The Road from the Grove To the Consumer

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(Editor's Note: This article is a summary by Tim Spann, CAC research project manager, based on a talk presented by Dr. Arpaia at the California Avocado Society seminars in San Luis Obispo, Ventura and Temecula in February.)

There are several features of the avocado that make it a unique and high quality fruit. Most fruits undergo a period of rapid cell division shortly after fruit set, which limits the maximum size the fruit can achieve, followed by a period of cell enlargement. However, avocados continue to undergo cell division until they are harvested, which allows them to continue to increase in size the longer they stay on the tree. Avocados also contain high levels of phytonutrients – they are higher in potassium than bananas – and unusual sugar alcohols, the potential health benefits of which are currently unknown. In addition, avocados accumulate large quantities of lipids (fats) in their flesh rather than sugar. These fats are monounsaturated (good) and include oleic acid, the same good fat as olive oil.

Despite its high quality, avocado does have some limitations, most of which affect its postharvest life. Avocados have a relatively short storage life, only three to four weeks. In addition, because avocados are harvested over a long period of time, their tolerance of postharvest handling and storage changes as the fruit maturity changes. There are some postharvest problems that can develop with avocados, which can be influenced, both positively and negatively, by cultural and harvest practices.

Seasonal quality changes

Avocado fruit quality is not uniform over the harvest season. Early season Hass fruit may not fully color, may have a watery texture, and may be bland or grassy in flavor following ripening. They also require ethylene treatment to ripen uniformly and avoid checkerboarding. Early season fruit also are more prone to shriveling during ripening because of their lower dry matter and higher water content, they suffer higher levels of decay than at other times of the season, have more internal disorders, and are most susceptible to low temperature (36-41°F) damage.

Mid season fruit have the best balance of quality, flavor and tolerance to postharvest handling. They ripen uniformly in response to ethylene treatment with little or no checkerboarding. Mid season fruit do not suffer from shriveling, have virtually no decay unless harvested after rain, and are the most tolerant of long-term (3 to 4 weeks) storage. When ripe, mid season Hass fruit develop a uniform green-black to black color, have a creamy texture and excellent flavor.

Late season fruit require little or no ethylene treatment and will generally ripen uniformly in about 2 days. Late season fruit suffer from decay which may be due to the breakdown of natural anti-fungal compounds found in less mature fruit. Due to their high maturity level, late season fruit are difficult to store for any significant length of time and they are more prone to internal disorders related to storage. Late season fruit can ripen unevenly, tending to remain firm above the seed, and the seed may begin to germinate in the fruit. Ripe late season fruit develop a full black color, but may be difficult to peel and their creamy texture can become dry and the flavor can become rancid if fruit are exposed to high temperature following harvest.

Grove inputs that affect fruit quality

Quite literally, everything that goes into grove management affects fruit quality. It is difficult to clearly define how each input – irrigation, fertilization, canopy management, pest management, rootstock, – affects fruit quality because each input interacts and influences each other.

The role of rootstocks on fruit quality is likely related to water and nutrient uptake. A rootstock that produces a larger, more vigorous root system can mine more soil volume for water and nutrients, increasing the quantity of these resources available to fruit. Rootstocks also influence the vegetative vigor of the tree, and the best fruit come from trees with a good balance of vegetative growth and crop load.

Research conducted in South Africa found that fruit from vigorous, low yielding trees suffered great chilling injury after being stored for 28 days at 42°F compared with fruit from less vigorous, higher yielding trees. The researchers found that the low yield, high vigor trees produced fruit with lower pulp calcium, zinc and manganese content. Similarly, Australian researchers found a correlation between fruit yield/tree vigor and postharvest decay from anthracnose, with the fruit from higher yielding, lower vigor trees having less anthracnose and higher calcium content.

Mineral nutrient effects on fruit quality are especially difficult to sort out because of the complex interactions among nutrients in plants. Calcium and nitrogen appear to be the two nutrients that stand out the most in avocado quality studies. Nitrogen is probably important for fruit quality because of the influence it has on canopy vigor. Calcium is strongly influenced by irrigation practices since it is non-mobile with the tree and must be taken up continuously from the soil solution to support actively growing cells.

Canopy density, which is influenced by rootstock, fertilization and pruning practices, can also affect fruit quality. A dense canopy may be a sign of a tree with high vigor, and the vegetative growth will compete with fruit growth for resources, reducing fruit quality. Canopy density is also associated with higher stem-end rot caused by the fungus *Botryosphaeria*. The spores of this pathogen live on dead wood, which tends to be more prevalent in dense canopies, so fruit from trees with a dense canopy enter the postharvest chain with higher inoculum level.

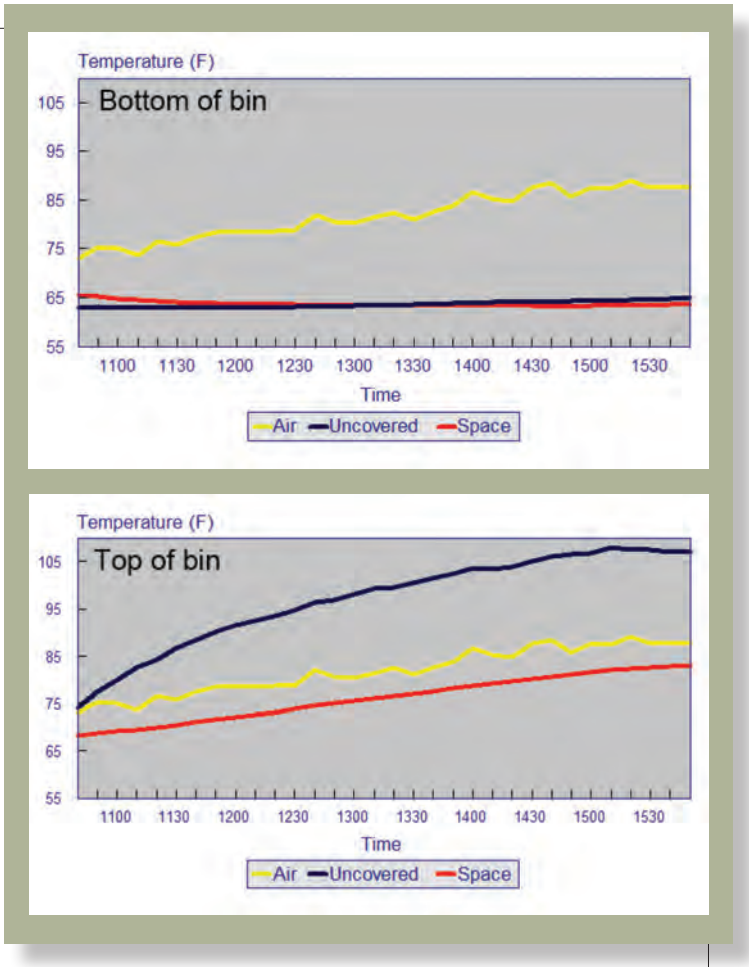
It is important to point out that fruit quality does NOT improve after harvest, so efforts should be made to maximize quality at harvest.

Harvesting considerations and transport

The first, and perhaps most important harvesting consideration, is to avoid harvesting during high temperatures. Research conducted in California has shown that when harvesting bins are left in the sun, the internal temperature of fruit at the bottom of the bins remains substantially lower than air temperature, while the internal temperature of fruit one layer down in the bin can be up to 20°F above air temperature if the bins are not covered. Under these conditions, fruit near the top of a bin can reach temperatures well above 100°F even at moderate air temperatures of just 85°F.

The later in the season fruit are harvested, the more critical temperature management becomes. If bins must be held in the field after harvesting, they should be placed in the shade to keep them out of direct sunlight. When temperatures are forecast to be about 90°F or higher, it is critical to move the bins out of the grove as soon as possible. Minimizing delays between harvesting and cooling the fruit is critical to maintaining postharvest quality.

Rainfall also needs to be considered when harvesting. Immediately following a rainfall, the cells of the fruit peel, especially those surrounding the lenticels, become very turgid (full of water), much like over-inflated balloons. It is very easy for these cells to rupture during harvesting, causing microscopic wounds through which pathogens can enter. Research showed that when fruit were harvested within 24 hours following moderate rainfall, the severity of body rot and incidence of stem-end rot increased by as much as two-fold. Furthermore, rainfall, especially short duration light rains, may help to disperse pathogen spores and wash them onto the fruit surface. This effect, combined with cellular damage, is the likely cause of increased fruit decay following rain. Fruit should not be harvested for 48 to 72 hours following rainfall.



Graphs showing how fruit temperatures change over the course of a day for fruit near the top of a bin and at the bottom of a bin. The yellow lines represent air temperature, the dark blue line fruit flesh temperature in uncovered bins, and the red line fruit flesh temperature from bins covered with a space blanket.

Lastly, the harvesting method can influence fruit quality and susceptibility to decay. If early season fruit are snap picked, there is a chance of tearing, which can increase the fruit's susceptibility to stem-end rot and water loss compared with clipped fruit. However, mid and late season fruit actually have lower incidence of stem-end rot when snap picked. Presumably, this is because the incidence of tearing is low and the decay pathogens that naturally exist on the fruit stems in the field are left behind when mid and late season fruit are snap picked.

Transporting the fruit starts when the bins are loaded. Bins should not be allowed to remain in the grove for more than eight hours after harvest and they should not be stored overnight. During actual transport, the bins should be covered to protect the fruit from sun damage and to minimize water loss. You should also work to maintain grove roads so that bins of fruit are not excessively jostled on rough roads as they begin their trip to the packer.