Southern Region Small Fruit Consortium
Progress Report (Research Grant 2009-17)

Title: Evaluation of rabbiteye blueberry cultivars and selections for fruit abscission characteristics

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Objective:

To evaluate rabbiteye blueberry cultivars and advanced selections for fruit abscission characteristics

Justification

Blueberries are rapidly emerging as an important and profitable crop in the southeastern US (Krewer and Nesmith, 2000). Sustained profitability of the blueberry industry will depend upon several factors including improvement of production efficiency. Harvesting blueberry fruits is highly labor intensive and an important challenge in blueberry production. An effective alternative to manual harvesting is utilization of mechanical harvesting techniques. Mechanical harvesting is utilized for improving harvesting efficiency in fruit crops such as citrus and to some extent in blueberry production (Burns et al., 2005; Takeda et al., 2008). Effective mechanical harvesting is determined by efficient fruit detachment which is in turn determined by the abscission characteristics of the plant.

Mechanical harvesting in rabbiteye blueberry cultivation is currently determined greatly by natural progression of fruit detachment from the pedicel. Fruit abscission (detachment) typically occurs at well defined regions termed as abscission zones. Blueberry fruits possess two well defined abscission zones: a) peduncle/pedicel junction; b) pedicel/berry junction. Fruit detachment/abscission in blueberry can occur at either of these abscission zones (Gough and

Litke, 1980). The point of detachment appears to be dependent on the stage of fruit development as well as the cultivar. Additionally, cultivars appear to differ in sensitivity to plant growth regulator-induced abscission at the two abscission zones (Malladi A., unpublished results). Excessive vibrations in mechanical harvesting operations often result in breakage of the pedicel or fruit detachment away from abscission zones. Such harvesting methods can ultimately lead to fruit injury and reduction of overall fruit quality (Howell et al., 1976).

Abscission characteristics are highly variable between cultivars. Determination of specific abscission characteristics in blueberry cultivars will lead to improved knowledge of their suitability for mechanical harvesting. Hence, understanding of abscission characteristics in current rabbiteye blueberry cultivars and advanced selections is essential to facilitate better mechanical harvesting. A similar approach is being utilized to understand abscission characteristics in southern highbush blueberry cultivars by the PI.

Experimental Plan

Plant Material

Current rabbiteye blueberry cultivars as well as advanced selections were utilized for evaluation of fruit abscission characteristics. Commercial cultivars and advanced selections from the University of Georgia blueberry breeding program of the Co-PI were used for this study (NeSmith, 2004). Plants selected for this study were maintained in Griffin, GA and managed according to commercial production practices.

Measurement of fruit detachment force

Fruit abscission characteristics were determined primarily by measurement of fruit detachment force. Fruit detachment force (FDF) was evaluated using a force gauge (Force One-Wagner Instruments). The force gauge is equipped with a force cell module (Max. 1 KgF; Resolution: 0.001 KgF) and has been retrofitted with an adapter to facilitate measurement of blueberry fruit detachment. Similar instruments have been previously utilized by the PI for FDF measurement in citrus (Pozo et al., 2007; Malladi and Burns, 2008). FDF was measured on 20 mature berries from each of four single plant replicates of every cultivar/selection. At the time of FDF measurement, most cultivars had about 30-50% mature fruits on the plant.

Results

Thirty rabbiteye varieties/selections were chosen for this study from Dr. Scott NeSmith's breeding program at University of Georgia in Griffin, GA. In addition, 23 southern highbush blueberry selections were also identified from the same program. The planting had been established in 2006. The above varieties and selections were chosen based on the availability of sufficient single bush replicates (n = 4). A list of the varieties is provided in Table 1.

Table 1: List of rabbiteye and southern highbush blueberry varieties used in the current study

Rabbiteye Blueberry Varieties		
T-877	T-961	03-06
T-882	T-963	Alapaha
T-883	T-964	Powderblue
T-884	T-965	Wild II
T-885	T-966	Wild Late 1
Centurion	T-967	Wild Late 3
Vernon	FL 80-11	Brightwell
T-957	T-968	T-227
T-959	02-63	T-83
T-960	01-34	T-107

Southern Highbush Varieties		
TH-878	TH-914	TH-954
TH-881	TH-917	TH-962
TH-886	TH-924	TH-681
TH-893	TH-927	
TH-894	TH-928	
TH-895	TH-929	
TH-897	TH-931	
TH-898	TH-934	
TH-900	TH-935	
TH-902	TH-940	

A method was previously developed to measure fruit detachment force (FDF) at the pedicel/berry junction (A. Malladi, unpublished results). This method was fine tuned to allow rapid and accurate measurement of FDF by addition of a smaller adapter to the pull force gauge (Figure 1). Fruits were cut from clusters with the pedicel attached and placed in the adapter. The pedicel was pulled along the axis of attachment using pliers. Peak force required for fruit detachment was recorded by the gauge. Several attempts were made to develop a technique for measuring FDF at the peduncle/pedicel junction. The unique structure of this zone prevents application of the existing method. One promising technique involves removal of the berry leaving the pedicel on the plant followed by measurement of force required to remove the pedicel, directly on the plant. We will be working with the University of Georgia, Instrument shop to explore and develop this technique.

Figure 1: Pull force gauge for FDF measurement. Individual berries were detached from the cluster with the pedicel attached and placed on an adapter attached to the gauge. The pedicel was held with the pliers and pulled along the axis of attachment. Maximum force required for berry detachment was determined (KgF: Kilograms Force).

Fruit Detachment Force in Rabbiteye Blueberry Varieties

FDF in the 30 blueberry varieties tested in this study varied over a 3-fold range (Figure 2). FDF values ranged from 0.079 KgF (Kilogram Force) to 0.246 KgF. The lowest FDF was observed in the selections, T-107, T-883 and T-877. Selections T-959 and T-965 had among the highest FDF values. FL 80-11 had the highest FDF which was almost 20% higher than the next highest selection (T-965). Other varieties studied here had intermediate FDF values. Interestingly, while the lower FDF values were associated with smaller fruit-size cultivars, higher FDF values appeared to be associated with larger fruit-size selections. Area of contact at the point of attachment between the pedicel and the berry may be greater in large fruit size berries leading to a higher FDF. A possible relationship between fruit size, FDF, and the area of contact at the pedicel/berry junction may need to be explored further in future research.

Fruit Detachment Force in Southern Highbush Blueberry Varieties

Although not included in the original proposal, FDF was determined in 23 southern highbush blueberry selections. Southern highbush blueberry selections tested in this study showed about a 2-fold range in FDF (Figure 3). Lowest FDF was observed in TH-934 (0.086 KgF) while the highest FDF value was obtained in TH-928 (0.181 KgF). While the lower range of FDF was similar to that in rabbiteye blueberry varieties, FDF in TH-928, the southern highbush selection with the highest FDF, was about 25% lower than that in the rabbiteye selection FL 80-11.

Impact

Characterization of fruit detachment force across many rabbiteye and southern highbush blueberry cultivars/selections was performed in this study. A wide range in FDF was observed suggesting that cultivars may inherently differ in the force required for fruit removal. FDF may influence mechanical harvesting properties of the cultivars/selections and the above data may present important indications regarding the suitability of a given cultivar for mechanical harvesting. Candidates with extremes in FDF values are potentially useful to understand the physiological basis of fruit detachment. Such candidates have been identified in this study. Further evaluation of abscission characteristics such as FDF at the peduncle/pedicel junction, extent of ethylene evolution, and response to growth regulators would enable a better understanding of fruit detachment and aid in developing tools for increasing mechanical harvesting efficiency. This will be the focus of future research.

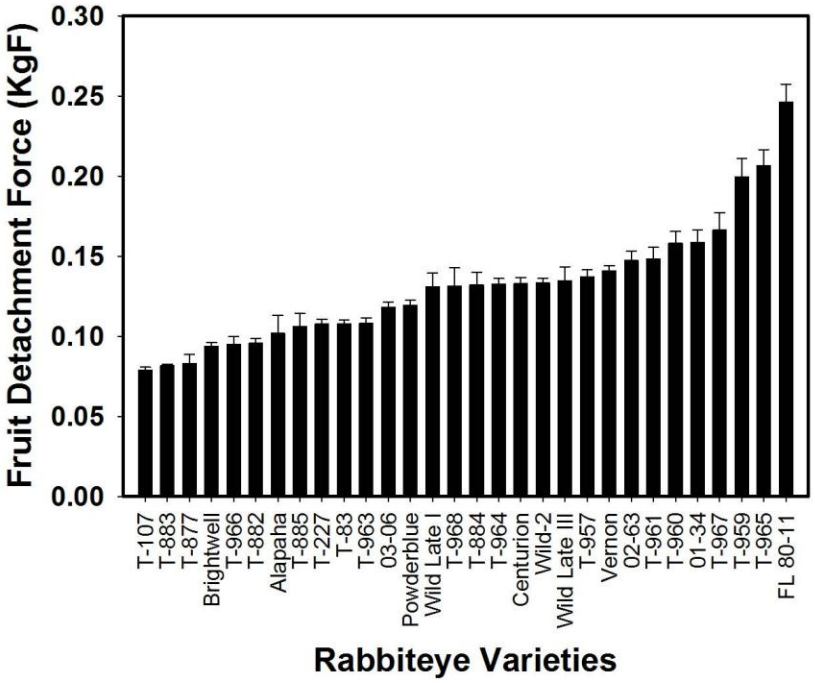

Figure 2: Fruit detachment force (FDF) in rabbiteye blueberry varieties/selections. FDF was measured at the pedicel/berry junction in 30 rabbiteye blueberry varieties (*n* = 4; 20 fruits per plant). The varieties/selections are arranged in increasing order of FDF. KgF: Kilograms Force.

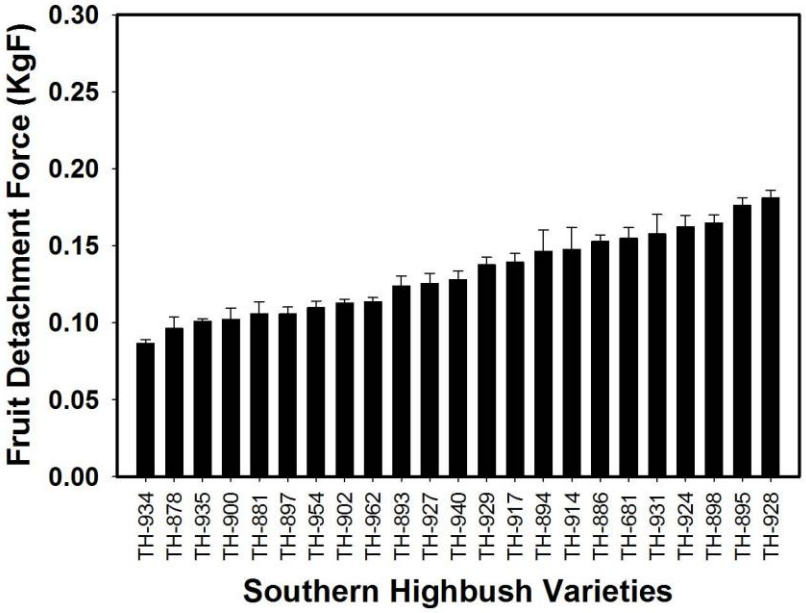

Figure 3: Fruit detachment force (FDF) in southern highbush blueberry varieties/selections. FDF was measured at the pedicel/berry junction in 23 southern highbush blueberry varieties (*n* = 4; 20 fruits per plant). The varieties/selections are arranged in increasing order of FDF.

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