Evaluation of Harvest Time on Postharvest Incidence of Red Drupelet Reversion Development and Firmness of Blackberry Cultivars

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Introduction

Red drupelet reversion (or simply referred to as reversion) is a postharvest disorder expressed in blackberry fruits in which some drupelets change from black to red after harvest (Fig. 1). This is among the most important postharvest issues in the blackberry shipping industry as well as retention of firmness of berries.

Blackberries for the shipping market often undergo a rapid change of temperature soon after harvest. Especially in the southern states, growers harvest fruit during warm or hot periods of the day and fruit is quickly transferred to cold storage. Therefore, berries can undergo a drastic change in temperature in a short period and this is thought to contribute to reversion development. It is hypothesized that this rapid change of temperatures contributes to the breaking apart of cell membranes in the fruit, primarily the vacuole membrane.

This study aims to determine the effects of harvest time on firmness and reversion in five commercially available blackberry cultivars.

Materials and Methods

Shiny-black fruits free of any defects were harvested into 0.24 L commercial plastic, vented clamshells and stored for 7 d at 5 °C prior to evaluations.

- Cultivars: Prime-Ark® Traveler, Prime-Ark® 45, Ouachita, Osage, and Natchez.
- Harvest Times: 7:00 AM, 10:00 AM, 1:00 PM, and 4:00 PM.
- Fruit were harvested two times for each genotype, with two clamshells (replications) used for each storage temperature.
- Fruit temperature was recorded at each harvest time. Mean fruit temperatures (Table 1) was lower at earlier harvest times and increased later in the day.

After 7 d of storage, fruit was evaluated for firmness and incidence of reversion.

- Firmness (Fig. 2) was measured using the iCon texture analyzer (Texture Technologies Corp. Hamilton, MA) in Newtons (N).
  - Compression: 10 fruits measured with cylindrical, plane probe of 7.6 cm diameter.
  - Penetration: 10 fruits, 3 drupelets each, measured with a probe of 1 mm diameter.
- Reversion was evaluated on all berries harvested.
  - Fruit was recorded for the presence of reversion or having no reversion.
  - Percent berries showing no reversion was used in data analysis.
- Data was analyzed as a split plot design by analysis of variance with SAS (version 9.3) using the GLIMMIX Procedure.

Table 1. Mean fruit temperature and standard deviation for all harvests and genotypes at each harvest time.

Harvest time	Mean fruit temp (°C)	Std. dev.
7:00 AM	23.1	1.68
10:00 AM	29.2	3.45
1:00 PM	31.1	3.32
4:00 PM	31.8	2.35

[y]Least square means seperated using the LSD procedure.

Objectives

This study utilized five blackberry cultivars to address the following objectives:
1. To quantify the effect of time of harvest on berry firmness.
2. To determine the impact of harvest time (particularly field temperature) on postharvest development of reversion.

Table 2. Main effect means of harvest time for compression.

Harvest Time	Compression (N)[x]
7:00 AM	5.91b[y]
10:00 AM	5.79b
1:00 PM	6.14b
4:00 PM	7.06a
P value	0.0015

[x]Mean compression values (N=Newton).
[y]Least square means separated using the LSD procedure.

Table 3. Main effect means of genotype for penetration.

Genotype	Penetration (N)[x]
Prime-Ark® Traveler	0.19a[y]
Prime-Ark®45	0.13b
Ouachita	0.12b
Osage	0.11bc
Natchez	0.11c
P value	<0.0001

[x]Mean penetration values (N=Newton).
[y]Least square means separated using the LSD procedure.

Table 4. Main effect means of time for incidence of reversion.

Harvest Time	Mean%[x]
7:00 AM	57.5a[y]
10:00 AM	50.7ab
1:00 PM	45.4b
4:00 PM	46.7b
P value	0.0142

[x]Percent berries showing no reversion.
[y]Least square means separated using the LSD procedure.

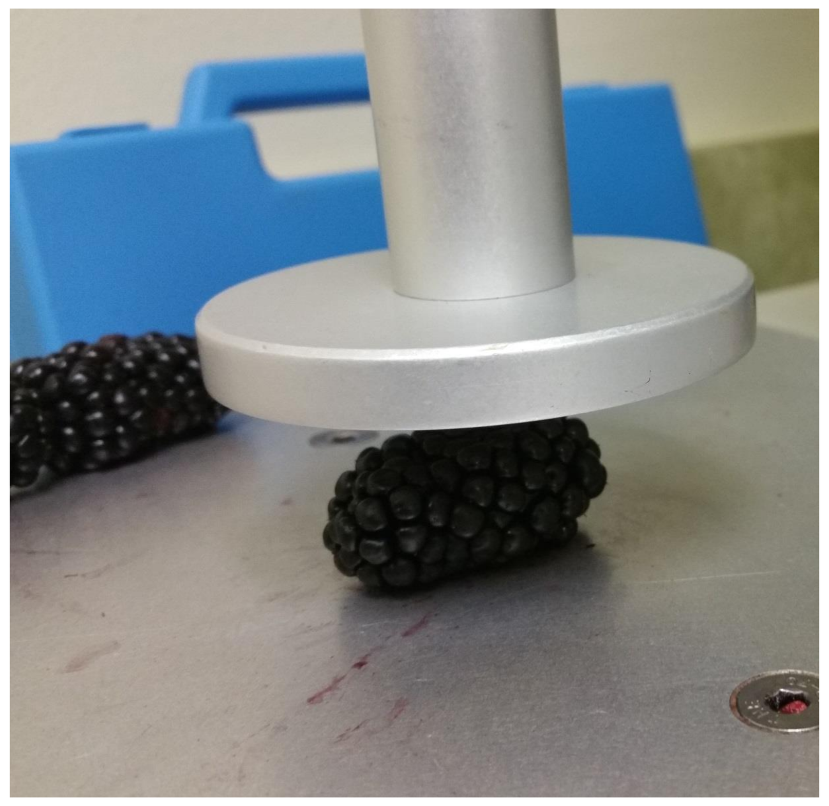

Fig. 2. Penetration (left) and compression (above) measurements using the iCon texture analyzer (Texture Technologies Corp. Hamilton, MA) .

Fig. 1. Red drupelet reversion in blackberry fruit.

Results and Discussion

Firmness (Table 2 and Table 3)
- Analysis of variance indicated significant main effects for:
  - Cultivar for penetration.
  - Time of harvest for compression.
- Surprisingly, no interactions were significant ($P \leq 0.05$). It was suspected individual cultivars would behave differently at individual harvest times, but this was not the case.
- Mean compression values indicated that fruit firmness was significantly higher at 4:00 PM harvest time.
  - Compression results were unexpected. It was anticipated that berries would be firmest early in the day and steadily decrease at later harvest times.
- Prime-Ark® Traveler had a significantly higher drupelet skin firmness compared with all other cultivars evaluated.

Reversion (Table 4)
- Analysis of variance for percentage of berries showing no reversion indicated significant main effects for harvest time, but not between genotypes.
- No cultivars were identified to have a significantly lower incidence of reversion.
- Once again, no significant interactions were found ($P \leq 0.05$).

Conclusions

- Results of this study suggest that this is a promising area for continued research.
- Prime-Ark® Traveler maintains a high firmness levels despite harvest time.
- It is thought that repeating this study for one or more years using more replications could contribute to significant differences being found among these variables for harvest time and genotype.