2013 SRSFC Progress report

Title:
Determination and inheritance of firmness and texture of the "crispy" trait in the Arkansas blackberry breeding program.

SRSFC 2013-08

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Objectives:

The main objective of this project is to evaluate and characterize the fruit morphology of firm and "crispy" genotypes within the Arkansas blackberry selections and possibly seedlings from these firm parents, and to evaluate its genetic potential as a source of exceptionally firm cultivars with high postharvest and shipment quality. If this unique trait can be incorporated into commercial cultivars then this would allow growers and marketers to have fruits of better quality after more extended storage periods.

Specific objectives:

1. To determine the fruit components that give rise to the firm and "crispy" trait found in genotypes within the Arkansas blackberry breeding program.

2. To quantify the flesh firmness of the firm and "crispy" trait.

3. To determine the postharvest potential of these new genotypes.

Justification and Description:

Fruit firmness is a critical characteristic for blackberry growers who are looking to produce and ship high-quality fruits to markets. For that reason fruit firmness is a fundamental trait that breeders want to improve in blackberry breeding. Fruit firmness, which is suggested as an intractable trait, depends on cultivar, ripeness stage, and storage duration (Clark, 2005; Perkins–Veazie et al., 1996) and is a critical characteristic in postharvest evaluation.

The University of Arkansas will continue studying further the crispy trait for the year 2014. Also, according to 2013 preliminary results, crispy genotypes show a notable difference compared to non-crispy genotypes in terms of firmness and exhibit exceptional postharvest performance in terms of color reversion (development of red drupelets during storage).

After one week of cold storage, crispy genotypes had the lowest proportion of red drupelets compared to non-crispy genotypes. The causes of color reversion are not known yet; therefore, selection against this problem appears to be the only solution to this (Clark, 2005).

Crispy genotypes are currently being used in crossing to transfer this trait to future generations with the objectives to improve firmness and postharvest quality of Arkansas blackberry genotypes.

Methodology:

All evaluations/phenotyping during the 2013 season was done at the University of Arkansas Fruit Research Station, Clarksville. Blackberry plants were grown with cultural components including annual routine plant management practices including fertilization, weed control, and irrigation.

Individuals analyzed were cultivars 'Prime-Ark® 45', 'Natchez', 'Osage', 'Ouachita', and the Arkansas selections A-1790, A-1917, A-1960T, A-2218, A-2252T, A-2297T, A-2416T, A-2417T, A-2418T, A-2428T, A-2435T, A-2453T, and A-2454T. These selections represent a range of firmness values and also have been used in crossing to improve firmness in seedling populations within the Arkansas program.

Fruit morphology:

Fruit components of cultivars and selections were characterized considering:

- Drupelets: shape of drupelet.
- Seeds: length, width and weight of 50 seeds per genotype will be measured.
- Torus: structure and width.
- Drupelet-torus association: how the drupelet is inserted into the torus, and the proportion of the drupelet in contact with the torus.

However, for this progress report only results of fruit firmness and color reversion are included. The remainder of the 2013 results and the 2014 data will be presented in the final report next year.

Fruit firmness:

-Compression: fruit compression was performed by placing individual fruits horizontally on a flat surface using a cylindrical and plane probe of 7.6 cm diameter.

-Penetration: each fruit was cut in half longitudinally. One half was used for drupelet penetration and the other half to measure the receptacle firmness.

a. Drupelet penetration: drupelet skin firmness was assessed using a probe of 1 mm diameter. For this, three drupelets of similar shape and size were used.
b. Receptacle penetration: measured using a probe of 1 mm diameter in the middle of the receptacle.

Color reversion:

Color reversion after one week at cold storage at 5°C was evaluated. For this evaluation each fruit was categorized in the following reddening scale:
RD_0: fruits with no red drupelets after cold storage.
RD_1: fruit only having one red drupelet after cold storage.
RD_2-3: fruits having two or three red drupelets scattered on the fruit after cold storage.
RD_4-5: fruits having four or five red drupelets scattered on the fruit after cold storage.
RD>6: fruits having six or more red drupelets scattered on the fruit after cold storage.

Results:

Genotypes considered crispy have a different sensorial (mouth feel) quality compared to the normal blackberry genotypes (Table 1). They have a texture considered crispy/crunchy, considered unique within blackberry genotypes.

Table 1. Blackberry genotypes classified by sensorial evaluation in classes crispy and non-crispy, 013. Clarksville, Arkansas.

Genotype	Crispy (Yes/no)
A-1790	Yes
A-1960T	No
A-2218	Yes
A-2252T	No
A-2297T	No
A-2416T	No
A-2417T	No
A-2418T	No
A-2428T	No
A-2453T	Yes
A-2454T	Yes
Natchez	No
Prime Ark® 45	No
Osage	No
Ouachita	No

Fruit texture:

Crispy genotypes showed the highest compression firmness compared to non-crispy genotypes (Table 2). The compression values of the crispy genotypes were, on average, 13.0 N, two times higher than selection A-2297 (the lowest value of the non-crispy genotypes). The four selections with the higher compression values were crispy genotypes and were significantly different from the non-crispy ones with the exception of the non-crispy but very firm A-2418T.

Skin drupelet penetration force (Table 3) showed a similar tendency to compression force, as some of the selections with firmer skin were crispy genotypes, such us A-1790, A-2218, and A-2454T. Crispy genotypes also showed a tendency to have high receptacle penetration force (Table 4), such us A-2454T, A-2218, and A-1790. Selection A-2418T is not a crispy genotype but presented high compression and drupelet penetration firmness values, which can be explained because one of its parents is A-1790, which was the first crispy genotype identified in the program.

Table 2. Mean of compression force (N) of blackberry genotypes, 2013, Clarksville, Arkansas.

Genotype	Force (N)*
A-2218	13.2 a
A-2453T	13.1 a
A-1790	13.0 a
A-2454T	12.3 a
A-2418T	11.5 ab
Natchez	10.1 bc
A-2416T	10.0 bcd
Prime Ark® 45	9.8 bcd
A-2417	8.6 cde
A-2252T	8.2 def
A-2428	7.5 efg
Osage	7.2 efg
Ouachita	7.1 efg
A-1960	6.5 fg
A-2297	6.2 f
p- value	*< 0.0001*

*different letters in the column indicate significant differences between genotypes at an α level of 0.05. Means were compared using LSD.

Table 3. Mean of skin drupelet penetration force (N) of blackberry genotypes, 2013, Clarksville, Arkansas.

Genotype	Force (N)*
A-1790	0. 38 a
A-2297	0.29 b
A-2218	0.25 bc
A-2454T	0.22 cd

Prime Ark® 45	0.20 cde
A-2428	0.19 def
Ouachita	0.18 def
A-2417	0.18 def
Osage	0.18 def
Natchez	0. 17 def
A-2252T	0. 17 def
A-2453T	0. 16 ef
A-2418T	0. 16 ef
A-2416T	0. 15 ef
A-1960	0.14 f
p- value	*< 0.0001*

*different letters in the column indicate significant differences between genotypes at a α level of 0.05. Means were compared using LSD.

Table 4. Mean of receptacle penetration force (N) of blackberry genotypes, 2013, Clarksville, Arkansas.

Genotype	**Force (N)***
A-2418T	0.33 a
A-2454T	0.31 ab
A-2218	0.30 abc
A-2416T	0.28 abcd
A-1790	0.25 bcde
A-2297	0.24 cde
A-2417T	0.24 cde
A-2453T	0.24 cde
Prime Ark® 45	0.23 de
A-2428	0.23 de
Natchez	0.22 def
A-2252T	0.21 ef
Ouachita	0.20 ef
A-1960T	0.16 fg
Osage	0.13 g
p- value	*< 0.0001*

*different letters in the same column indicate significant differences between genotypes at a α level of 0.05. Means were compared using LSD.

Color reversion:

After one week of cold storage (5°C), crispy genotypes presented low levels of color reversion (Table 5). Selections A-2218, A-2453T and A-2454T had the lower values of color reversion of the crispy genotypes, while A-1790 had slightly more reversion. 'Natchez' and selection A-1960T were the genotypes with higher number of fruits having at least four drupelets with color reversion after one week of cold storage.

Table 5. Red drupelet development after one week of cold storage at 5°C for blackberry genotypes, 2013, Clarksville, Arkansas.

Genotype	Number of evaluations for color reversion	Color reversion (%)				
		RD0	RD1	RD2-3	RD4-5	RD>6
A-2218	2	100	0	0	0	0
Osage	1	100	0	0	0	0
A-2454T	2	96	0	0	0	4
A-2453T	2	92	4	0	0	4
Ouachita	1	87	13	0	0	0
A-2297T	2	85	0	0	5	10
A-1790	2	85	10	0	5	0
A-2252T	2	70	0	0	5	25
A-2428T	2	68	12	4	0	16
Prime Ark® 45	2	63	13	4	4	17
A-2417T	2	56	8	12	0	24
Natchez	2	55	5	0	10	30
A-2416T	1	50	10	30	10	0
A-1960T	1	10	0	10	20	60

Discussions and conclusions:

The first findings show that crispy genotypes had higher values of compression and penetration firmness and a reduced presence of red drupelets after one week of cold storage compared to most non-crispy genotypes during 2013. Values of compression and receptacle skin firmness for 2013 were more effective in differentiating between crispy and non-crispy genotypes. Further, harvest date showed a significant correlation between firmness and color reversion, while another harvest date did not (data not shown), meaning that this problem could be highly influenced by climatic conditions on the harvest day or days prior to harvest. To clarify this, this relationship will continue to be studied for both variables and next season.

Impact statement:

This is the first year of research and its first results are promising, showing a superior postharvest quality and shipping potential of these genotypes based on color reversion development and also superior firmness. This research will continue for a second year to provide further, expected to confirm the results found during season 2013.

Literature Cited

Clark, J. R. 2005. Intractable traits in eastern U.S. blackberries. HortScience 40:1954-1955.

Perkins-Veazie, P., J. Collins, and J. Clark. 1996. Cultivar and maturity affect postharvest quality of fruit from erect blackberries. HortScience 31:258-261.