

Preliminary results from evaluating new cranberry cultivars under Massachusetts growing conditions

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Abstract

Massachusetts (MA) cranberry growers are reliant on native cultivars like 'Howes' (1843) and 'Early Black' (1852). The project, conducted at the UMass Cranberry Station, East Wareham, USA, aims to increase the profitability and sustainability of the MA cranberry industry by evaluating 12 new hybrid cultivars for improved yield, fruit quality, disease resistance, and size. Propagation and planting of the new cultivars was started in March and June of 2021, respectively. The trial was a randomized complete block design with four replications per treatment and buffer zones between the plots. Standard cultural practices for new plantings regarding irrigation, fertilization, pest control, and canopy management were followed. In 2022, fruit were removed from the vines to allow maximum resource allocation for canopy growth. The first fruit harvest was in 2023, and yield was measured by picking all fruit within a 0.09-m² quadrat. The fruit samples were then sieved through an 8-mm opening to remove undersized berries; the remaining berries represented the yield of marketable berries. Additional samples (~500 g) were collected from each treatment replication for fruit quality analysis. In terms of yield, 'Haines[®]', 'Welker[™]', and 'Crimson King' had the highest yield, while 'Vassana[®]' and 'HyRed[®]' performed poorly, with the other cultivars in the mid-range. 'Scarlet Knight[®]', 'HyRed[®]', and 'Midnight 8' had the best fruit color, while 'Badgers', 'Granite Red', 'Sundance[®]', and 'Pilgrim King' had poor fruit color. The highest fruit rot incidence was observed in 'HyRed[®]', 'Welker[™]', and 'Vassana[®]', while 'Granite Red', 'Mullica Queen[®]', 'Badgers', and 'Sundance[®]' had the lowest incidence. The fruit size measured as fruit weight was largest in 'Crimson King', and 'Pilgrim King'. In conclusion, first-year data showed differences in the performance of the cultivars under MA growing conditions. Further data spanning multiple years is required to guide growers with comprehensive recommendations.

Keywords: *Vaccinium macrocarpon*, yield, fruit color, fruit rot, internal quality

INTRODUCTION

Cranberry production has a long history in Massachusetts (MA), adding significant economic and aesthetic value to the region. According to Thomas (1990), the cultivation of the American cranberry (*Vaccinium macrocarpon* Ait.) began in the early 1800s with the selection of vines from the wild that possessed qualities considered favorable by the growers. Vines with favorable characteristics were then sold to other growers, increasing their popularity. As of 2023, some of these native cultivars, such as 'Howes' (1843) and 'Early Black' (1852), are still being cultivated today, making up 14.8 and 19.6% of MA acreage, respectively (A, Korejwa, 2024, pers. commun.).

The most important parameters when evaluating the performance of new cranberry cultivars are yield, fruit quality, and fruit rot resistance. Yield is very important in cranberry production. Growers need to produce high yields to cover the cost of production. The ability to choose new cultivars based on productivity will be advantageous for MA cranberry growers. Fruit quality has become very important in the cranberry industry. Cranberry handlers are implementing stringent quality criteria for color and size, and growers must meet these criteria to earn incentives. There are no published studies on differences in fruit

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quality between cranberry cultivars. Fruit color is an important quality parameter in cranberry production. Growers are incentivized for fruit that attains certain color levels as measured by the total anthocyanin content test (TAcybaim). Cranberry fruit rot, a significant deterrent to fruit quality, has been a persistent challenge in cranberry cultivation since the late 1800s (Caruso et al., 2000; Oudemans et al., 1998; Thomas, 1990). Plant pathology research was in its infancy at that time, and data implicating fungi or bacteria as disease-causing agents were sparse. Research on fruit rot, which began in the early 1900s, has established that fruit rot is a disease complex consisting of over a dozen taxonomically distinct fungal species (Halsted, 1889; Bain, 1926; Shear et al., 1931; Weidemann and Boone, 1983; Stiles and Oudemans, 1997; Oudemans et al., 1998; Polashock et al., 2009). To this date, fruit rot is a major challenge in cranberry cultivation from season to season. If left uncontrolled, crop losses in excess of 50% may occur (Caruso et al., 2000; Polashock et al., 2009; Wells et al., 2014).

MA does not have a breeding program for new cultivars. Growers in MA are interested in bringing in new hybrid cultivars from breeding programs in New Jersey and Wisconsin. However, without proper cultivar evaluation under MA growing conditions, growers hesitate to do so because of the significant financial risk. Renovating a cranberry bog can range from USD \$ 24,000 to 108,000 ha⁻¹ (M. Sylvia, 2021, pers. commun.), and growers assume significant financial risk when they 'experiment' with these new cultivars without proper evaluation. There are no published studies on recent cranberry cultivar evaluation studies conducted in MA; the last published information on cultivar evaluation under MA growing conditions is from 50 years ago (Chandler and Demoranville, 1961; Chandler and Demoranville, 1958). In 2007, a new cultivar evaluation trial was done at the UMass Cranberry Station, but the results were not published. The study compared the hybrid cultivars 'Stevens', 'Mullica Queen®', 'Crimson Queen®', 'Demoranville®', 'Ben Lear', 'Grygleski 1' with the 'native' cultivars 'Early Black' and 'Howes'. The aim of our project was to increase the profitability and sustainability of the Massachusetts cranberry industry by evaluating 12 new hybrid cultivars with improved fruit quality, yield, and disease resistance. The data collected will be used in the decision-making process by cranberry growers when renovating their bogs.

MATERIALS AND METHODS

Study site, plant material, and treatments

The study was conducted on a 0.28-ha cranberry bog in East Wareham, Massachusetts, USA (41.49°N, 70.45°W) in 2019. The cranberry bog was renovated in March 2021, starting with removing the existing confining organic layer. A new layer of sand (25 cm thick) was applied to form the new planting medium to ensure adequate drainage and aeration. At the same time, the propagation of rooted cuttings was started in the greenhouse (Figure 1a). The rooted cuttings were propagated in a high porosity growing medium to allow for good drainage. The rooted cuttings were ready for planting in May 2021. Planting started in early June and was mostly finished by the first week of July; the rooted cuttings were planted using the industry standard 30 cm spacing (Figure 1b). Altogether, a total of 12 new cultivars comprising 'Vassana®', 'HyRed®', 'Ruby Star®', 'Pilgrim King', 'Scarlet Knight®', 'Sundance®', 'Granite Red', 'Midnight 8', 'Badgers', 'Crimson King', 'Welker™' and 'Haines®' were planted. These cultivars were sourced from breeding programs in New Jersey and Wisconsin. We also planted 'Mullica Queen®' as the industry standard control. 'Mullica Queen®' is a cultivar from New Jersey that does well in MA, with high yields, good fruit quality, larger berries, and good disease resistance. Between 2018 and 2023, it was the most popular new cultivar in terms of new acreage planted. The experimental design was a randomized complete block design with four plot replicates for each cultivar. Each plot replicate was 7.5 m long and 4.75 m wide with 1.5 m buffer rows left in between.

During the first two years of the study (2021 and 2022), the cranberry bog was managed under standard commercial and cultural practices for new planting regarding irrigation, pest, and fertilizer management (Ghantous et al., 2018). In 2023, the first year of data collection, the cultural practices applied were those of a mature, bearing bog.

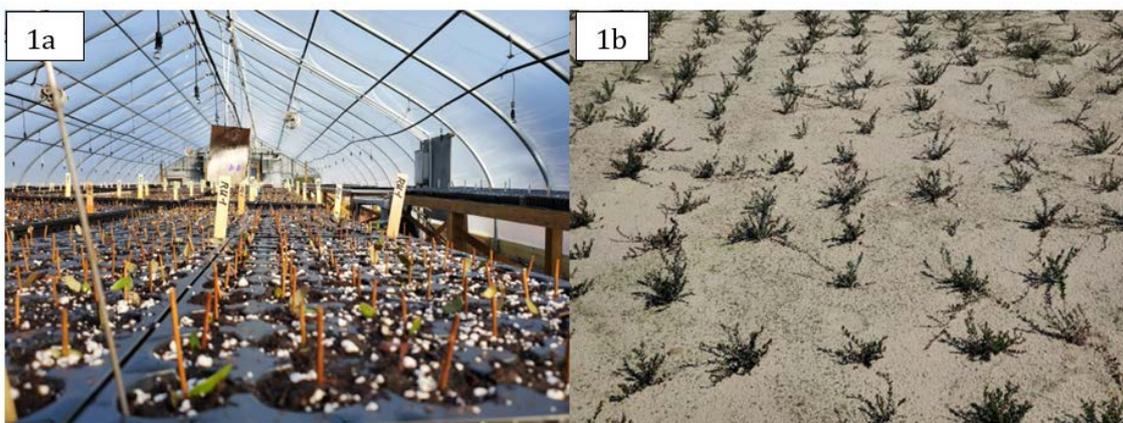


Figure 1. a) Cranberry cuttings propagated in a high porosity growing medium in the greenhouse, and b) rooted cuttings planted on a cranberry bog.

Yield and fruit quality

Fruit was harvested on October 4th, 2023, to determine yield. The harvest date was based on the commercial harvest date at the UMass Cranberry station. Fruit for yield estimation was picked from a 930-cm² quadrant as described by Suhayda et al. (2009). One sample was collected from each treatment replicate. The fruit samples were then sieved through an 8-mm opening to remove undersized berries, and the remaining berries represented marketable yield. Fruit size of marketable berries from each sample was calculated by dividing the total weight by the number of marketable berries. A second sample of about 500 g was also scooped from the plot using a traditional wooden scooper. The second sample was used to analyze total anthocyanin content (TAcy), total soluble solids (TSS), and titratable acidity (TA). TAcy was determined on 200 g of fruit from the additional sample using a modified protocol from Fuleki and Francis (1968). The juice used to measure TSS and TA was extracted by blending 150 g of fruit in a commercial juice extractor (Waring® 6001C, Torrington, Connecticut, USA). TA was determined by titrating 10 g of juice with 0.1 N NaOH with an automated titrator (EasyPlus Titrator, Mettler-Toledo LLC, Columbus, Ohio, USA) until an end-point of 8.2. TSS was measured using a hand-held refractometer (PAL-Easy ACIDF5, Atago CO, Tokyo, Japan).

Data analysis

Data were analyzed using one-way ANOVA in OriginPro 2019b (OriginLab Corporation, Northampton, Massachusetts, USA). Where significant differences occurred ($p \leq 0.05$), means were separated by the least significant difference (LSD).

RESULTS AND DISCUSSION

In the first year of harvest, only 'Haines®' and 'Welker™', outperformed the control 'Mullica Queen®', which has the highest five-year average yield in MA (Figure 2). 'Granite Red', 'Midnight 8', 'Badgers' and 'Crimson King', also had high yields but were lower than 'Mullica Queen®'. Only two cultivars, 'Vassana®' and 'HyRed®', yielded lower than 'Early Black', which currently has the lowest five-year average yield in MA. The yield results are expected to improve and should peak in Years 5-6 when the canopies are fully established.

In general, we had very high fruit rot incidence, which is expected in a new planting (Figure 3). Fruit rot incidence is high in newly established plantings where the less developed canopies expose the fruit to abiotic stresses, leading to sunscald, which consequently turns into fruit rot (Croft, 1995). 'Vassana®' and 'Welker™' had the highest incidence of fruit rot (over 50%). 'Mullica Queen®', 'Sundance®', 'Badgers', and 'Granite Red' had the lowest incidence of fruit rot (less than 20%). The incidence of fruit rot is expected to go down once the canopies are fully established.

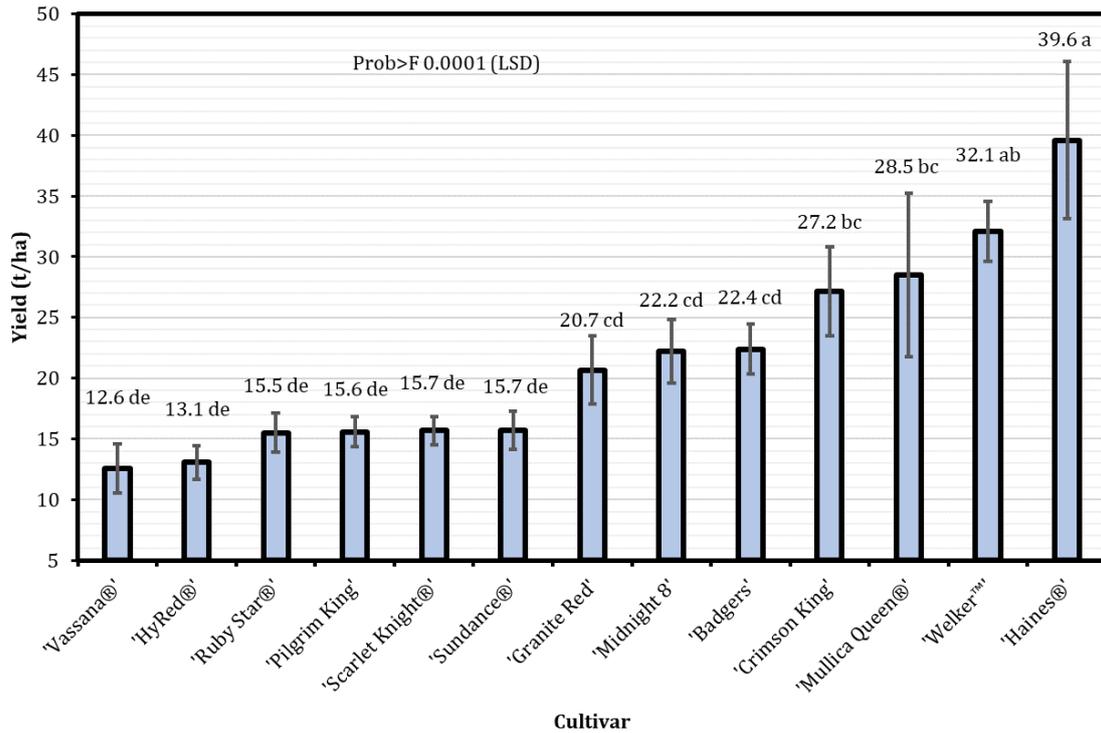


Figure 2. Yield differences in new cranberry cultivars that were evaluated in the study. Data were collected in 2023, and the cranberry bog was planted in 2021.

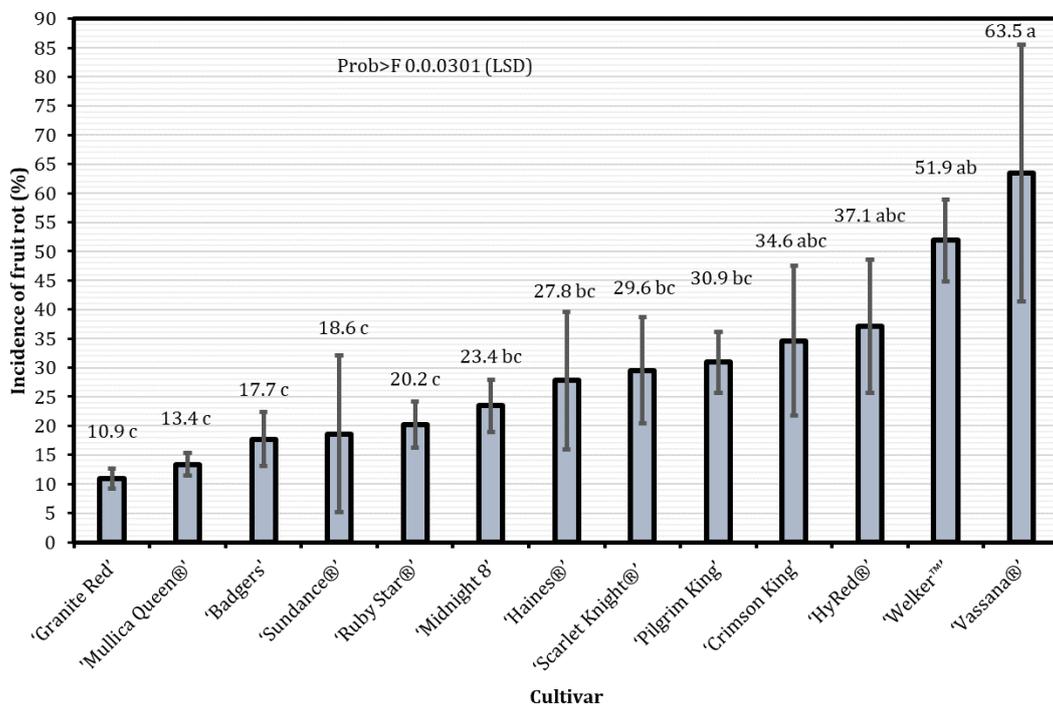


Figure 3. Differences in the fruit rot incidence between different cranberry cultivars that were evaluated in the study. Data were collected in 2023, and the cranberry bog was planted in 2021.

All the cultivars, except for ‘Badgers’, had total anthocyanin content (TAcY) values above 20, which is the minimum required for delivering fruit to the handler when using TAcY as a standard (Figure 4). The best color was observed in ‘Scarlet Knight®’ and ‘HyRed®’. The development of TAcY is expected to change when the canopies are fully developed and more fruit becomes shaded within the canopy. It must be noted that under commercial practices, some cultivars are harvested later in the season (up to mid-November), unlike in our study, where we had to harvest everything in early October because of logistics. Therefore, all the cultivars in the study are assumed to have sufficient color at harvest.

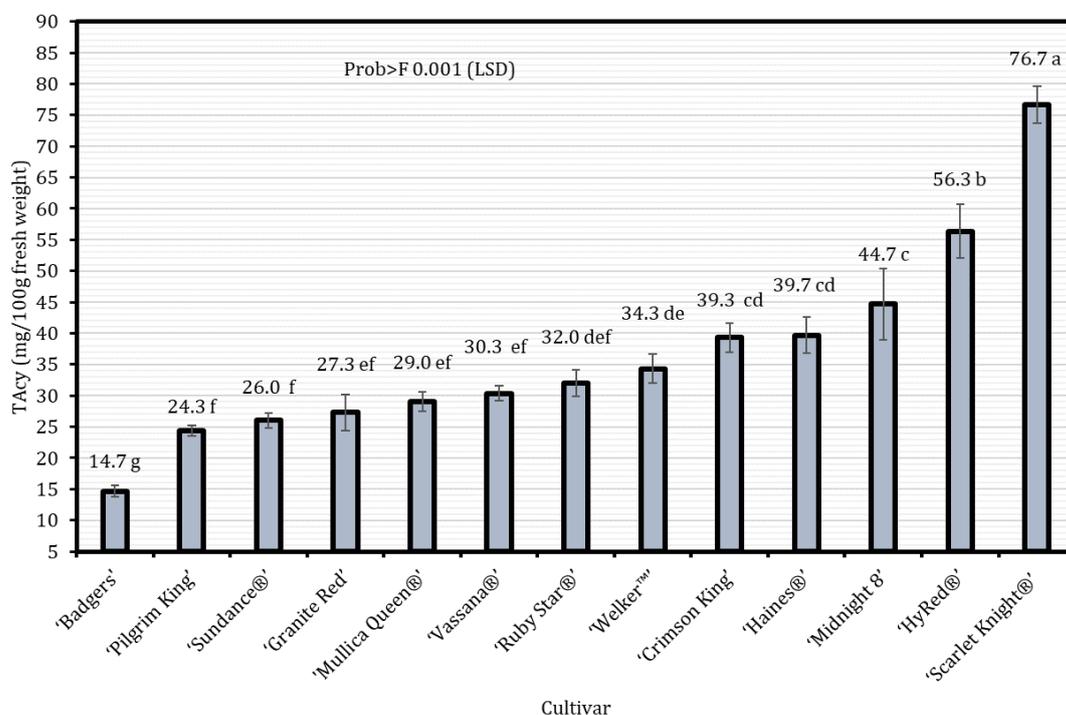


Figure 4. Fruit color in the different cranberry cultivars measured as total anthocyanin content (TAcY). Data were collected in 2023, and the cranberry bog was planted in 2021.

In terms of size, the largest cultivars were ‘Crimson King’ and ‘Pilgrim King’, weighing over 3 g in size (Table 1). Most of the cultivars were in the 2 g range, which is an acceptable size and comparable to ‘Mullica Queen®’. Only two cultivars were below 2 g, these were ‘Ruby Star®’ and ‘Scarlet Knight®’. The size of ‘Ruby Star®’ and ‘Scarlet Knight®’ is similar to that of the native cultivars like ‘Howes’ (1843) and ‘Early Black’ (1852). In terms of internal fruit quality, there were no significant differences between the cultivars.

CONCLUSIONS

Preliminary results from the first year of the study are promising, with a few cultivars showing the potential to perform well under MA growing conditions. Multiple seasons of data are still needed in order to draw firm conclusions on the performance of the new cultivars and make recommendations to growers on which cultivars to plant.

Table 1. Differences in the fruit size, total soluble solids (TSS), and titratable acidity (TA) between different cranberry cultivars that were evaluated in the study.

Cultivar	Fruit weight (g)	TSS (°Brix)	TA (%)
Mullica Queen®	2.42 cd	11.40	2.47
Badgers	2.76 b	10.27	2.18
Crimson King	3.04 ab	10.07	1.83
Granite Red	2.87 ab	9.77	1.87
Haines®	2.27 cde	10.13	2.22
HyRed®	2.01 ef	9.90	1.79
Midnight 8	2.16 def	10.27	2.02
Pilgrim King	3.08 a	9.93	1.94
Ruby Star®	1.89 fg	9.60	2.08
Scarlet Knight®	1.70 g	10.73	2.23
Sundance®	2.42 cd	10.83	2.09
Vassana®	2.37 cd	11.00	2.17
Welker™	2.47 c	10.50	1.94
<i>P</i> value	0.0001	0.6094	0.6832

Means with a different letter differ significantly at the 5% level (LSD).

ACKNOWLEDGEMENTS

This material is based upon work supported by the National Institute of Food and Agriculture, the US Department of Agriculture, the Center for Agriculture, Food and the Environment, and the Cranberry Station at the University of Massachusetts Amherst, under project number MAS00566. The contents are solely the responsibility of the authors and do not necessarily represent the official views of the USDA or NIFA.

This material is based upon work supported by the National Institute of Food and Agriculture, the US Department of Agriculture through the Northeast-Sustainable Agriculture Research and Education program under sub-award number ONE20-374.

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