

# Evaluating the effect of harvest maturity on the quality characteristics of Gala and Honeycrisp apple cultivars grown under the Mid-Atlantic conditions

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## Introduction

Gala and Honeycrisp apples are among the top-three cultivars produced in the US. Honeycrisp in particular has become very popular among consumers in the fresh fruit market due to its crisp texture and distinct flavor profile. Honeycrisp, therefore, is a high-value cultivar, sold for premium prices, especially in the Mid-Atlantic which is one of the first regions to harvest Honeycrisp each season. Nevertheless, overall apple fruit quality can be impacted by several factors, including environmental conditions, preharvest management practices, and stage of maturation at harvest, each affecting fruit marketability. The objective of this research was to evaluate one of these factors – the effect of maturity at harvest – on the quality characteristics of these two key cultivars grown under the Mid-Atlantic conditions and provide recommendations of maturity at harvest depending on the target fruit market.

## Materials and Methods

- Fruit from Honeycrisp/M26 and Crimson Gala/M9 was harvested at three different maturity stages (Fig. 1): (i) August 25<sup>th</sup> (ii) September 5<sup>th</sup> (iii) September 19<sup>th</sup>
- On August 27<sup>th</sup>, both cultivars received an application of ReTain® (an ethylene production inhibitor).



Fig 1. Whole fruit images of Gala and Honeycrisp cultivars at each stage of evaluation.

- For each stage of maturation ten factors were evaluated [1]:
  - Fruit diameter (mm) with a caliper
  - Internal ethylene concentration (uL L<sup>-1</sup>) using gas chromatography (Fig. 2A)
  - Flesh firmness (lbs), utilizing a texture analyzer (Fig. 2B)
  - Starch content using Cornell scale (1(full starch)-8(starch-free)) [2] (Fig. 4B)
  - Soluble solids contents (%), utilizing a refractometer (Fig. 2C)
  - Acidity (% malic acid), with a titrator (Fig. 2D)
  - Fruit skin hue angle (blushed and unblushed) with a colorimeter (Fig. 2E)
  - Fruit skin red (blush)color (%)
  - Chlorophyll content quantification (I<sub>AD</sub>) using the difference of absorbance meter (Fig. 2F)

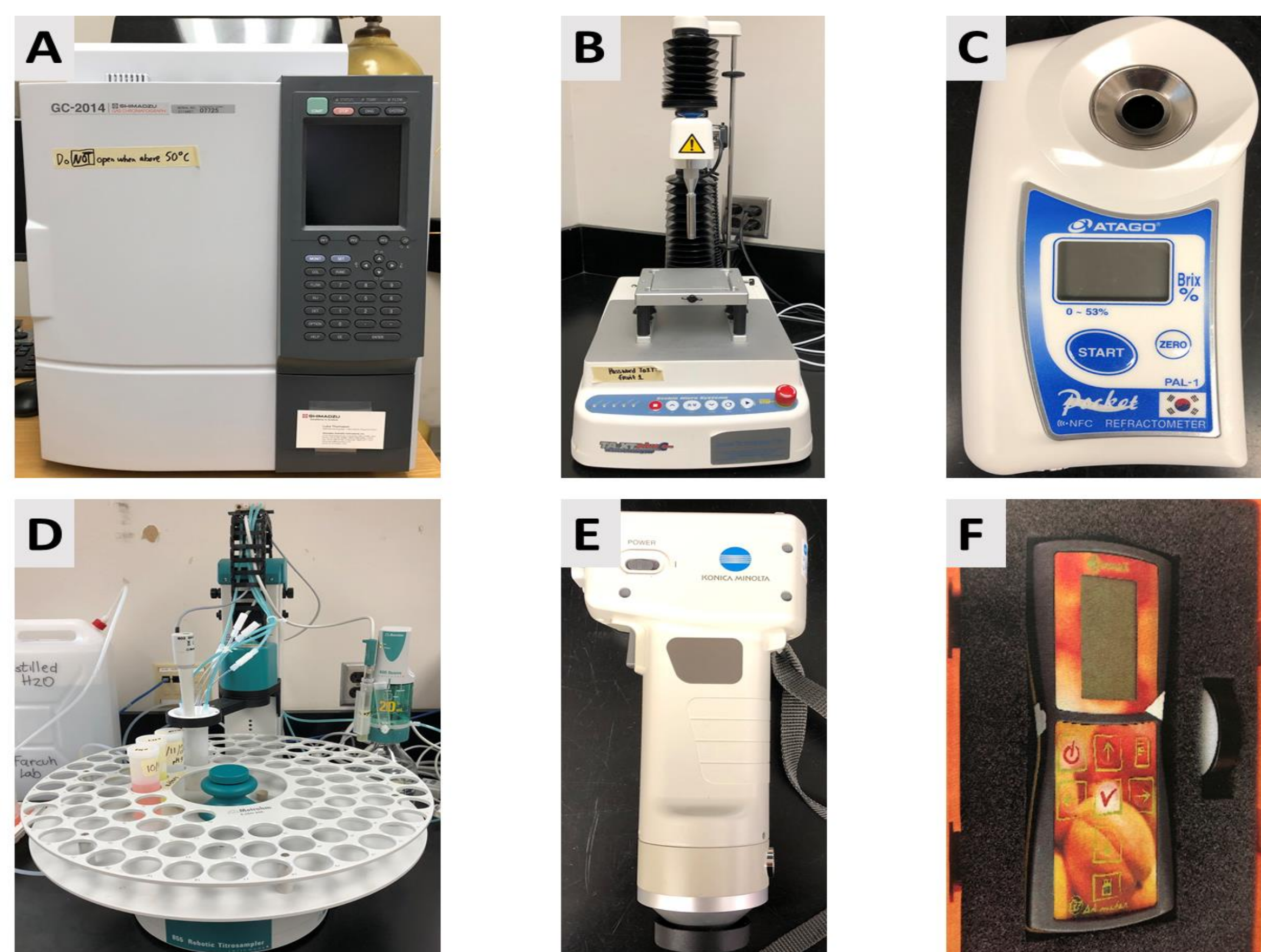


Fig. 2. Instruments used for evaluation of Gala and Honeycrisp quality parameters. (A) Gas Chromatograph (GC-FID), (B) Texture analyzer, (C) Refractometer, (D) Titrator, (E) Colorimeter, (F) Difference of absorbance meter.

- Means of four biological replications were submitted to two-way analysis of variance, using Tukey's test to compare between cultivars and maturity stages for significant differences at P < 0.05 for each parameter. The software package JMP® (ver.10.0, SAS Institute) was used for statistical analyses.

## Results

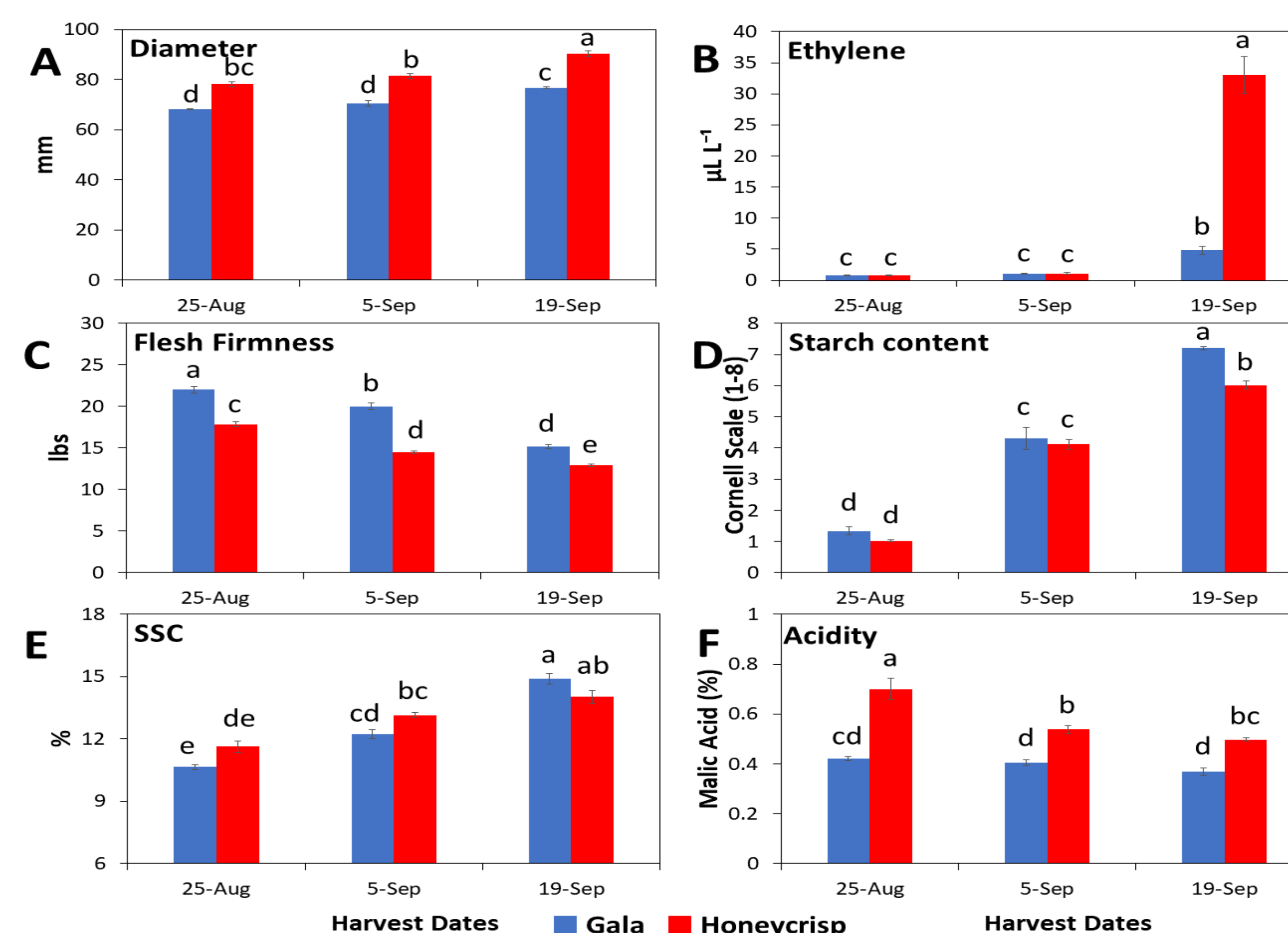


Fig. 3. Fruit quality assessments for Gala and Honeycrisp apple cultivars at three different maturities, harvested on August 25<sup>th</sup>, September 5<sup>th</sup>, and September 19<sup>th</sup>, 2020. Values are means ± SE (n=4). Different letters indicate significant differences (p < 0.05). (SSC = soluble solids content. DA = difference of absorbance. I<sub>AD</sub> = index of absorbance difference.)

### Fig. 3A: Fruit diameter:

- Diameter increased at all harvest dates
- Honeycrisp statistically larger than Gala at all harvest dates

### Fig. 3B: Internal ethylene concentration:

- August 25<sup>th</sup> exhibited low internal ethylene concentration due to fruit immaturity
- September 5<sup>th</sup> exhibited low internal ethylene due to ReTain® application effect
- September 19<sup>th</sup> exhibited a significant increase in ethylene concentration, which was dramatically higher in Honeycrisp

### Fig. 3C: Flesh firmness:

- Gala was statistically firmer than Honeycrisp
- Flesh firmness decreased as maturity advanced for both cultivars

### Fig. 3D and Fig. 4: Starch content changes:

- Starch index values increased throughout the different harvest dates
- Gala showed higher starch breakdown than Honeycrisp by the third harvest date
- Both cultivars were tree-ripe (>6) by the third harvest date

### Fig. 3E: Soluble solids contents (SSC):

- Sugar content increased in both cultivars throughout the three harvest dates
- SSC readings recommended for high quality fruits, ranging between 12% to 14%, were met by both cultivars at the second harvest date

### Fig. 3F: Acidity changes:

- Malic acid content decreased in both cultivars with Honeycrisp showing significant higher values at all harvest dates.

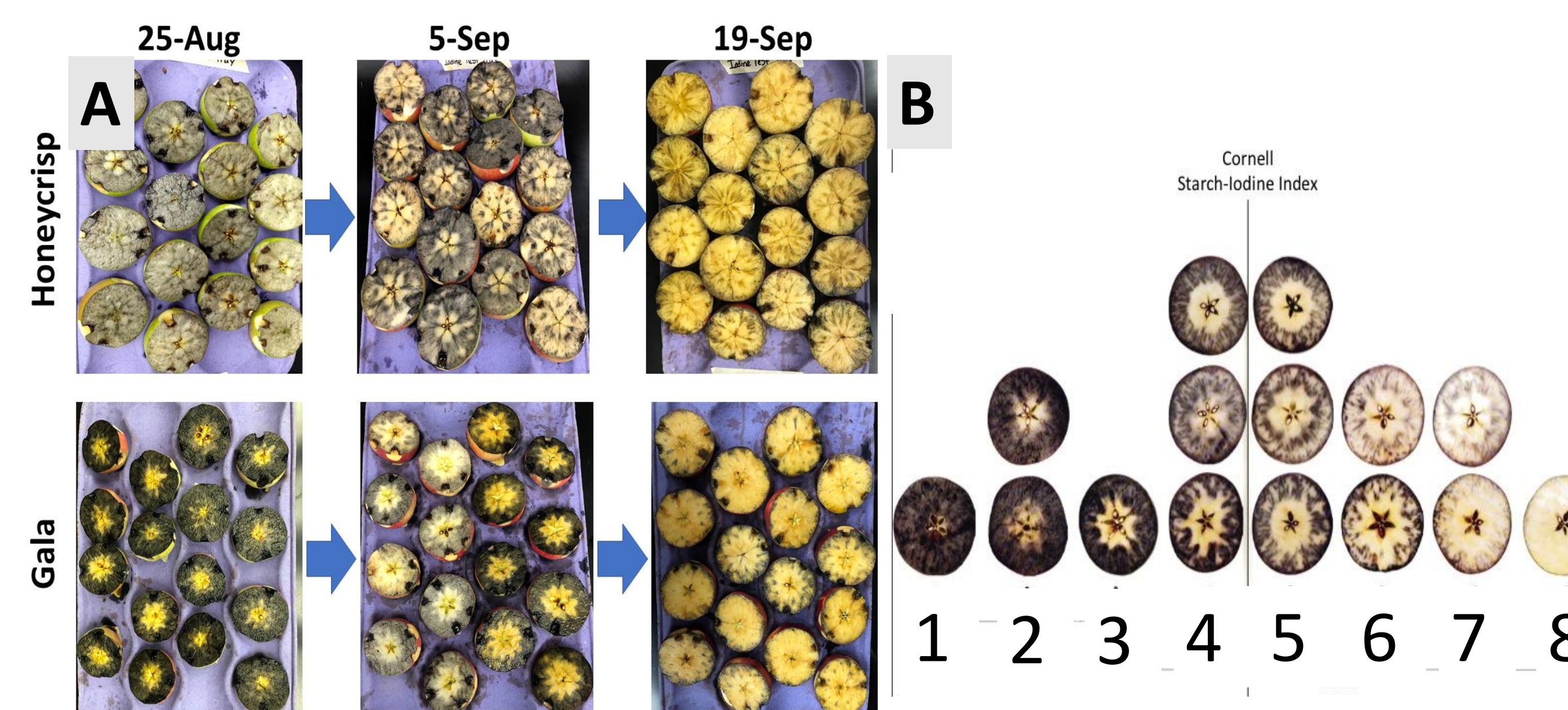


Fig. 4. (A) Starch content changes for Gala and Honeycrisp apple cultivars at three different maturities using the starch-iodine test (full starch (all blue-black) and starch-free (no stain)). (B) Cornell Scale utilized for quantification of starch patterns [2].

## Acknowledgements

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## References

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- Blanpied, G.D. and Silsby, K.J., 1992. Predicting harvest date windows for apples. Cornell Cooperative Extension.

## Results

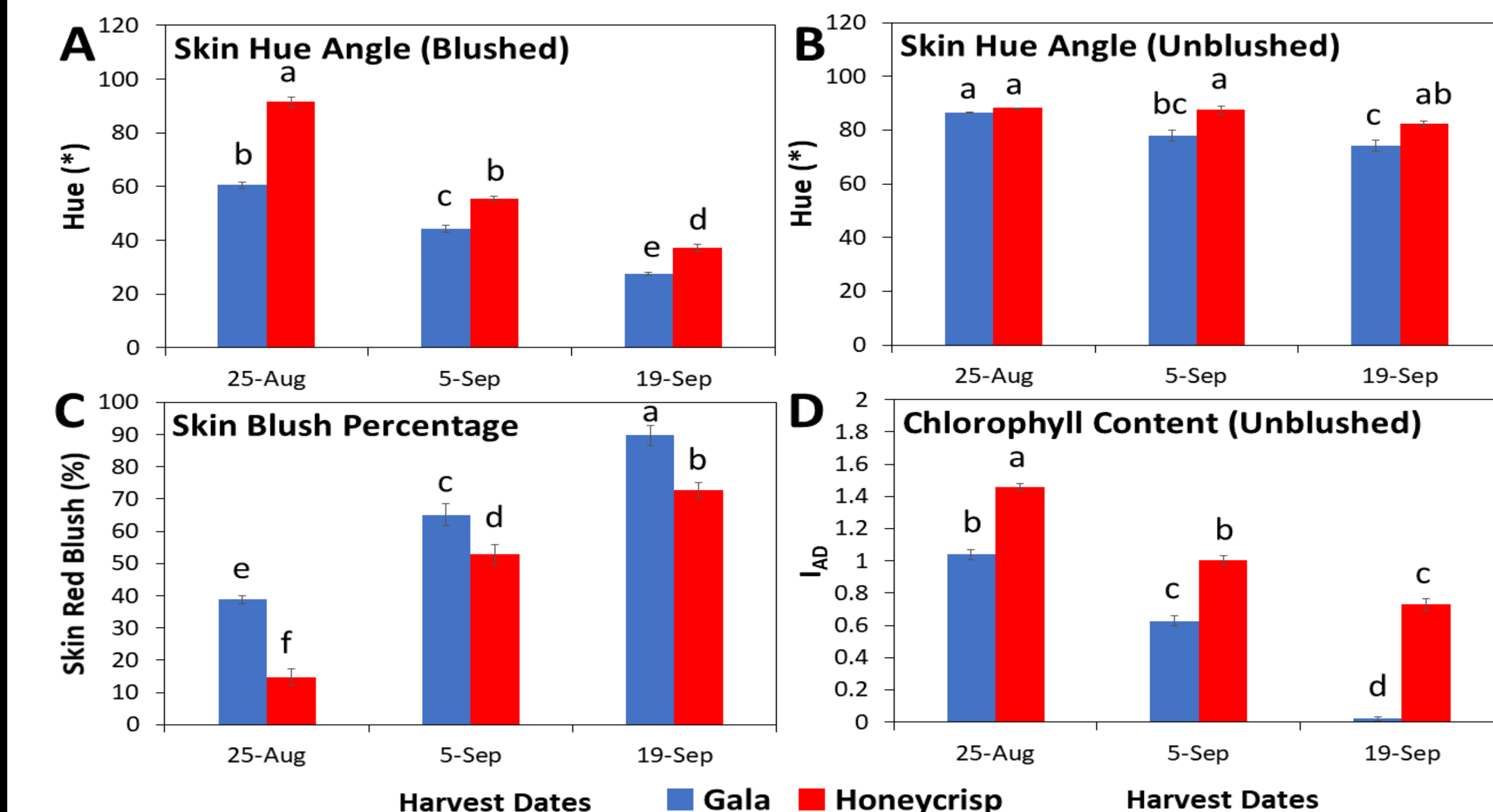


Fig 5. Skin color assessments for Gala and Honeycrisp apple cultivars at three different maturities, harvested on August 25<sup>th</sup>, September 5<sup>th</sup>, and September 19<sup>th</sup>, 2020. Values are means ± SE (n=4). Different letters indicate significant differences (p < 0.05). (SSC = soluble solids content. DA = difference of absorbance. I<sub>AD</sub> = index of absorbance difference.)

### Fig. 5A: Skin Hue (blush Side):

- Hue angle decreased during three harvest dates: yellow --> red skin coloration
- Gala statistically darker red than Honeycrisp at all harvest dates

### Fig. 5B: Skin Hue (unblush side):

- Hue angle decreased at harvest dates: green/yellow --> darker yellow skin color
- Gala significantly darker yellow than Honeycrisp after August 25<sup>th</sup>

### Fig. 5C: Skin blush percentage:

- Marketable blush (>50%) achieved: September 5<sup>th</sup>
- Maximum blush (>70%) observed: September 19<sup>th</sup>

### Fig. 5D: Chlorophyll content quantification (unblush side):

- I<sub>AD</sub> decreased over time for both cultivars
- Gala I<sub>AD</sub> << Honeycrisp I<sub>AD</sub> at all harvest dates

## Discussion

### Fig. 3 and Fig. 4:

- Largest fruit diameter occurred at the third maturity stage, but exhibited an increased risk to fruit cracking and fruit rots
- Ethylene production increased in time, indicative of acceleration of ripening
- Harvesting fruit at an advanced maturity will decrease shelf-life capacity, increase susceptibility to rots/cracking, due to decreased firmness
- When fruit ripens, starch in the fruit flesh is converted to sugars, limiting the fruit's shelf-life capacity
- Coinciding with the breakdown of starch, sugar content increased similarly in both cultivars throughout harvest dates.
- Harvesting Honeycrisp fruits at an advanced maturity will decrease fruit acidity and can have an impact in overall flavor when the fruit reaches consumers.

### Fig. 5:

- Gala displayed significantly darker red (blush) and yellow (unblushed) coloration as compared to Honeycrisp in most stages
- Darkest red coloration was achieved at later harvest dates (advanced maturity), at the risk of decreased shelf-life

## Conclusions

- Maturity at harvest plays a key role on the quality characteristics of Gala and Honeycrisp cultivars grown in the Mid-Atlantic region, influencing fruit marketability.
- Fruit harvested at an advanced maturity will be tree-ripe and display darker red and yellow (skin coloration, larger size, and higher soluble solids). Nevertheless, fruits will also display higher ethylene concentration, lower firmness, decreased storage capacity, together with increased susceptibility to cracking and rots.
- Fruit destined for long-term storage should be harvested at the second date of maturity.
- Cultivar-specific differences in Gala and Honeycrisp result in different quality characteristics in each cultivar.