Wild Blueberry Fruit Quality at Harvest for Fresh Pack Production

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January 2022

Introduction

Over 90% of wild blueberry fields are picked using mechanical harvesters. Mechanical harvesters, utilizing a range of technologies, have been developed for timely operations and efficient field picking as compared to traditional hand raking. Quality of the harvested berries remains a major criterion for judging the performance of the harvesting approach. In addition to the harvesting methods, the meteorological and field conditions also affect the quality of the harvested berries. Similarly, careful post harvest storage also plays a role with maintaining fruit quality. A scientific comparative assessment of the wild blueberry harvesting conditions can aid farmers, processors, and stakeholders in making informed decisions when pursuing options for harvesting wild blueberries for the fresh market.

Objectives

- Adopt/develop novel methods to measure/quantify wild blueberry fruit quality.
- Determine harvesting parameters that optimize wild blueberry fruit quality.
- Assess the effect of temperature on the post harvest fruit quality.

Materials & Methods

Harvesting materials used in this study included hand-held metal rakes, manual walk behind harvester developed by Maine Blueberry Equipment Co., and a Doug Bragg Enterprises (DBE) mechanical harvester mounted on a farm tractor (Fig. 1). Berries were harvested at various commercial sites in central Nova Scotia during August 2021 within 2.5-hour timing intervals at four temperature ranges including: TH-I (≤20°C), TH-II (20.1-25°C), TH-III (25.1-29.9°C), and TH-IV (≥ 30°C).

Figure 1: Harvesting of wild blueberries with the help of (left) a hand-held metal rake, (center) walk-behind harvester, and (right) a DBE mechanical harvester.

A stand-alone portable weather station (HOBO U30-NRC-SYS-C) was installed at each sampling site (Fig. 2) to download time-series meteorological data for the duration of the field experiment.

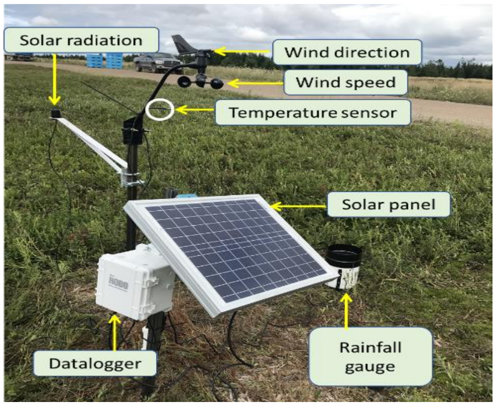

Figure 2: Weather station installed at sampling site for real-time recording of the meteorological variables.

Five-meter-long plots were flagged for data collection from the mechanical harvester tracks. The length and width of plots were based on the time of travel for the berries to be harvested and transported to the rear storage tote of the on the tractor. Sampling from the walk-behind harvester was made from 3 x 0.86 m plots, the length of the plot responded to the stretch travelled by the machine prior to dropping the harvested berries in the collection box. Hand raked berry samples were collected from 0.5 x 0.5 m quadrats placed next to each machine harvested plot for comparison. In each sampling plot, soil moisture content was taken using a TDR-300 moisture probe. Plant density and weed density (in case of harvesting from weedy plots) was also measured from each plot using a 15 x 15 cm quadrat. Plant height was measured, and canopy wetness was calculated using a leaf wetness sensor. An external photosynthetically active radiation (PAR) sensor was used to measure PAR above and below the plant canopy. Berry temperature was measured with a thermal camera prior to berry harvesting and intermittently after harvest.

The berries harvested with hand raking, walk-behind harvester, and mechanical harvester were immediately transferred to the field sorting station, temporarily set besides the sampling site, for calculating the fruit quality components. The berry samples harvested by the three methods were separately processed for their physical quality contents including i) ripe good quality berries, ii) bruised berries that were considered unfavorable, iii) cut-split berries that were poor in quality due to badly ruptured skin, and iv) debris (Fig. 3).

Figure 3: A harvested raw sample of wild blueberries sorted into: A) good berries (marketable berries without any bruises and/or foreign materials), B) unfavorable bruised berries having soft and/or damaged skin, C) cut-split berries (poor berries having badly ruptured skin), and D) debris composed of foreign materials and off-color unripe or shrunk berries.

The individual components were placed into empty containers and weighed using an electronic scale. Weights of individual components were then divided by the total weight of the raw sample and multiplied by 100 to obtain percent values of individual components. A FruitFirm® 1000 was used to calculate the firmness of berries from each data collection set (Fig. 4). The effects of varying temperature on berry firmness were also assessed to understand the effect of temporarily storing the harvested berries under shade prior to shifting the harvested berries to the processing facilities.

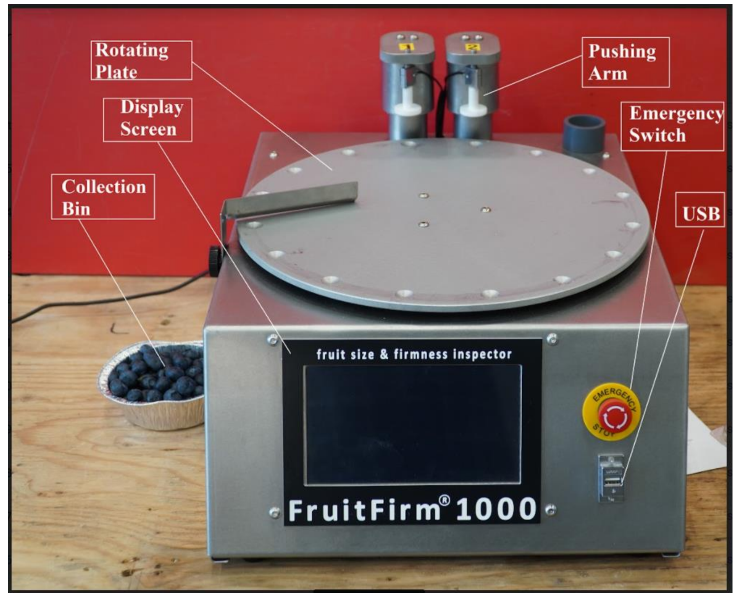

Figure 4: FruitFirm® 1000 instrument to measure fruit diameter and firmness.

Results & Discussion

Analysis of the berry yield data collected on the days of berry quality sampling, showed that the harvested yield ranged from 2,015 to 12,690 kg ha^{-1} during the 2021 sampling season. The berry surface and leaf temperature increased with increase in ambient air temperature (Fig. 5).

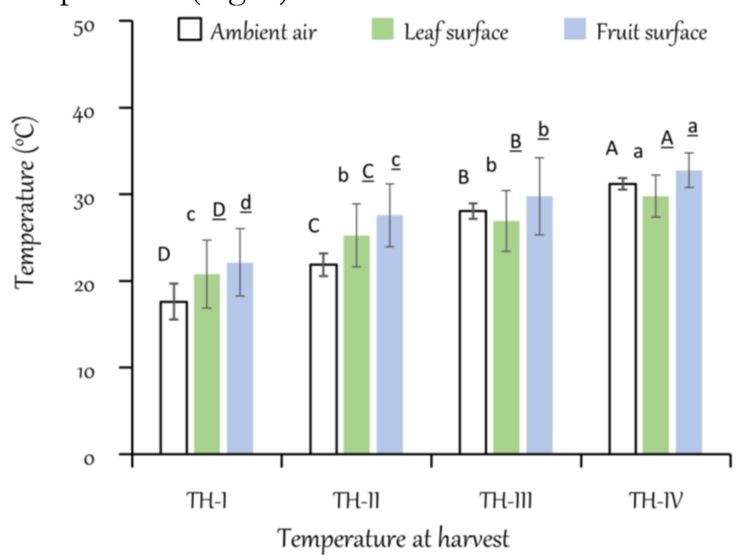

Figure 5: Mean temperature values (°C) and standard deviations from the means for ambient air, leaf surface, and berry surface measured during replications of harvesting of four temperatures at harvest.

The temperature at harvest had a significant effect on the berry quality components (Fig. 6). When harvesting wild blueberries via hand raking, walk-behind harvester, or mechanical harvester the optimum temperature to harvest good quality berries was ≤20 °C. The quantity of good quality berries decreased by 8.08, 13.5, and 28.8% while harvesting at TH-II (20.1-25 °C), TH-III (25.1-29.9 °C), and TH-IV (≥ 30 °C), respectively.

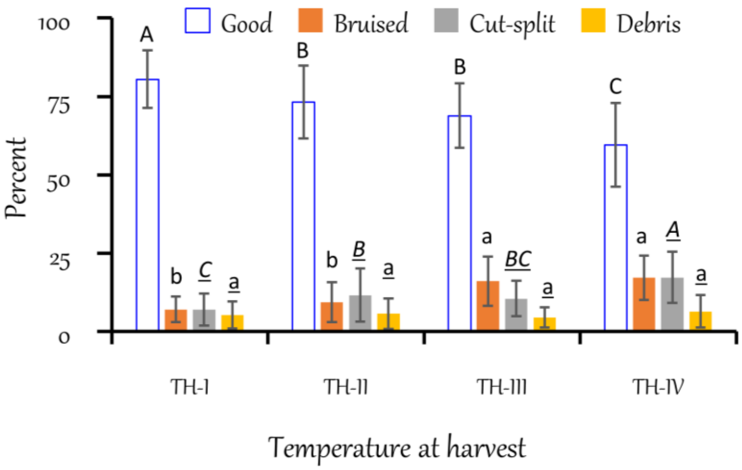

Figure 6: Percent berry quality components plotted against ambient air temperature for mechanically harvested data set.

Weeds had a significant effect on all quality components of the harvest samples except for debris collected with the hand raking method. The percent of good quality berries found in the harvest of clean plots were significantly higher than their values obtained from the harvests of weedy plots (Fig. 7). The results suggest an adverse effect of weeds on berry quality characteristics as good quality berries decreased and bruised, cut-split berries and debris increased in the harvest samples due to the presence of weeds in the plots.

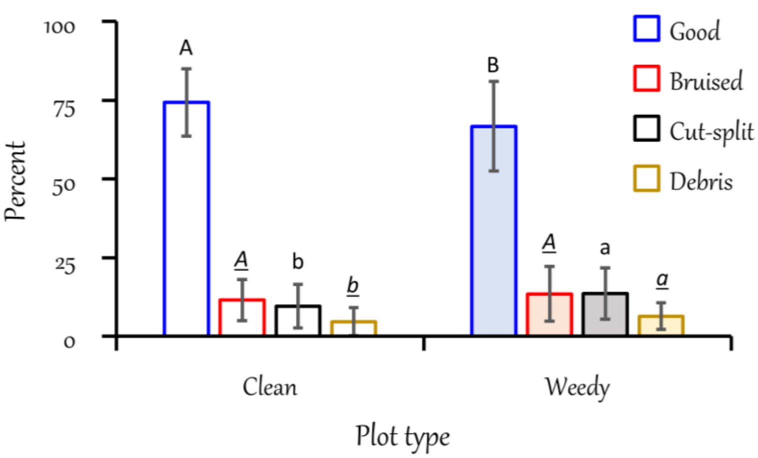

Figure 7: Percent berry quality components of clean and weedy plots for mechanical harvester samples.

Berry firmness influences consumer judgement for marketing of fresh blueberries. Blueberries normally soften during the postharvest processing, which compromises final quality leading to rejection in the marketplace due to firmness levels below retail standards. The temperature of the harvested berries had a linear relationship with the firmness of the berries. As berry temperature increased the fruit firmness decreased linearly ($R^2 = 0.64$) (Fig. 8).

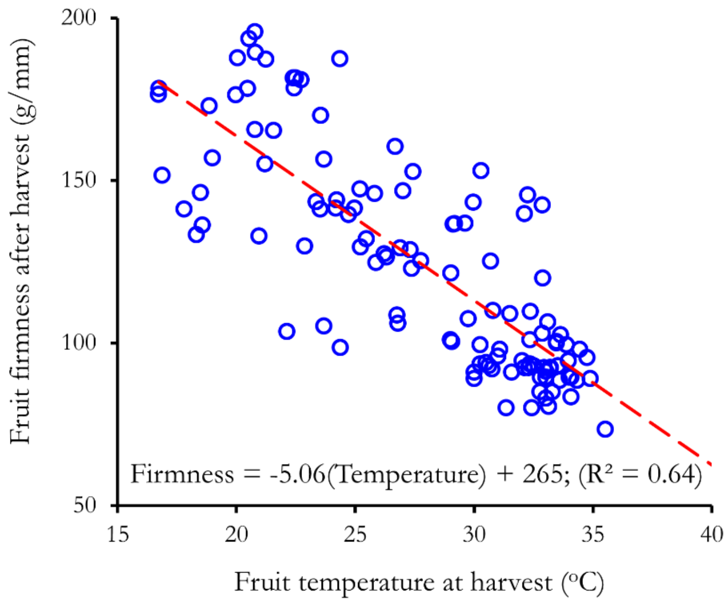

Figure 8: A negative linear relationship between berry firmness with their surface temperature is shown with a broken red line through scattered firmness data points that are drawn as hollow blue circles.

Regardless of the method of harvest, the ambient air temperature had a significant effect on berry quality components. As expected, the berries stored without a shade entrapped more heat than those stored under shade (Fig. 9). During the early hours of the day, when the ambient air temperature was in the range of TH-I and TH-II (i.e., <25 °C), there was no substantial difference between the temperatures of berries stored in the two conditions. The results comparing the effect of berry storage conditions revealed a significant effect of storing conditions of berries on fruit temperature. The mean temperature of berries stored under the shade (21.3 °C) remained significantly lower than the temperature of those stored without a shade (33.1 °C).

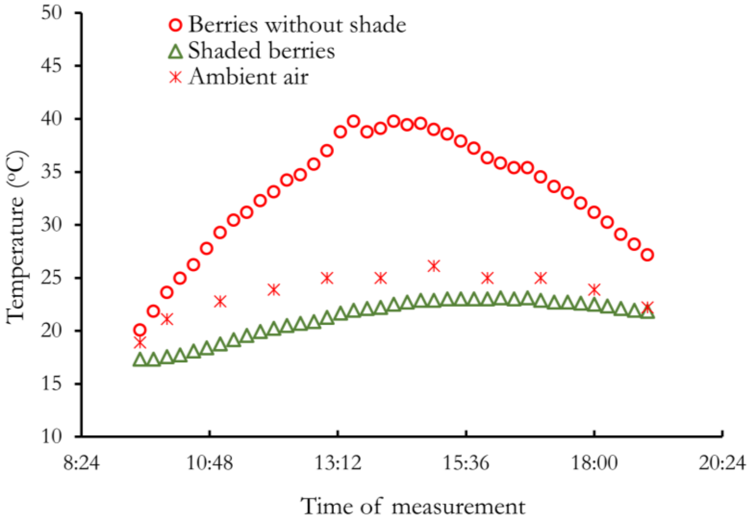

Figure 9: Temperatures of ambient air and berries stored with and without a shade measured during the sampling date of August 22, 2021.

When considering sale of only high-quality fruit, an economic study showed a significantly higher income while harvesting at temperature ≤ 20 °C as compared to harvesting during the warmer temperature ranges. Income decreased by 8.08, 13.5, and 28.8% with harvesting at higher temperatures than 20 °C, i.e., TH-II (20.1-25 °C), TH-III (25.1-29.9 °C), and TH-IV (≥ 30 °C), respectively (Fig. 10). This resulted in calculated losses of 721, 1,112, and 2,254 $/ha for harvesting and selling berries at TH-II, TH-III, and TH-IV, respectively than at TH-I.

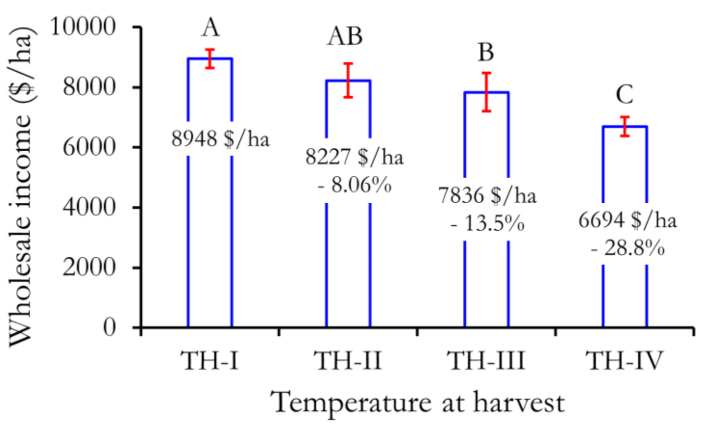

Figure 10: Decrease in income and percent decrease in income when selling only good quality berries, harvested at four temperatures at harvest including TH-I (≤ 20 °C), TH-II (20.1-25 °C), TH-III (25.1-29.9 °C), and TH-IV (≥ 30 °C) to processors at a market rate of 1.76 $/ha.

Conclusion & Recommendations

The goal of this project was to aid wild blueberry growers in making informed decisions when pursuing favorable harvesting conditions to maintain optimum fruit quality when harvesting for fresh market. Results from this study suggests harvest temperatures ≤ 20°C are best for maximizing berry quality. Storage temperature was found to affect quality components of the harvest samples and firmness of berries for all methods of harvest. Results suggest that berry temperature after harvest should be kept below 20°C to maintain the fruit firmness within an acceptable range prior to shifting the harvest to the processing facilities.

- Ideal temperature range to harvest to maximize fruit quality was found to be ≤20 °C for all methods of harvesting i.e., hand rakes, walk-behind, and mechanical harvesters.
- Weeds (sheep sorrel, goldenrod, hair fescue) were found to deteriorates berry quality regardless of the method of harvesting.
- The acceptable berry firmness was at least 128 – 160 ± 22.2 g/mm during harvest to maximize fruit quality.
- Cool cloudy dry field conditions were found to help maximize fruit quality for all methods of harvest.
- Post harvest berries should be left out of direct sunlight and transported timely to the processing facility for grading.