots for first collection and the approximate sites for the subsequent collections). Collect from two spots in Bog 2 – placing square randomly in the centre of each plot **(1 m from edges).** Flag the centre point of each collection area so that subsequent collections do not overlap.

4a) Ideally berries are collected in the early morning (before 10 am) and placed in fridge/shade within one hour of collection. This is especially important for the final assessment when fruit rot at harvest and post harvest is also assessed. Avoid having picked berries siting in the sun in the paper bags. Take out a cooler with ice packs to get berries cooled more quickly.

4b) IF heavy rains occur during harvest then fruit should be collected in the field into plastic bags - use waterproof paper to ensure plot information stays with fruit. Return fruit to farm building and pour into labelled paper bags that have been lined with paper towel. Place additional paper towel layers into bag if the number of berries going into the bag is large. Ensure that berries are not squished as they are handled. However, not drying berries could result in over estimates of field rot.

4c) Fruit should be assessed within 30 days of harvest. Fruit can be stored at 4oC if it cannot be assessed directly Stressed fruit, e.g. fruit picked under extreme heat or rainfall, should be assessed ASAP.

5) For assessment the following supplies are needed - a scale that can weigh to 0.01g at a minimum. For this work we work with a scale that can weigh to 0.001g. The more accurate the scale the better the subsequent yield estimates will be. Screens - a 9/32" inch screen and a 1/2" inch screen. Containers for the screens to sit and catch berries. A series of containers to hold the different categories of berries.

6) Get the total weight of the entire sample

7) Pour and shake berries over the 9/32" inch screen. Count and weigh the berries that do not pass through; these meet the minimal size for Oceanspray.

8) Separate out any berries with rot or insect feeding (count and weight these as you will subtract them from your marketable count).

9) Count and weigh berries that pass through the screen as these are undersize. For undersize discard obviously dead fruit that look pinhead sized (these are aborted fruit).

10) For berries that do not pass through the 9/32" screen, after they have been counted and weighed (Step 7) and insect damage/rot removed (Step 8) pour the remaining berries through the 1/2" screen. This corresponds to the minimum SDC size of 3. (NB: additional screen sizes ¾" (19mm) and 5/8" (16mm) correspond to SDC #1 and #2 – and these can be used in the future).

11) SDC screens are round so ensure that you have a single layer of fruit in the screen bottom – otherwise you will overestimate the category. Additionally because the edges of the screens are only partial squares smaller fruit can be caught up along edges. So care must be taken at this step. If there is more fruit than a single layer then put the excess fruit back in the bag for a second measurement.

12) Weigh all the berries that do not pass through the 1/2" screen. This will allow for calculation of the % marketable weight that meets the additional criteria for sweeten dried cranberry production.

13) Before discarding fruit ensure that no further analyses are needed – e.g. Brix, Tacy, ABS, keeping quality. Fruit can be frozen for the Brix, Tacy, ABS – freeze 500g (1 lb) of fruit/collection bag (however confirm with Oceanspray if they will accept a frozen sample or prefer fresh).

D. Fruit Quality Post Flooding and Beating

Fruit quality following harvest practices can also be assessed. This must be done on the day that flooding and beating is done and before the water level in the bog is raised and berries begin to move around. Depending on the practices being evaluated berries can be held in flood water or be assessed right away. In addition to the supplies needed above for the Pre-flooding Assessment plastic bucket, metal colanders, Ziploc bags and rain paper are needed for this activity (Fig X).

1. **Take samples at three random locations within the middle of each plot (use the sprinkler line running through each plot as guide).** Sample by placing colander below water surface and fill with berries. Try to minimize large debris. Try and sample shortly after beating to minimize any additional factors exacerbating rot (e.g. prolong exposure to sunlight after flooding).

2. Raise colander to drain water and determine if more berries are needed. Fill colander to a level layer even with the rim (Fig. 1a). Do not heap cranberries above rim.

3. IF holding cranberries, then place them into a plastic bucket that is pre-labelled. Rain paper is the best as it can be placed right into the bucket (Fig. 1b).

If not holding cranberries, then berries can transferred to a pre-labelled plastic Ziploc bags.

5. IF holding cranberries, then buckets should be filled with water so that berries are standing in water. Buckets are placed inside the farm building out of direct sunlight (Fig. 1c)

6. Assess fruit rot by collecting a 125 mL (1/2 cup) sample of berries from the bucket at regular intervals for at least one week and no more than two weeks

7. Record the total number of berries in the 125 mL sample and the number of berries with rot. Weigh total berries and rotted berry weight.

Figure 1. A (Top Left) – Cranberries collected from field are placed in a metal colander, water is drained out and cranberries are filled to rim level. B (Bottom Left) – One colander of cranberries is placed in a bucket with water proof paper. C (Right) – Cranberries are then held in the farm building out of direct sunlight for at least seven days to observe degradation of fruit quality in water.

Additional Demonstration Trial Work

In addition to the data collection activities for assessing performance of varieties there were two additional demonstration trials conducted over the course of the 2016 field season.

Fungicide Trial (Bog 1 Fungicide Treatments and Bog 2 Untreated Comparison): A fungicide trial was conducted in Bog1 to test the efficacy of different fungicide programs

(Table 4) in reducing fruit rot. Treatments were laid out in all 10 plots in Bog 1 following the same pattern (Fig. 2). However, we assessed the efficacy of these combinations on reducing fruit rot in only seven of the varieties: Mullica Queen, Crimson Queen, Haines, Welker, Demoranville, BG, and Willipa Red. We took three 1-foot square samples of berries from each of the six treatment areas in these seven plots on October 4 and 5, 2016. Samples were processed as described above (Yield and Quality Assessment Pre-Flooding). We compared rot levels for each variety among the six treatments and (when possible) against the untreated berries harvested from Bog 2 for the same varieties. Berries were also examined for any indications of phytotoxicity such as discoloration or splitting.

Table 4. Summary of fungicide treatments tested for fruit rot protection in Bog 1.

Treatment location (on map – Fig. 2)	**Fungicide Treatment**	**First Application: Product, Date and Method**	**Second Application: Product(s), Date and Method**	**Third Application: Product(s) Date and Method**
2	Bravo	Bravo, May 17 via Chemigation	N/A	N/A
3	Bravo + Proline	Bravo, May 17 via Chemigation	Proline, June 6, via boom sprayer	N/A
1	Bravo + Quadris	Bravo, May 17 via Chemigation	Quadris, June 6, via boom sprayer	N/A
6	Bravo + Quadris/Proline Tank Mix	Bravo, May 17 via Chemigation	Quadris+Proline June 6 via boom sprayer	N/A
4	Bravo+ Quadris +Quadris	Bravo, May 17 via Chemigation	Quadris, June 6, via boom sprayer	Quadris, June 16, via boom sprayer
5	Bravo + Quadris/Proline Tank Mix + Quadris/Proline Tank Mix	Bravo, May 17 via Chemigation	Quadris+Proline June 6 via boom sprayer	Quadris+Proline June 16 via boom sprayer

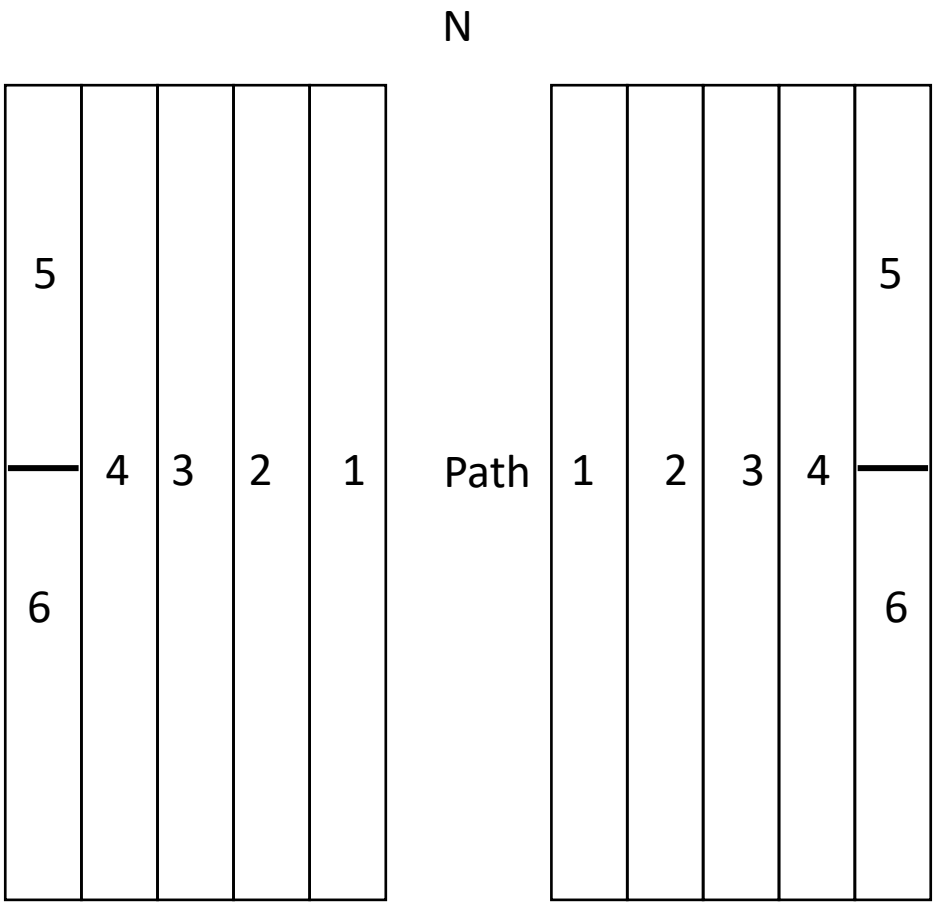


Figure 2. Layout of treatments for fungicide trial in Bog 1 (plots shown are East and West of the central path). Treatment layout was the same for each of the 10 plots in Bog 1. Numbers correspond to treatments – 1: Bravo+Quadris; 2: Quadris; 3: Bravo+Proline; 4: Bravo + Quadris + Quadris; 5: Bravo + tank mix of Quadris +Proline + tank mix of Quadris +Proline; 6: Bravo + tank mix of Quadris +Proline (see Table 4).

Girdler Control with Nematodes Demonstration (Bog 4): A multi-year trial was initiated in Bog 4 to evaluate the long-term effectiveness of different nematode treatments for cranberry girdler *(Chrysoteuchia topiaria)* control. The trial consisted of three treatments: 1) Control, 2) 2 billion nematodes applied every two years and 3) 1 billion nematodes applied every year. There were six replicates for each nematode treatment and 14 replicates for the Control, with treatments randomly assigned to plots. Plots were 10m wide X 15 m long and were placed along the east edge (starting at the third sprinkler) and part way up the west edge (starting at the third sprinkler) of the field. On July 16, we released a small colony of girdler eggs along with one or two gravid female moths into each plot. Releases were made in the centre of each plot. On August 2, we released 1 billion nematodes/acre into plots 3, 10, 14, 20, 21, and 29; and 2 billion

nematodes/acre into plots 1, 8, 13, 15, 24, and 27. Nematodes were mixed with irrigation water into a tank and were watered on with hose. A small sample of nematodes was collected from each tankful and nematodes were inspected under a dissecting to microscope to confirm mobility and general quality. The number of nematodes needed to treat all six plots at the two different rates were diluted into the tank. The sprayer was calibrated prior to adding nematodes to determine the amount of time required to thoroughly wet plots (approximately 30 gallons of water/plot). Before nematode application, Bog 4 was irrigated thoroughly to ensure that soil moisture levels were high. Soil moisture levels were maintained at high levels for the week following nematode application.

Findings to date:

General observations

1) Pest management: A weekly pest monitoring program was run by E.S. Cropconsult Ltd. during 2016. Scouts monitored the farm on Fridays which allowed them extra time to help with any other research or data collection activities. Blackheaded fireworm (*Rhopobata naevana*) larvae and adult males (in pheromone traps) were observed in all four fields. Cranberry fruitworm (*Acrobasis vaccinii*) adult males were observed in pheromone traps placed in Bogs 1 and 4. Insecticide applications for cranberry fruitworm were based on pheromone trap catches. Fruit was collected and submitted to the ministry but no eggs or other evidence of fruitworm activity were found (T. Heuppelsheuser, BC Ministry of Agriculture, personal communication, October 2016). We did however observe the characteristic fruitworm damage on berries in the field - along the West edges of both Bogs 1 and 2. Cranberry tipworm (*Dasineura oxycoccana*) were very low all season long, with minimal damage observed in the field and no eggs or larvae observed under microscope examination on 3 separate dates. Cranberry girdler (*Chrysoteuchia topiaria*) counts were higher in all four fields compared to 2015 counts.

Pest management recommendations for 2017:

- Continue with weekly pest monitoring program using combination of visual observation and pheromone trapping. If warranted, include intensive tipworm monitoring during bloom to determine if post-bloom applications are needed. Research farm tipworm counts could be done separately on Fridays - and a scope should be obtained to be at the farm permanently.

- Pest monitoring to include calculation of % bloom and out of bloom to time both fungicide and (if necessary) tipworm sprays. For Bog 1 this could be done on a per plot basis. For Bog 3, this could be done separately for the East and West halves of the field. For Bog 2, it will be very challenging to determine spray timing

based on bloom phenology because of the many varieties being grown. Timing could perhaps be based on the earliest and latest blooming varieties.

- Nematode treatment schedule be developed and implemented for Bogs 1, 2 and 3 for girdler control, with the first applications occurring in 2017. (These applications would be occurring independently of the girdler trial).

- An alternate type of pheromone trap should be explored as the white wing traps are consistently destroyed at the research farm by coyotes.

2) Nutrient management:

Table 5. Soil fertility status of Bogs 1, 2 and 4 (September 2, 2016 collection)

Bog	pH	Est. E.C. Mmhos cm	O.M. %	Total N%	C/N	Bray Avail P ppm	Avail K ppm	Avail Ca ppm	Avail Mg ppm	Avail Na ppm	Avail Cu ppm	Avail Zn ppm	Avail Fe ppm	Avail Mn ppm	Avail B ppm
1	3.6	0.58	85	0.87	48.9	15	125	1500	1038	250	1.0	12	85	7.5	1.3
2	3.5	0.58	88	0.99	44.4	7	125	1250	1213	238	0.8	8.8	84	8.3	1.0
3	3.4	0.60	87	1.03	42.2	4	113	1250	963	225	0.8	7.8	75	3.5	0.5
4	4.0	0.64	86	1.11	38.7	6	113	1188	988	200	1.0	7.8	64	6.3	1.6

Bog 1. Summary of Observations.

- Dr. Nick Vorsa observed that all varieties in Bog 1 appeared to be healthy on September 29, 2016. However, foliar nutrient data (Table 6) suggests that NPK concentrations in leaf tissue are below the optimal range as used in Massachusetts. This suggests that optimal nutrient ranges for production at the Cranberry Research Farm may be unique. Dr. Vorsa recommends we explore this further in 2017. (See handout prepared by Dr. Vorsa for September 29, Field Day)

- We observed that the sequence of when certain varieties bloom compared to each other was different from last year. For example, in 2015 Haines and Welker were the last varieties to bloom and had relatively long bloom periods. In 2016, however, Welker started blooming at approximately the same time as Mullica Queen (Table 7). Although, relatively, the last variety to bloom, Haines was not as far behind Mullica Queen in 2016 as it was in 2015.

- At the end of August overgrowth was highest in Crimson Queen and CNJ99-9-25; vines covered 25% or more of the surface 1 square-foot plots. However, in all four bogs we observed higher levels of overgrowth in the south end of each bog. So the higher levels of overgrowth in Crimson Queen and CNJ99-9-25, in Bog 1, could be related to the south location within the bog, rather than variety differences.

- In terms of yield, there were dramatic differences in the performance of some varieties in 2016 compared to 2015. In 2015, the top yielding varieties, based on square-foot estimates, were Haines, Welker, and CNJ99-9-25 (Fig. 3 – compare 2015 bars). In 2016, production declined in Haines and Welker although both varieties were estimated to produce over 300 barrels/acre. Production in CNJ99-9-25 was fairly consistent between the two years and estimated to be over 400 barrels/acre (based on October 5 harvest)

- Varieties that saw an increase in production in 2016 compared to 2015 were Mullica Queen, Demoranville, Willipa Red, and BG (Fig. 3). Mullica Queen also had an estimated harvest on October 5 of over 400 barrels/acre (Fig. 3)

Table 6a. Foliar macronutrients for plots in Bog 1. Uprights were collected on August 26, 2016 (Data courtesy of PSAI Inc., Richmond BC)

	Nitrogen %	Phosphorus %	Calcium %	Magnesium %	Potassium %
Crimson Queen	0.84	0.07	2.25	0.34	0.31
CNJ99-9-25	0.96	0.08	2.00	0.29	0.28
Mullica Queen	0.79	0.06	1.65	0.39	0.21
Haines	0.68	0.07	1.80	0.29	0.26
Demoranville	0.64	0.06	1.65	0.29	0.30
Welker	0.62	0.06	1.75	0.32	0.26
Scarlet Knight	0.71	0.07	1.75	0.39	0.27
CNJ99-52-69	0.60	0.06	1.50	0.22	0.23
BG	0.77	0.06	1.20	0.27	0.26
Willipa Red	0.58	0.06	1.15	0.23	0.34

Table 6b. Foliar micronutrients for plots in Bog 1. Uprights were collected on August 21, 2015 (Data courtesy of PSAI Inc., Richmond BC)

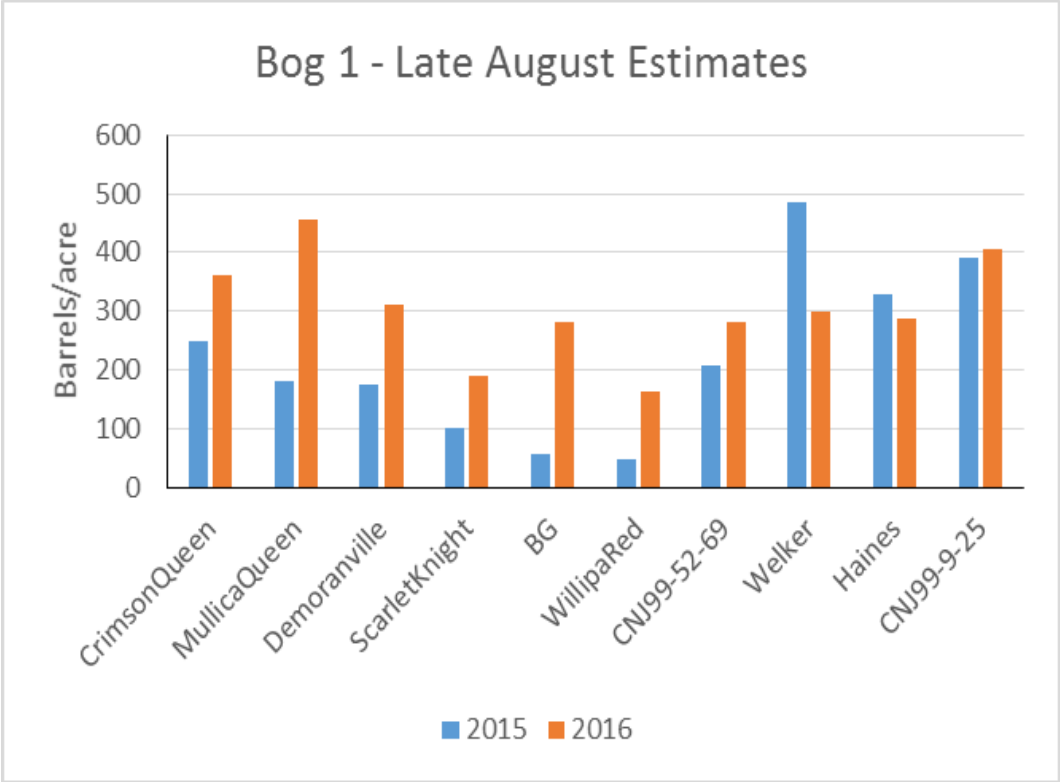
	Copper (ppm)	Zinc (ppm)	Iron (ppm)	Manganese (ppm)	Boron (ppm)
Crimson Queen	3	31	135	208	41
CNJ99-9-25	3	30	155	215	47
Mullica Queen	3	32	125	138	52
Haines	3	25	130	88	38
Demoranville	3	28	145	100	40
Welker	2	27	135	93	47
Scarlet	3	36	140	108	42

Knight					
CNJ99-52-69	3	22	150	93	48
BG	2	22	160	125	55
Willipa Red	2	21	110	105	34

Table 7. Crop development observations for cranberry varieties planted in Bog 1.

	Elongation on **April 15**	% Bloom on **May 12**	% Bloom **May 26**	% out of bloom **June 4**	% out of bloom **June 24**	Overgrowth*
Crimson Queen	Yes	18	68	50	73	Between 25 and 50%
CNJ99-9-25	No	14	49	25	65	Between 25 and 50%
Mullica Queen	Yes	15	35	50	63	<5%
Haines	No	5	30	<5	38	<5%
Demoranville	No	6	33	25	57	<5%
Welker	No	16	46	10	67	<5%
Scarlet Knight	Yes	25	48	50	63	25%
CNJ99-52-69	Yes	15	27	10	48	Between 5 and 25%
BG	Yes	15	39	20	48	<5%
Willipa Red	No	19	31	<10	51	<5%

* Measured as the % of a 1 square-foot plot covered with vine overgrowth on August 27. Values are the average of 3 square-foot plots/variety. Plots were scored into one of four categories: <5%, 6 to 25%, <25% to <50%, 50%+ (reference plot for 50%+ cover with over growth was Stevens in Bog 1).



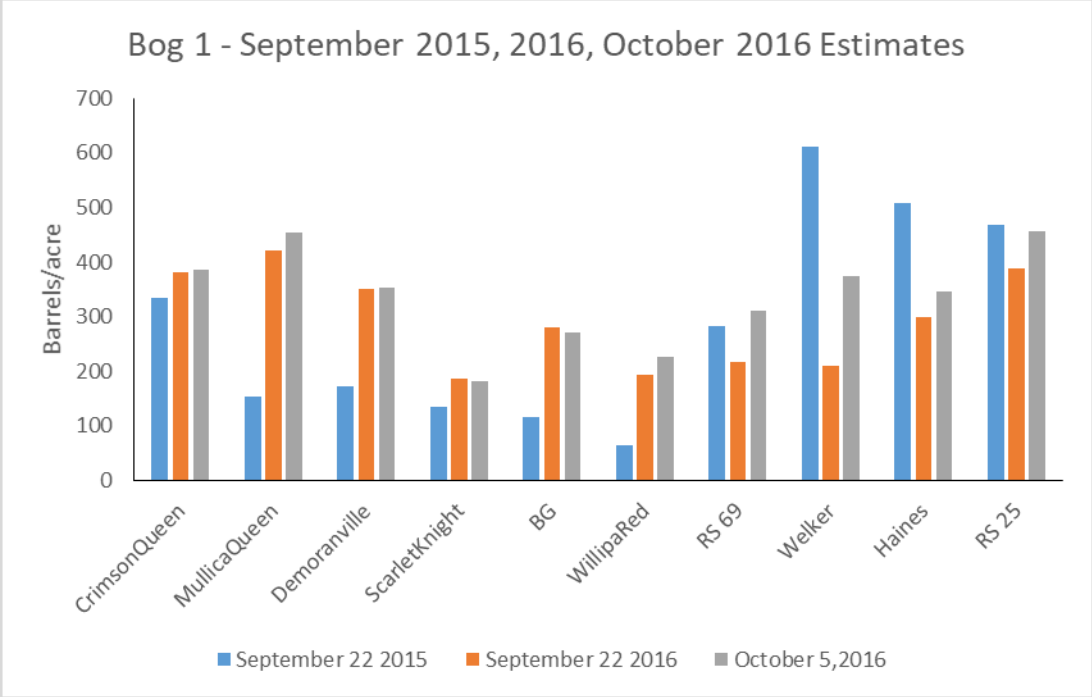


Figure 3. Bog 1 yield estimates based on square foot harvests from three locations in each variety plot in late August, 2015 and 2016 (top) and late September 2015, 2016, and October 5, 2016 (bottom). NB – BG and Willipa Red Varieties were planted later than the other varieties.

Table 8. Bog 1 berry characteristics based on Oceanspray Canada parameters for ABS, TACY and Brix. (Data courtesy of Oceanspray Canada, Richmond, BC).

	BRIX	TACY	Firmness
Crimson Queen	9.66	65	862.9
CNJ99-9-25	9.44	70	832
Mullica Queen	9.79	65	832.4
Haines	9.66	80	935.1
Demoranville	10.30	70	902.1
Welker	10.21	79	909.6
Scarlet Knight	10.21	118	777.1
CNJ99-52-69	9.86	86	755.2
BG	10.16	68	762.2
Willipa Red	9.83	75	782.9

Fungicide Trial (Bog 1 Fungicide Treatments and Bog 2 Untreated Comparison)

Overall levels of fruit rot were quite low at the cranberry research farm in 2016. Levels of fruit rot in Bog 2, which was untreated were similar to fruit rot occurrence in Bog 1, for Demoranville, Haines, Crimson Queen and Mullica Queen (Table 9). However, for Welker we did observe dramatic differences in fruit rot levels - 21.92% of total fruit weight consisted of rotted fruit in the Bog 2 samples. But following any type of fungicide treatment the amount of fruit rot dropped to below 15% (Table 9) for Welker in Bog 1. The lowest levels observed were in the Bravo + Proline and Bravo + 2 Quadris treatments (Table 9). It is important to note that within the same variety the range of rotted fruit relative to total fruit weight overlaps for almost all of the fungicide treatments (Table 9 – compare the values in brackets). This suggests that even if there are slight differences in the average amount of fruit rot, the differences are unlikely to be statistically significant.

Rotted fruit was separated out from fruit that clearly had mechanical damage. Nevertheless some of the patterns within a variety suggest that location of the fungicide treatment may have contributed to higher levels of rot, due to the amount of mechanical damage. For example, for several of the varieties the tank mix treatments had some of the highest levels of rot (e.g. BG, Demoranville, Welker, and Crimson Queen). All of these plots are located adjacent to the field edges (Fig. 2). Vines located next to the field edge experience the most foot traffic for activities like pest scouting, for example. A design that allows for randomization of treatments within a smaller area and controlled foot traffic could help to control for these factors in future trial. Additionally, focusing fungicide work on Mullica Queen and Demoranville would allow for replication across Bog 1 and Bog 3.

While we did observe some fruit spotting there were no symptoms that were consistent to one treatment. Further the amount of spotted fruit was very low, <1% of all the fruit collected and sorted. We did not observe any evidence of splitting.

Table 9. Summary of fungicide treatment effects on fruit rot occurrence in seven different cranberry varieties. Values represent the % of total fruit weight harvested from a 1 square foot sample that was assessed to be rotten (% fruit rot based on weight). Values are the average of three samples/variety (Bog 1) or four samples/variety (Bog 2). Values in parenthesis are the lowest and highest % rotten fruit observed among the samples.

	BG	Demoranville	Welker	Haines	Crimson Queen	Mullica Queen	Willipa Red
Control (Bog 2)	N/A	3.28% (1.09 to6.13)	21.92% (4.84-41.95)	4.49% (0.52 to 10.42)	7.49% (3.50 to 12.23)	2.78%	N/A
Bravo	14.58% (10.23 – 21.96	3.00% (2.06-3.67)	3.32% (1.33-6.05)	1.82% (0.18-3.19)	6.10% (5.04-6.92)	2.53% (0.14-5.39)	9.53% (1.50-17.41)
Bravo+ Quadris	11.22% (5.56-14.67)	4.59% (2.72-6.31)	6.02% (4.85-8.15)	0.47% (0-1.05)	11.70% (9.07-13.18)	3.34% (0.83-5.93)	2.34% (1.52-3.16)
Bravo + Proline	6.66% (3.32-11.04)	2.38% (0-4.13)	1.75% (0.45-4.24)	1.85% (0.96-3.38)	5.67% (5.57-5.58)	2.04% (0.84-3.76)	15.91% (0.47-31.40)
Bravo + Proline/Quadris Tank Mix	15.74% (8.24-29.20)	5.00% (3.63-7.00)	13.13% (0.17-37.40)	1.84% (1.14-2.30)	7.02% (1.75-17.48)	2.70% (1.99-3.65)	8.9% (0.35-23.47)
Bravo + Quadris + Quadris	26.96% (8.91-43.20)	3.30% (2.36-3.80)	1.94% (1.12-2.50)	4.40% (3.23-6.52)	4.95% (3.51-5.81)	2.81% (1.04-3.92)	2.93% (0.54-5.97)
Bravo + Proline/Quadris Tank Mix + Proline/Quadris Tank Mix	44.39% (30.61-63.12)	7.54% (2.10-15.43)	8.75% (3.54-14.94)	0.48% (0-1.00)	11.59% (4.23-20.52)	6.36% (3.10-9.91)	6.61% (3.53-8.37)

Bog 2. Summary of Observations

Rutgers Breeding Program: Bog 2 consists of repeats of released varieties (Demoranville, Scarlett Knight, Crimson Queen, Mullica Queen, Haines, and Welker) from the Rutgers breeding program along with a number of unreleased varieties. In 2016 we focused our data collection efforts on those unreleased varieties that showed promise in 2015 and have been proving to be promising for different reasons in other

growing regions. These are the varieties most likely to be released in the future by Rutgers.

- The four top yielding unreleased varieties were RS (Rutgers Selection) 71, RS155, RS18 and RS11 – with estimated yields (end of September harvest) of 294 to 394 barrels/acre (Fig. 4)

- Levels of fruit rot were under 10% for all four varieties (Fig. 5)

- Brix and firmness levels were within the acceptable ranges (Table 9)

- Interestingly, RS11 had a very low TACY score relative to other varieties in Bog 2 or 1 (Table 9); this suggests that it may be a good candidate for late season harvests

- Among these four varieties we observed high levels of overgrowth (average score of 3 or between 25 and 50% cover with runners) at the end of the season (August 27) in RS18. The remaining varieties had overgrowth scores of 2 or less (<25% cover with runners). In 2017, it would be good to take foliar nutrient samples from these four varieties as well as to track more closely other growth parameters.

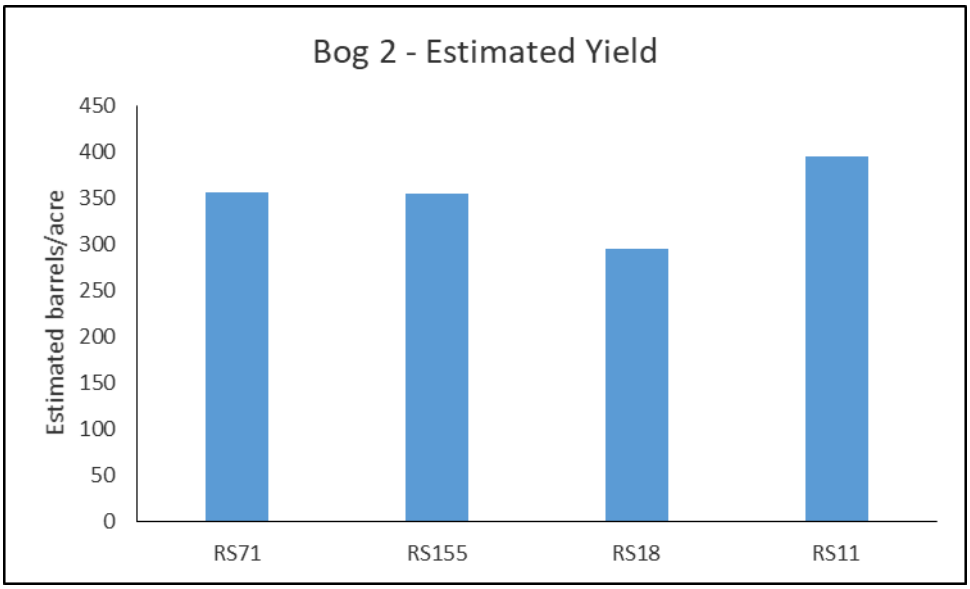


Figure 4. Bog 2 yield estimates from four focal unreleased varieties from the Rutgers breeding program. Data are based on two 1ft^2 plots harvested from two locations/ plot/variety; each variety has two plots.

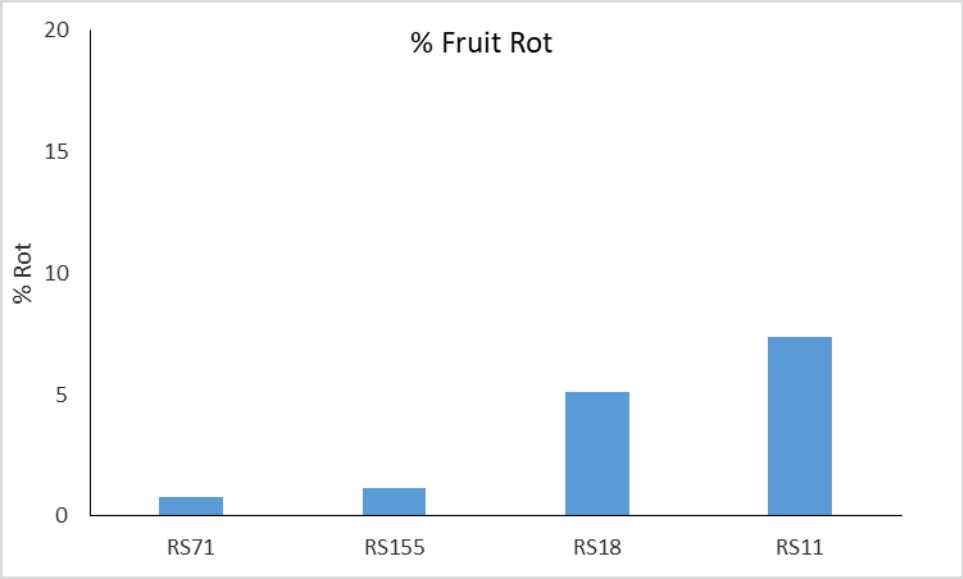


Figure 5. Fruit rot from berries harvested from four unreleased varieties in Bog 2. Data are based on two 1ft^2 plots harvested from two locations/plot/variety; each variety has two plots.

Table 9. Bog 2 berry characteristics, from four focal unreleased varieties from the Rutgers breeding program, based on Oceanspray Canada parameters for ABS, TACY and Brix. (Data courtesy of Oceanspray Canada, Richmond, BC).

	BRIX	TACY	Firmness
RS71	10.8	85	653
RS155	10.47	53	799
RS18	9.99	85	811
RS11	9.68	30	785

Wisconsin Breeding Program: 2016 was the first year that yield and berry characteristic data were collected from the six varieties from the Wisconsin breeding program.

- The top yielding variety was Valley King – with an average yield of 260.36 barrels/acre. Valley King is commercially available from the Wisconsin breeding program (Fig. 6)
- Fruit rot levels were below 10% for all Wisconsin varieties (Fig. 7)
- Berry characteristics for Wisconsin varieties were similar to those from the Rutgers program and were consistent with traits preferred by Oceanspray (Table 10); Valley King had the lowest TACY score which might make it another candidate variety for late season harvest

- In 2017, it is recommended that more detailed phenology and bloom data be collected on the Wisconsin varieties, along with foliar tissue sampling for nutrient analysis

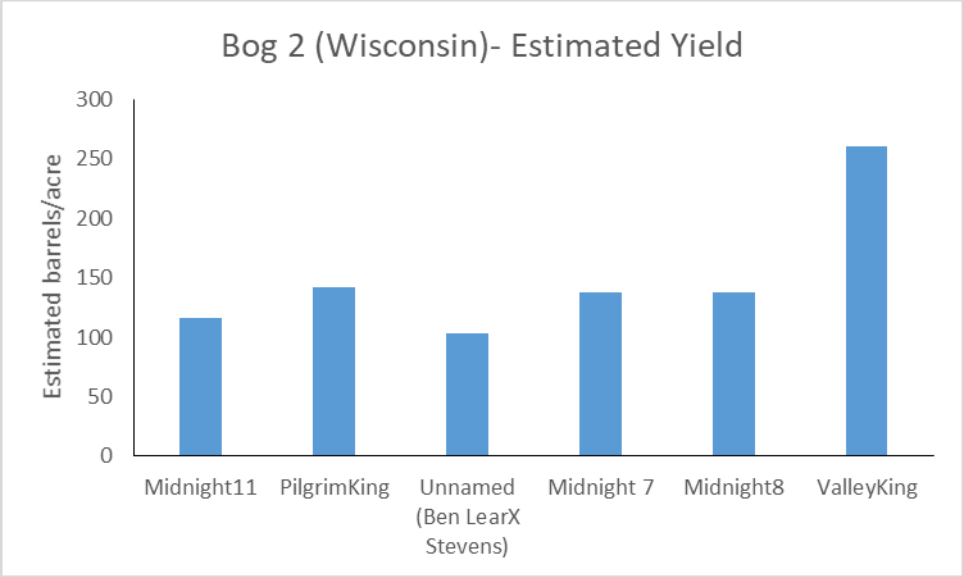


Figure 6. Bog 2 yield estimates from six varieties from the Wisconsin breeding program. Data are based on two 1ft^2 plots harvested from two locations/ plot/variety; each variety has two plots.

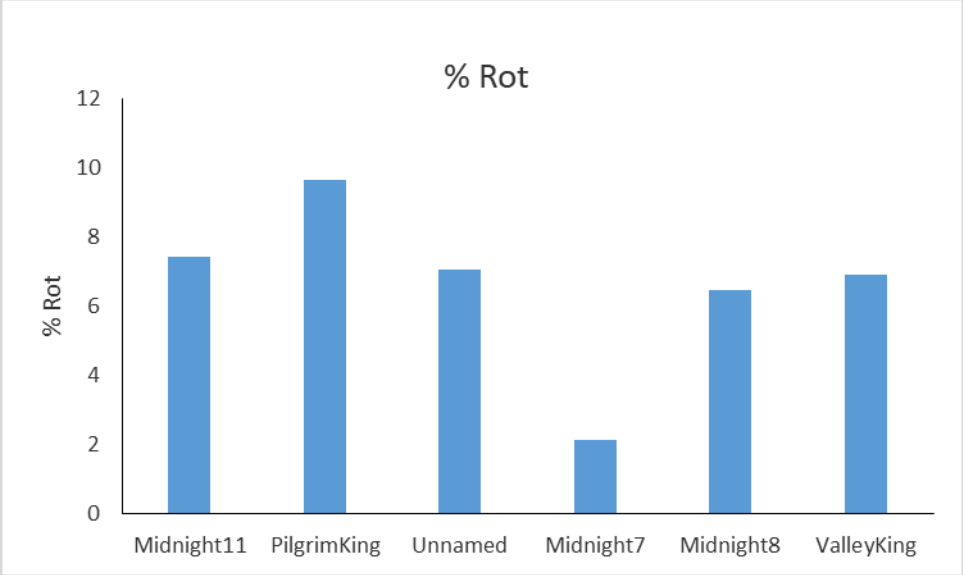


Figure 7. Fruit rot from berries harvested from six varieties from the Wisconsin breeding program (Bog 2). Data are based on two 1ft^2 plots harvested from two locations/plot/variety; each variety has two plots.

Table 10. Bog 2 Wisconsin varieties berry characteristics based on Oceanspray Canada parameters for ABS, TACY and Brix. (Data courtesy of Oceanspray Canada, Richmond, BC).

	BRIX	TACY	Firmness
Midnight11	11.08	111	749.9
PilgrimKing	10.53	72	850.8
Unnamed (Ben LearX Stevens)	11.17	67	893.3
Midnight 7	11.5	94	765
Midnight8	11.72	108	787.1
ValleyKing	10.23	53	746.9

Bog 4. Girdler Trial Summary - In Progress

In late September, plots were inspected for any signs of girdler larva activity in Control plots, for example colour changes in uprights indicating feeding damage on roots. We did not observe any symptoms at that time. Cranberry girdler is a challenging pest to work with, and the low infestations in Bog 4 (even with pest introduction) may not results in symptoms of feeding damage on uprights.

The impact of nematode treatments on girdler populations in Bog 4 will also be assessed in late June/early July 2017 with girdler walks in each plot. Girdler walks are used during crop scouting as a way to identify girdler hotspots. As the moths are relatively week flyers conducting walks in the areas of the egg and moth releases should provide some indication of the success of a) our egg releases and b) nematode treatments. It is expected that it may take several years of egg releases in order to build sufficient girdler populations to make comparisons feasible.

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