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Are Your Peaches Ready to Harvest?

U.S. peach production and per capita consumption decreased by approximately 30% and 50%, respectively from early 2007 to 2019 (Figures 1A and 1B). The decline in consumption was due to competition with other fruit and lack of year-round production. but poor eating quality is a big issue leaving consumers dissatisfied. Harvesting peaches at the right maturity stage is crucial to improving fresh market quality and potentially increasing marketability. Peaches harvested too early may never reach full maturity and will have poor flavor. Peaches harvested too late (overmature) are more susceptible to pathogen invasion, bruising during handling, and off-flavor.

Harvest time for peaches sold at farmer markets or pick-your-own operations can be delayed until a red blush develops with softer texture and higher sweetness for better eating equality.

Peach maturity indices based on target markets can help growers identify the right conditions for optimum fruit quality harvest. Multiple maturity indices, including change in background coloration, chlorophyll contents, fruit size/diameter, firmness, sugar content and acidity, can be used to determine peach maturity and harvest dates. None of these maturity indices alone is sufficient to indicate the maturity stage of peaches. Growers should use multiple indices to make harvest and marketing decisions.

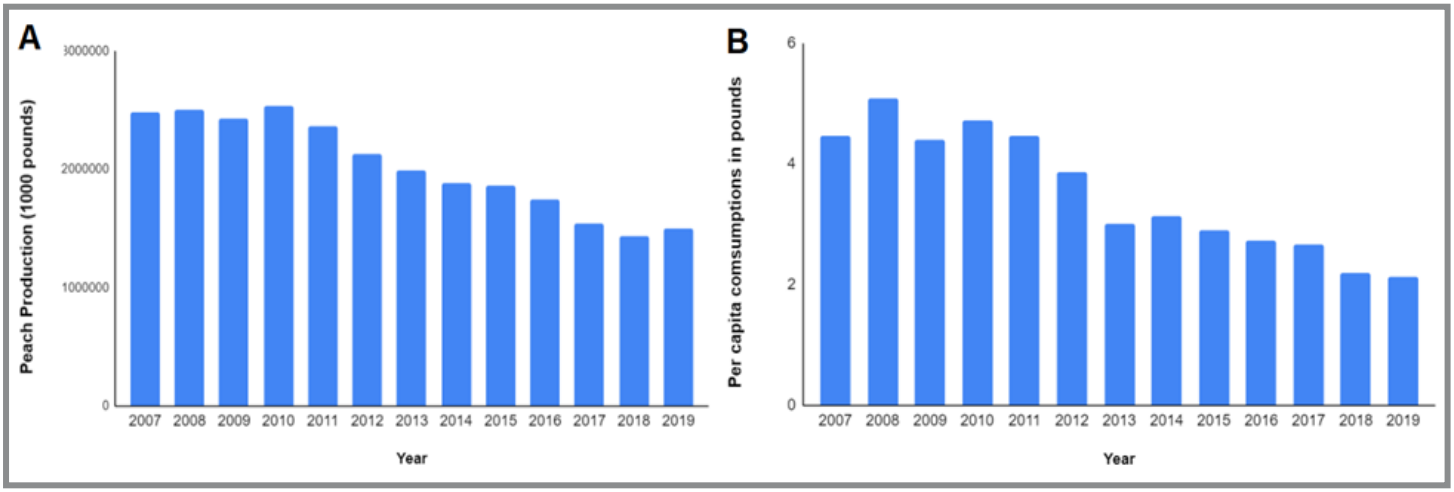

Figure 1. *(A) U.S. peach production trends, 2007-2020 (in 1,000 pounds). Source: USDA National Agricultural Statistics. (B) U.S. per capita consumption of fresh peaches and nectarines, 2007-2019 (in pounds). Source: Statista.com.*

Peach maturity stage at harvest also depends on the target market. Peaches for wholesale are usually harvested firm when their skin just turns yellow for better storability.

The optimal value of each maturity index is based on the

target market for the fruit. Peaches destined for farmers market or pick-your-own practices are harvested more mature than peaches for wholesale/retail. As maturity indices can vary among cultivars, orchard block and season, it is critical to select representative fruit for the maturity measurements and start sampling weekly four weeks before anticipated harvest date.

Collecting Representative Samples is Key!

Peach maturity differs among cultivars/rootstocks, different blocks of the orchard, or even the same tree. Therefore, each cultivar and each block should be sampled separately and representative samples should be collected in the same manner from each sampled tree.

Sampling for maturity ideally takes place four weeks before the estimated time of harvest and continues until harvest. Analysis for maturity should be performed weekly and every other day when fruit is close to anticipated maturity. Days after full bloom (DAFB) is a useful tool to estimate the harvest timing if the previous harvest dates for each block are well recorded. In general, DAFB can range from 100 to 130 days depending on cultivars. The actual DAFB can vary 5 to 20 days depending on the environmental conditions of the season.

The first step for sampling is to choose 10 to 20 trees per block per cultivar and rootstock. Selected trees should be representative in terms of crop load and vigor. Avoid choosing trees from the borders of any blocks, as those trees are likely encountering more traffic, wind, and light interception. Label the sampled tree and keep sampling from the same tree.

Fruit from the outer part of the tree canopy receive more sunlight and will ripen earlier than fruit located inside the canopy. Therefore, sample two or three fruits from the periphery of each marked tree. Select fruit with uniform size without visible defects. Keep sampling methods consistent and collect samples at the same time of day and measure quality within 2 hours of picking.

What are the Main Peach Fruit Maturity Indices?

Color Changes

Surface color: The red skin color in most peach cultivars increases with sunlight exposure which is influenced by location in the canopy. The characteristic color decreases with high temperature and excessive or insufficient nutrient availability. There is also cultivar/ rootstock variation in red skin color. Therefore, the degree of red coloration is not a good indicator for maturity, although it is a key aspect for marketability. According to the USDA grade standard, 50% of the peaches should have no less than 1/4 of surface pink or red color (blush) to meet US. Extra No.1; while 90% of the peaches should have no less than 1/3 of surface showing blush to meet U.S. Fancy. Furthermore, the redness in peach skin is more appealing to consumers, which is a key aspect for selling in farmers markets and pick-your-own operations.

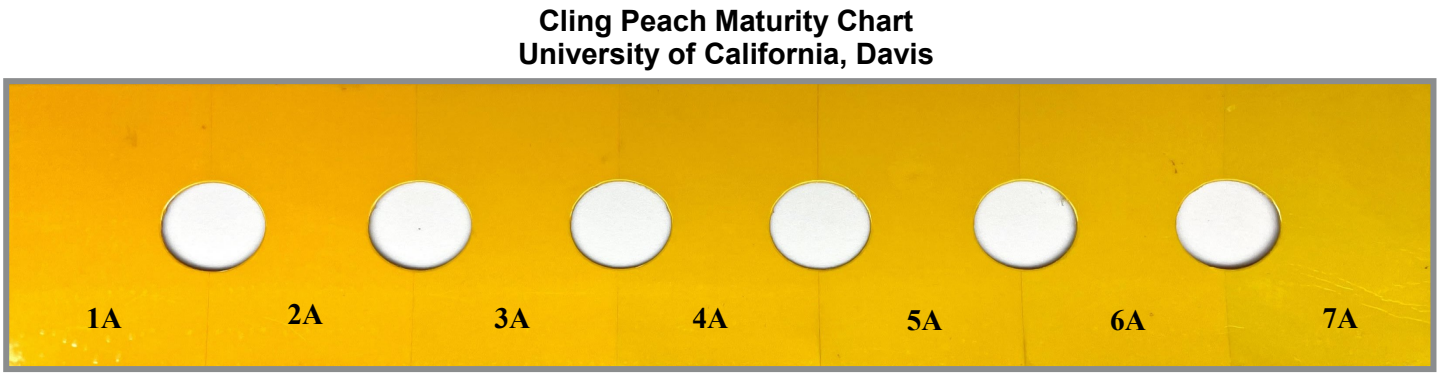

Figure 2. *Peach color chart (1 to 7 scale). Source: UC Davis Postharvest Center.*

Background color: Changes in background color are widely used as one of the maturity indices for peaches. The transition from green to yellow (for yellow flesh peaches) or cream color (for white flesh peaches) is a sign of maturity for harvest if targeting for long-distance shipping or long-duration storage. In general, a fully ripened peach has dark yellow color and should be sold immediately, while orange color indicates that the fruit is overripe. Tools such as color charts (Figure 2) are useful to help estimate more defined maturity stages. However, background color measurement does not work well with solid red cultivars (i.e., 'Sunhigh') because they have a higher percentage of red color even before their optimal maturity and their background color change is not perceptible to the naked eye. For those cultivars, it is necessary to choose other maturity indices for accurate harvest timing.

Chlorophyll content: As fruit ripens, chlorophyll contents decrease. The DA meter is a portable device measuring the Index of Absorbance Difference (I_{AD}), which is strongly related to the chlorophyll-a content in fruit skin. The I_{AD} value decreases as chlorophyll degrades during ripening. The DA meter shines LED light on fruit skin and measures the amount of light reflected back (Figure 3).

Figure 3*. Using a DA meter to quantify the Index of Absorbance Difference (I_{AD}) in peaches which relates to the actual content of chlorophyll-a in the fruit skin. Source: Yixin Cai, University of Maryland*

Peaches that are:

- immature have $I_{AD} > 0.9$;
- ready to be harvested for the wholesale market have I_{AD} between 0.4 and 0.9;
- ready to eat, sold locally through farmers markets, have I_{AD} between 0 and 0.4.

I_{AD} decreases at a much higher rate once background color goes from green to yellow/cream. Although a DA meter is a handy tool to assess maturity stage, it must be used in combination with other indices.

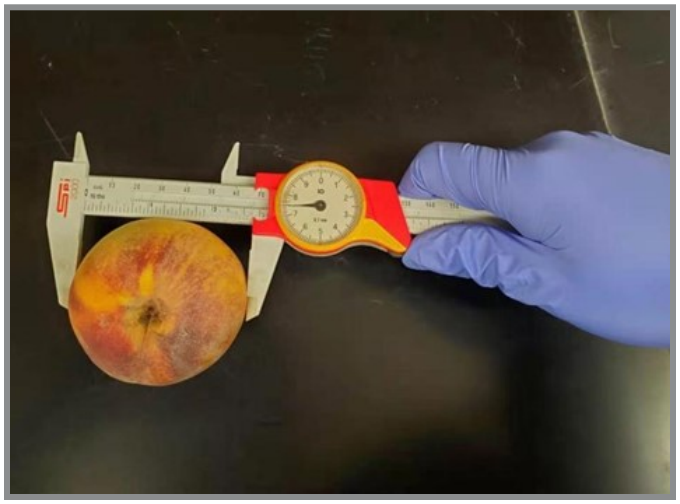

Figure 4. *Using a hand-held caliper to measure the diameter of peach. Source: Yixin Cai, University of Maryland*

Size and Diameter

Fruit shape: Producers also can determine peach maturity by fruit shape and cheek fullness, especially when the shoulders and suture are filled out and well developed. The diameter of a peach can be measured equatorially by a hand-held caliper at its widest part (Figure 4). The size of peach varies by canopy position, crop load, water and nutrient status, as well as genetics of cultivar and rootstock. Peaches that are 2.5 inches and larger in diameter appeal more to consumers and are in high demand at farmers markets.

Flesh Firmness

As fruit matures, flesh firmness decreases. Firmness can be easily measured by either a hand-held penetrometer (i.e., Effegi firmness tester) or a bench stand penetrometer (i.e., Magness-Taylor pressure tester). The instruments measure the amount of force needed to penetrate the fruit flesh.

To measure, use a peeler and remove a section of skin between the size of a nickel and a quarter on both equatorial sides of the peach at a point midway between the stem end and tip. Choose a 5/16-inch (8mm) diameter plunger (the 7/16-inch one is for harder fruits such as apples). Hold the peach against a stationary, hard surface and push the plunger to the scribed line into the flesh Figure 5). It is important to insert the plunger using smooth and uniform pressure. Pay attention to the speed of penetration. It should take about two seconds to push the plunger with constant speed. Read to the nearest 0.5 lb.-force. Measure both sides to get an average of firmness. The same person should perform the tests for each fruit for consistency.

Peaches with a flesh firmness of 10-16 lb.-force are recommended for wholesale and long-term storage, while peaches with a 2-4 lb.-force are considered ready to eat and are targeted for selling at farmers markets and pick-your-own operations. In general, ready-to-eat peaches have a better eating quality and flavor than firmer peaches, but they are prone to damage during transportation and have reduced storability potential.

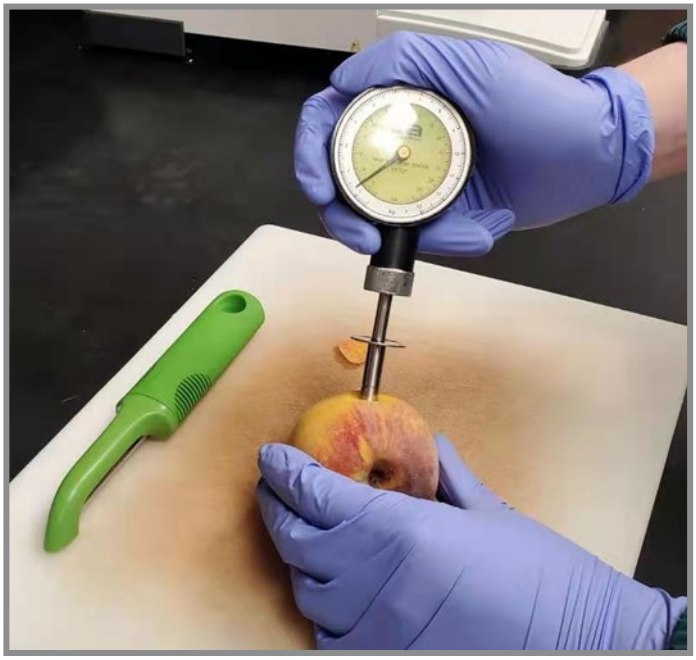

Figure 5. *Using a hand-held penetrometer to measure the flesh firmness of peach. Source: Yixin Cai, University of Maryland*

Firmness is not uniform in peaches, and the tip, suture, and shoulders are considered weak points, which are prone to bruising and damage during postharvest handling. Early season cultivars (i.e., Candor, Garnet Beauty) tend to soften faster at the tip, while late season cultivars (i.e., Cresthaven, Redskin) soften faster at the suture/shoulders. For the wholesale market, firmness at the tip of early season cultivars also should be measured to ensure fruit has minimum firmness (above 10 lb.-force) for transportation and storage.

Figure 6. *A hand-held manual refractometer (right) and digital refractometer (left) for measuring soluble solids contents of extracted peach juice sample. Source: Yixin Cai, University of Maryland*

Soluble Solid Contents (SSC)

Sugar is the major component of soluble solid contents (SSC) in fruit. Other components include organic acids, amino acids, phenolic compounds, and soluble pectins. Growers can measure changes in SSC in juice using a

manual or digital refractometer to estimate the sugar content (Figure 6). The device measures the light deviation when passing the juice and scales the refractive index into °Brix or SSC percent.

To measure SSC, cut two wedges from both sides of the fruit. Each wedge should be sliced longitudinally from stem end to calyx end and to the center. Use a garlic or potato-presser to squeeze juice through a cheesecloth. It is important to keep the temperature of the juice constant for each measurement. Digital and some manual refractometers have temperature compensation capability to correct for variations in temperatures.

To use a manual device (Figure 6), drop a small amount of juice on the prism. Close the lid and turn the instrument toward light. The position where the light and dark regions cross gives the reading. The digital refractometer has an internal light source and sensor which help minimize operator error. Use distilled water to rinse the prism and wipe with soft tissue paper after each measurement.

Many factors including climate, cultivar/rootstock, and orchard practices can influence SSC in peaches, making comparison between seasons difficult. Hot weather and direct sunlight increase SSC by enhanced photosynthesis, while precipitation, irrigation, and heavy crop load dilute sugar accumulation and lower SSC. Training systems and thinning practices affect fruit light exposure as well as leaf/fruit ratio, which consequentially impact SSC of fruit within the same tree. Variation in SSC content can be found even within a peach between stem and calyx ends,

Table 1. Summary table including some of the main peach cultivars that are mainly established in the Mid-Atlantic Region and some of their main characteristics

Cultivar name	Main characteristics
Candor	Early, medium-sized fruit. Semi-freestone, resistant to bacterial spot but susceptible to pit splitting.
Garnet Beauty	A sport of Redhaven. Medium-to-large, fuzz-less, red fruit. Firm, yellow, semi-freestone flesh. Vigorous and productive.
Reliance	Buds are cold-hardy. Good for gardeners in Northern and Western areas of Maryland.
Redhaven	Most popular peach in Mid-Atlantic region. Red, semi-freestone fruit. Requires thorough thinning.
Raritan Rose	Large, red fruit with white flesh; excellent quality. Vigorous and productive trees.
Loring	Medium-to-large red fruit over a yellow background. Can produce heavy crops but blooms early.
Newhaven	Similar to Redhaven. Very reliable with good disease resistance.
Cresthaven	Medium-to-large golden fruit overlaid with red. Vigorous trees require thorough thinning.
Summerglo	Large, yellow fruit. Vigorous and productive trees with above-average cold hardiness.
Sunhigh	Large, oblong fruit turns red over an orange background. Important commercial cultivar. Susceptible to bacterial spot.
Redskin	Large fruit, very high quality. Blooms over a long period. Vigorous tree developed at the University of Maryland in 1931.
Red Rose	Medium-sized, red fruit with white flesh. Vigorous, hardy trees.
White Hale	Similar to J.H. Hale but with white flesh. Large, high-quality fruit; productive trees.

Table 2. Summary of peach maturity indices to use depending on target market: wholesale or direct marketing

Maturity index	Wholesale market and long-term storage	Direct marketing
Background color*	Green to yellow (for yellow flesh peaches) Green to cream color (for white flesh peaches)	Dark yellow
Chlorophyll content (DA value)	IAD between 0.4 and 0.9	IAD between 0 and 0.4.
Flesh Firmness	10-16 lb.-force	2-4 lb.-force
Soluble Solids Contents (%)	>10%	>12%

**Background color measurement does not work well with solid red cultivars.*

making it necessary to sample longitudinally across the fruit.

SSC of 10% is considered a minimum marketable quality standard. SSC in peaches continues to increase until full maturity but stays constant after harvested. Peaches with higher SSC (12% and up) are considered higher quality and preferred by the consumers. Depending on the target market, decisions regarding how late a peach can be left on a tree to accumulate SSC should be balanced with its storability.

Acidity Change

Organic acid content decreases as peaches mature and can be measured as titratable acidity (TA). However, TA itself is usually not used as a maturity index because there are few guidelines for peach maturity based on TA. This is due to the large variation in TA among peach cultivars, which ranges from 0.2% to over 1%. Peach cultivars can be sorted into three groups based on acidity: low acidity (TA< 0.5 or pH>4); standard/medium acidity (TA: 0.5-0.7 or pH:3.8-4); and high acidity (TA>0.7 or pH<3.8). In general, white fleshed peaches are less acidic than yellow fleshed peaches.

TA measurement requires specialized laboratory instruments, such as a titrator. To measure TA, a known volume of juice is titrated with a base such as sodium hydroxide, to an end point of pH=8.2. TA is calculated based on the volume of juice, the volume of base solution used and acid milliequivalent factor of malic acid in peach.

Ratio of Soluble Solids Content over Titratable Acidity

SSC/TA is an important quality index as human's taste is a combination of sweetness and sourness. The ratio of SSC to TA increases as peaches mature; however, there are no suggested SSC/TA values corresponding to maturity stages due to the large variation in SSC and TA among different cultivars. It is important not to compare SSC/TA across different acidity groups as low acidity cultivars can yield a ratio four times or more higher than standard/high acidity cultivars. Generally, a higher ratio is linked to consumers' perception of sweetness and satisfaction. SSC/TA of 13 or higher in high-acidity cultivars and 28 or higher in low-acidity cultivars can have an over 80% customer acceptance rate.

References

Cirilli, M., D. Bassi, and A. Ciacciulli. 2016. Sugars in peach fruit: a breeding perspective. *Horticulture Research* 3.1: 1-12.

Crisosto, C. H. 1994. Stone fruit maturity indices: a descriptive review. *Postharvest News and Information*, 5 (6): 65-68.

Fruit & Nut Research & Information Center Website, UC Davis <http://fruitsandnuts.ucdavis.edu/Weather_Services/Harvest_Prediction__About_Growing_Degree_Hours/>. (Accessed on April 5 2021).

Gasic K, Reighard G L, Windham J, et al. 2015. Relationship between fruit maturity at harvest and fruit quality in peach. *Acta horticulturae.* 1084, 643-648

Kelley K M, Primrose R, Crassweller R, et al. 2016. Consumer peach preferences and purchasing behavior: a mixed methods study[J]. *Journal of the Science of Food and Agriculture*. 96(7): 2451-2461.

Layne, D. 2010. *How to Determine Peach Ripeness*. Clemson Cooperative Extension. <https://hgic.clemson.edu/how-to-determine-peach-ripeness/> (Accessed on April 5, 2021).

Marini, R. 2019. Peach Marketing: *Can Peach Consumption be Increased?* Penn State Extension. <https://extension.psu.edu/peach-marketing-can-peach-consumption-be-increased>

Mitcham, B., Cantwell, M., & Kader, A. 1996. Methods for determining quality of fresh commodities. *Perishables handling newsletter*, 85: 1-5.

Statista.com. (2019) Per capita consumption of fresh peaches and nectarines in the United States from 2000 to 2019 <https://www.statista.com/statistics/257229/per-capita-consumption-of-fresh-peaches-and-nectarines-in-the-us/> (Accessed on April 5, 2021).

University of Maryland Extension. *Growing, Selecting, Planting Peach and Cherry Trees*. <https://extension.umd.edu/resource/growing-selecting-planting-peach-and-cherry-trees> (Accessed on September 9, 2021).

U.S. Department of Agriculture. *U.S. Grade Standards for Peaches*. <https://www.ams.usda.gov/grades-standards/peach-grades-and-standards> (Accessed on April 5, 2021).

U.S. Department of Agriculture. National Agricultural Statistics system. https://quickstats.nass.usda.gov/results/ED50DBB4-339A-3786-8E23-90A27FCA7849?pivot=short_desc (Accessed on April 5, 2021).