When to Harvest Honeycrisp: A Preliminary Evaluation of Methods?

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Honeycrisp is one of the most popular apples, not only in New England, but also nationally. But, it has a plethora of problems that have been well documented. A number of these problems can be either eliminated or their severity dramatically reduced by harvesting the fruit at the proper stage of maturity. Currently, the volume of Honeycrisp produced in the United States is insufficient to have fruit available to be stored for an extended period of time. When this happens, however, it will be important to have harvest metrics in place to provide guidance in determining the proper stage of maturity to harvest fruit that will assure high quality fruit out of storage.

DeLong et al. (2014) recently published a paper that evaluated the Delta Absorbance (DA) meter developed to determine the proper time to harvest fruit. A commercially available DA Meter (T. R. Turoni srl, Forli Italy) nondestructively measures the loss of chlorophyll from apple fruit. This loss of chlorophyll results in changing the dominant color of an immature fruit from green to varying shades of light green to yellow as fruit matures. This group of researchers in Nova Scotia conducted a series of experiments with the goal of using the DA meter to identify the appropriate fruit maturity range to harvest Honeycrisp that would result in successfully storing Honeycrisp with minimal loss due to disorders.

The purpose of this preliminary research was to evaluate the DA meter and compare the results obtained following manufacturer directions compared with other more traditional methods for evaluating fruit maturity and for determining the appropriate time to harvest Honeycrisp.

Methods

Fruit from a block of Honeycrisp/M.9 trained as a tall spindle in their fourth leaf at the UMass Cold Spring Orchard, Belchertown, MA were selected for this evaluation. Initial harvest was done on September 11, 2014. At that time, fruit from these trees had an average starch reading of about 6.0, using the Cornell Generic Starch Chart (Blanpied and Silasby, 1992). Fruit were harvested that had a light green ground color, and a portion of the fruit surface showed commercially acceptable red color. In this initial harvest, about 35 % of the fruit were harvested. Fruit from trees were taken to the lab where up to 10 fruit per tree were randomly selected for evaluation. During the evaluation process, fruit were individually marked so that the various methods of maturity assessment could be cross referenced. Fruit were visually evaluated for red color development by estimating the percent of the fruit surface with red/pink color. The ground color was then estimated using a ground color chart on a scale of 1 to 5 in 0.5 unit increments (Bulletin 750, Ground Color for McIntosh Apples, Figure 1). This chart was developed for McIntosh apples and was published in 1948. While the match was not ideal for Honeycrisp, it was sufficiently similar to be very useful and instructive. The fruit were then

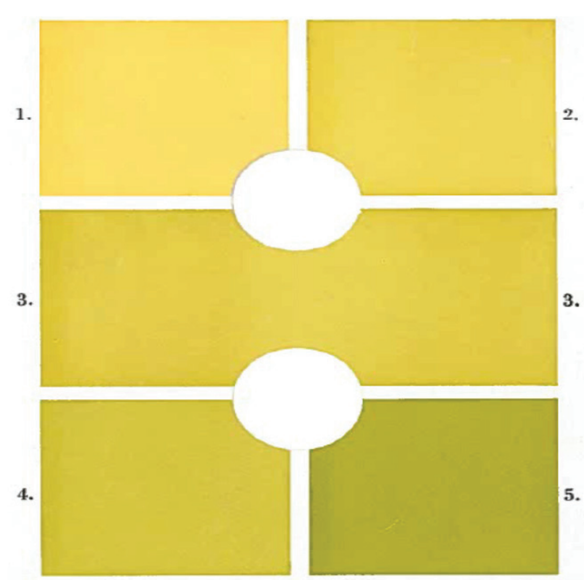

Figure 1. Ground color chart for McIntosh. Cornell Extension Bulletin 750 showing ground color of fruit ranging from immature (5) to over mature (1).

Table 1. Significance of correlation coefficients (r) between methods evaluated to assess fruit maturity of Honeycrisp apples.

Method	Red color	Background color	Internal Ethylene	DA value	Starch content
Red color	---------	0.0003		0.05	0.007
Background color	0.003	--------	0.01	0.001	0.005
Internal ethylene		0.01	---------		0.001
DA value	0.05	0.001		---------	
Starch content	0.007	0.005	0.001		---------

evaluated using the DA meter following manufactures directions by taking two readings per fruit. Data were expressed in I_{AD} units. The internal ethylene was then determined by taking an air sample from the core cavity of the fruit and then determining the ethylene content in a 1 ml sample injected in a gas chromatograph. Fruit were then cut at the equator, dipped in an iodine solution, and then after a period of development, the starch content and pattern of development were rated on a scale of 1-8 using the Cornell Generic Starch Chart.

Results

The harvest data were statistically analyzed to determine the relationship between parameters evaluated. The statistical significance of the correlation coefficients (r) is presented in Table 1. Only the correlation coefficients that were significant at P= 0.05 or greater are presented.

Data were sorted according to each parameter used to evaluate stage of maturity. Results presented in Table 2 are those that were sorted by DA reading and the number for each parameter in the table is the mean for each fruit within that DA range. The higher the DA reading the greater the amount of chlorophyll detected in the peel. Thus, fruit with higher DA readings are less mature than fruit that have lower numbers. The internal ethylene content of fruit appeared to be quite similar and thus may have limited usefulness in identifying fruit with different levels of maturity. This confirms previous published reports. The large majority of fruit had internal ethylene levels higher than 1.0 ppm threshold, the content that we generally use for most varieties to designate a fruit

Table 2. Relationship of the delta absorbance (DA) meter in I_{AD} units with other methods to assess fruit maturity (ethylene content, starch rating, fruit red color, and background color) on first-harvest Honeycrisp apples.

DA Range (I_{AD} units)	Background color (1-5)	Internal ethylene ($\mu l \cdot L^{-1}$)	Starch rating (1-8)	Red color (%)
0.91-1.00	3.1	6.1	4.9	70
0.86-0.90	3.1	7.4	4.7	55
0.81-0.85	2.7	3.0	4.7	59
0.76-0.80	2.5	7.1	5.3	66
0.71-0.75	2.3	6.3	5.3	68
0.66-0.70	2.1	7.2	5.9	72
0.61-0.65	2.1	11.3	6.3	74
0.56-0.60	2.2	7.7	6.1	68
0.51-0.55	1.8	8.5	6.0	74
0.46-0.50	1.5	6.6	6.1	76
0.36-0.45	11.8	13.1	7.2	73

Table 3. Relationship of fruit background color with delta absorbance (DA) meter and other methods to assess fruit maturity (ethylene content, starch rating, fruit red color) on first-harvest Honeycrisp apples.

Background color (1-5)	DA absorbance reading (I_{AD} units)	Internal ethylene ($\mu l \cdot L^{-1}$)	Starch rating (1-8)	Red color (%)
1.0	0.53	24.8	6.8	78
1.5	0.51	8.6	6.3	74
2.0	0.62	7.3	5.8	70
2.5	0.72	6.2	5.7	69
3.0	0.80	6.7	5.1	62
3.5	0.88	4.8	5.0	50
4.0	0.91	5.8	5.3	60

to be climacteric. There was a statistically significant relationship between ethylene and red color and starch content (Table 1). Essentially, over the whole DA range the ethylene content varied little. There was a fairly close relationship between DA reading and the ground color estimation. This is not surprising since both parameters are based upon measuring or assessing the amount of chlorophyll present in the skin.

Data were sorted according to background color (Table 3). There was a statistically significant correlation between ground color and all of the other parameters measured. Even though significant, the relationship between ground color and ethylene did not appear to be very tight and thus of questionable usefulness. There was a close relationship between background color and starch rating.

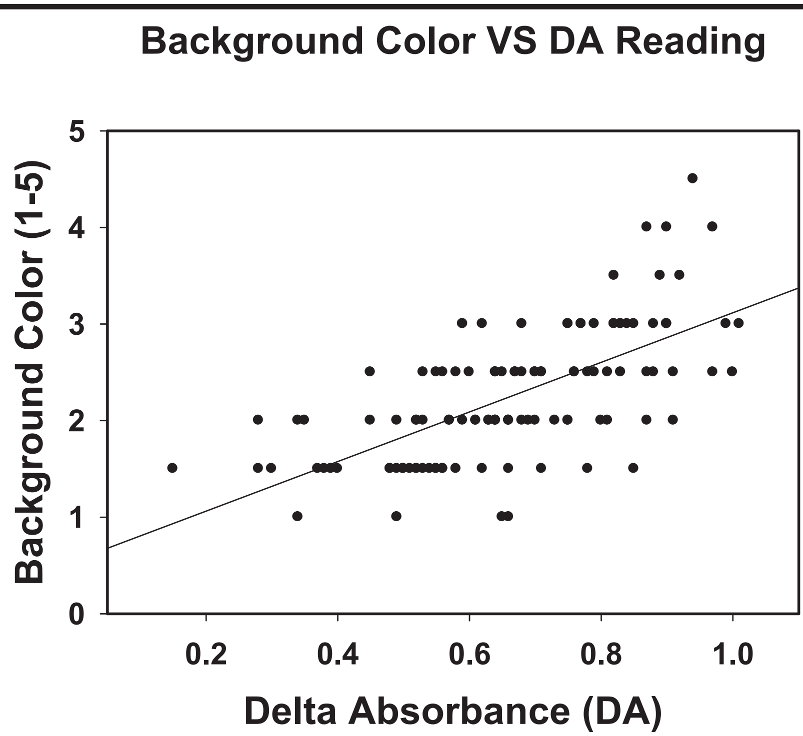

Figure 2. Relationship between Delta absorbance reading and the background color of first harvest Honeycrisp apples.

Discussion

Delong et al. (2014) suggested that fruit with a DA reading of 0.6 or higher are
more prone to develop bitter pit in storage, whereas if harvest is delayed until the DA reading of fruit drops below 0.35, fruit would be more likely to develop senescent breakdown in storage. Therefore, the ideal range for orchardist to harvest Honeycrisp using the DA meter is between 0.35 and 0.60 I_{AD} units One of the most revealing aspects of this investigation was the extremely large amount of variability that was apparent when attempt-

ing to establish relationship among maturity parameters (Figures 2 and 3). Honeycrisp appears to show more variability than most varieties.

The price of the DA meter is approximately $4,000, thus prompting the question of whether purchasing a unit is a good investment, particularly for a small grower with limited acreage. The background color chart yielded about the same if not better information, and it was the only method that correlated well with all of the other methods evaluated to assess maturity. Its cost would be small and the time required to make appropriate readings would be equal to or less than the DA meter. Having ground color as a component in making a harvest decision seems like a more prudent investment than a DA meter. While the ground color chart used in this investigation probably is not readily available, colored sheets can be purchased and a ground color chart assembled with relative ease. This would not be a difficult task and an activity that seems to have merit.

We conclude that it appears that the approach that makes the most sense and would be most useful is to use more than one parameter in the decision making. We suggest sampling the block periodically and do a starch test on a representative sample of fruit. When the starch readings average about 6 on the Cornell generic starch chart, make the initial harvest by spot picking. At this time, harvest all fruit that have a background color of light green, white, or light yellow (according to the ground-color chart) that also show signs of red or pink turning to red color.

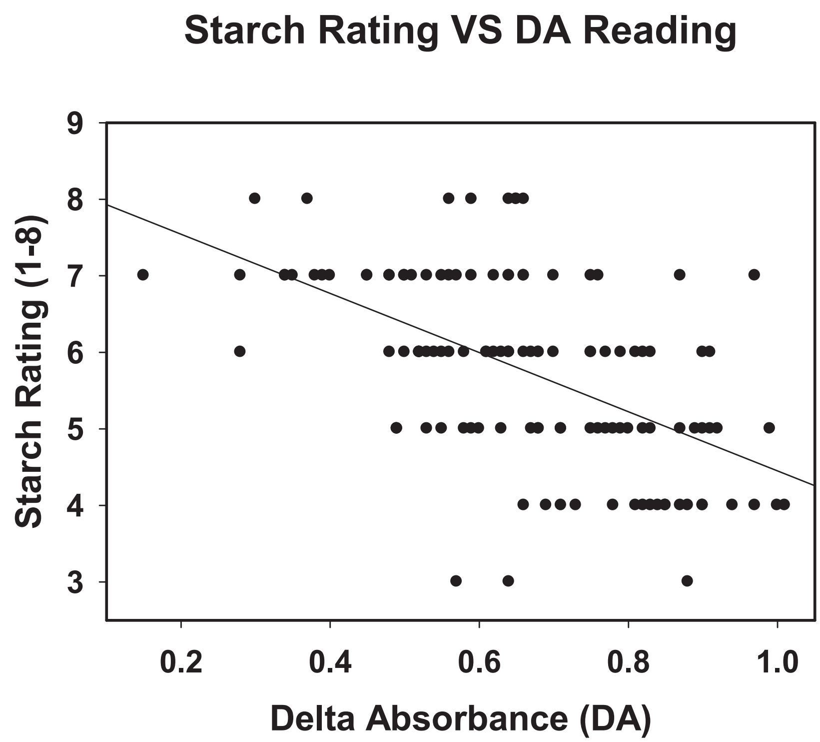

Figure 3. Relationship between background color and Delta absorbance reading of first harvest Honeycrisp apples.

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