Southern highbush blueberries (SHB) (*Vaccinium corymbosum* L.) are mostly hand harvested for the fresh market. Hand harvesting of blueberry is labor intensive (over 500 hours/acre) and costly. With the uncertainty of labor availability in the near future efforts are under way to develop blueberry genotypes that will develop less bruising after impact with hard surfaces on the harvesters.

A key step to addressing this challenge is to advance the mechanical harvest technologies (Brown et al., 1996; Peterson et al., 1997). Commercial over-the-row blueberry mechanical harvesters improve labor productivity by nearly 60 times, while cutting the harvest cost by 85%. In the southeastern US most mechanical harvesters are currently used for the processing market and not for harvesting fruit for fresh market because highbush blueberries that have been machine harvested lose firmness and become much softer than hand-harvested blueberries. The key constraints to a wider use of machines to harvest fruit for fresh market have been summarized by Takeda et al. (2008) as follows:

- **Damage to fruit during harvest**, particularly bruising which lowers overall fruit quality by producing softer, leaky berries that are at increased risk of decay during postharvest storage (Ballinger et al., 1973; Dale et al., 1994; Funt et al., 1998; Mehra et al., 2012; Miller and Smittle, 1987; NeSmith et al., 2002). Furthermore, bruising often resulted in a loss of the visually appealing fruit surface wax (bloom), thereby further decreasing quality (Dale et al., 1994). Stem tearing, a third important type of damage, occurred when mechanical harvesting operations result in the forceful removal of the fruit from the pedicel. These injuries increased postharvest moisture loss and were particularly prone to infection by fruit-decay fungi (Ceponis and Cappellini, 1979).

- **Excessive ground losses**, i.e., berries are detached during the harvesting processes but are missed by the catching pans (“fish scales”) at the base of the machine. These losses often reached 20-30% with commercial mechanical harvesters (Mainland, 1993; Strik and Buller, 2002; van Dalfsen and Gaye, 1999).

- **Excessive green berry detachment**, resulting in yield losses and increased sorting costs in the packinghouse. To reduce the proportion of green berries in the harvested product, the first picking in machine-harvested blueberries is usually delayed by 5 to 7 days relative to hand-harvesting. This is undesirable in southern highbush blueberries due to the rapidly declining prices as volume increases later in the spring.

- **Mature fruit missed by the mechanical harvester**, resulting in overripe fruit by the next harvest two to three days later (Mainland, 1993). Again, this produced softer, leaky berries that rapidly lost quality and were at increased risk of postharvest decay. Most commonly, such missed fruit were on upright canes in the center of the bush (Takeda et al., 2008).

In this study, the fruit of ‘Farthing’, ‘Scintilla’, ‘Sweetcrisp’, and other SHBs were either hand-harvested or machine-harvested and assessed during postharvest storage for bruise damage, disease incidence and softening. Studies showed that ground-loss that occurred during machine harvesting can be reduced by modifying the blueberry plant architecture. Fruit drop tests from a height of 40 inches on plastic surface showed that a soft-textured, conventional-flesh genotype (‘Scintilla’) was more susceptible to bruising than the crispy-flesh genotypes (‘Farthing’, ‘Sweetcrisp’, and selection FL 05-528). When the contact surface was cushioned with ‘Poron’ foam sheet, bruise incidence was significantly reduced in all genotypes. Also, the fruit dropped 40 inches developed more bruise damage than those dropped 20 inches. Machine harvesting contributed to bruise damage in the fruit and softening in storage. Fruit firmness in crispy-type SHB was higher than in soft-textured SHB. Further modifications to mechanical harvesters and blueberry plant architecture are necessary to improve the quality of machine-harvested blueberries and the over harvest efficiency.

Until recently, evaluation of blueberry mechanical harvesters and various contacting surfaces was done by visually assessing the quality of blueberries after harvest or after dropping berries due to lack of
effective real-time sensing tools. Treatment of the mechanical harvesters as a “black box” has not uncovered how the blueberry is bruised within the mechanical harvesters or revealed the mechanism of the interaction between the fruit and the harvester to quantitatively measure the mechanical impacts created by the mechanical harvester and various contacting surfaces. Visual assessment of blueberries and quantitative evaluation of machine-harvested fruit during storage is time consuming and laborious. Laser-based technology for kicking out bruised/soft fruit is quite expensive (> $125,000).

The instrumented berry impact recording device (BIRD) developed in the USDA SCRI funded project titled “Advancing blueberry production efficiency by enabling mechanical harvest, improving fruit quality and safety, and managing emerging diseases,” has contributed to a better understanding of physical impacts on blueberry fruit quality. The current version of the BIRD sensor (Yu et al., 2012) is about twice the size of average blueberry fruit. It records impacts in three directions and acceleration values in real time that are integrated to obtain velocity. A project funded by US Highbush Blueberry Council will help further refine the sensor through size and mass reduction. It will be used to quantitatively measure improved design of harvesting equipment and altered cultural practices and packing house operation to reduce the size of the physical impacts on the blueberry fruit.

The blueberry industry will expand the use of over-the-row mechanical harvesters for picking blueberries for fresh market. This study provided evidence that some of the crispy blueberry genotypes that have been released in last ten years can withstand the physical impacts of mechanical harvesting better than the conventional genotypes. Machine harvesting results in softer fruit, presumably through bruising. In storage, machine-harvested fruit lost their firmness more rapidly than hand-harvested fruit. Drop tests showed that both drop height and contact surface material affect the amount of bruising in blueberry fruit. Physical impacts on fruit does not just lead to a cosmetic problem, but they alters the functioning of fruit cells that culminates in internal bruise damage (e.g. water soaked and darkened tissues) and fruit softening. Improved design of harvesting equipment, such as reducing the drop height, and horticultural practices, such as crown restriction, will help to increase harvest efficiency by capturing more fruit in lugs (e.g. leaving less fruit in the field) and maintaining better fruit quality in cold storage. Additional research is necessary to determine how blueberry quality can be affected by physical damage incurred at harvest.

References


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