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## Avocado Fruit Set, Is it Just a Lottery?

The avocado crop in California tends to be erratic with highs and lows that generally follow an alternate bearing pattern. This year the crop is expected to be more than 500 million pounds, which will be the third historically large crop in four years. Based on the cropping history of the California avocado industry, the expectation would be for the next crop to be small.

The reason for a small crop is often attributed to a fruit set failure. For many growers what determines the amount of fruit their avocado trees set each year is somewhat mysterious, making an apparent fruit set failure hard to understand. Some years the reason for a small crop is obvious, for example it was too cold at flowering. Whereas in other years, fruit set may be just average even though everything seems to be the same as a year when fruit set was large. Achieving consistent fruit set each year is important as large swings in the amount of fruit causes large swings in income, often resulting in financial hardship for growers. Thus, to maintain the economic viability of avocado groves, consistent fruit set each year is a very necessary goal.

The most common, strongly-held opinion is that temperatures below 50°F (10°C) during flowering cause poor fruit set. The theory is that a few nights below 50°F destroy the newly created viable embryos of recently-pollinated flowers. Therefore, avocado fruit set depends on “warm” temperatures (greater than 50°F at night) with an increase in the number of warm nights resulting in

a greater fruit set. Those fruit whose embryos are killed by low night temperature either drop or develop as seedless avocados. The idea that low temperatures could damage fruit set is not unreasonable as avocados are subtropical plants and are chilling sensitive. Mature avocado fruit are damaged by exposure to temperatures below 40°F (5°C) and freeze damage occurs just below 32°F (0°C). It is possible that avocado flowering and fruit set is also chilling sensitive with poor fruit set being another symptom of chilling injury.

Avocado fruit set is also vulnerable to high temperatures. An upper temperature limit for avocado fruit set has been observed at about 90°F and above. Above this temperature a severe drop of newly set fruit and

flowers often occurs. If warm temperatures essentially define avocado fruit set, there is the opportunity to create a temperature model predicting yield that would be a great aid in crop estimation. For a grower, predicting how much fruit is on trees would be useful for planning inputs like water and fertilizer as well as labor requirements for harvesting and pruning.

If avocado fruit set is solely determined by temperature, the implication is the avocado grower is gambling each year, betting that the weather will be warm, which suggests that cultural management has only a minor influence on fruit set. However, it's commonly observed in a poor fruit set year that some groves or individual trees within groves can

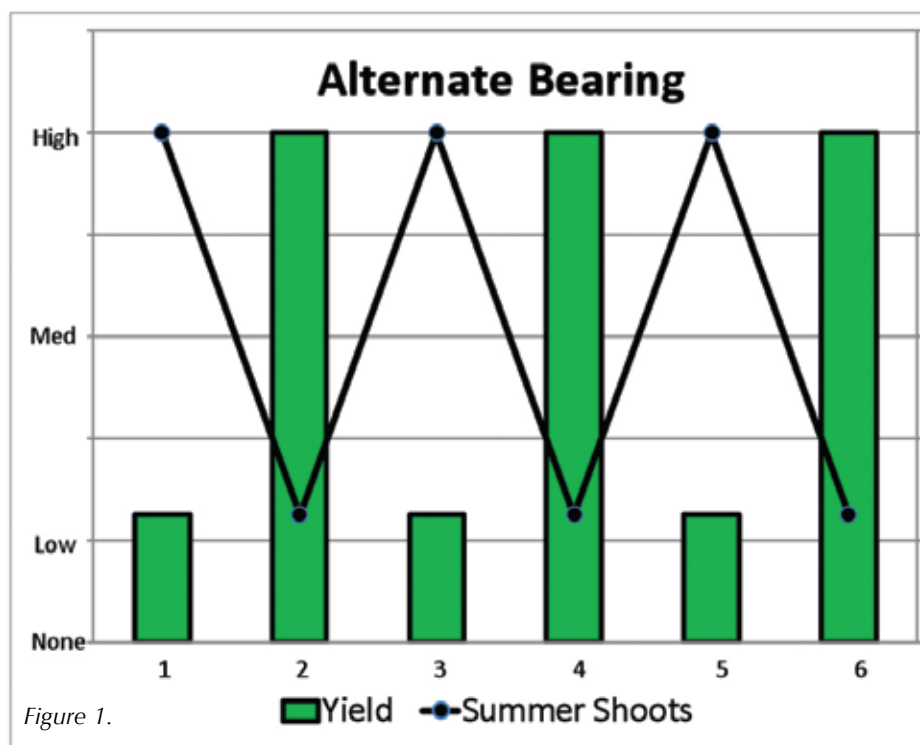


Figure 1.

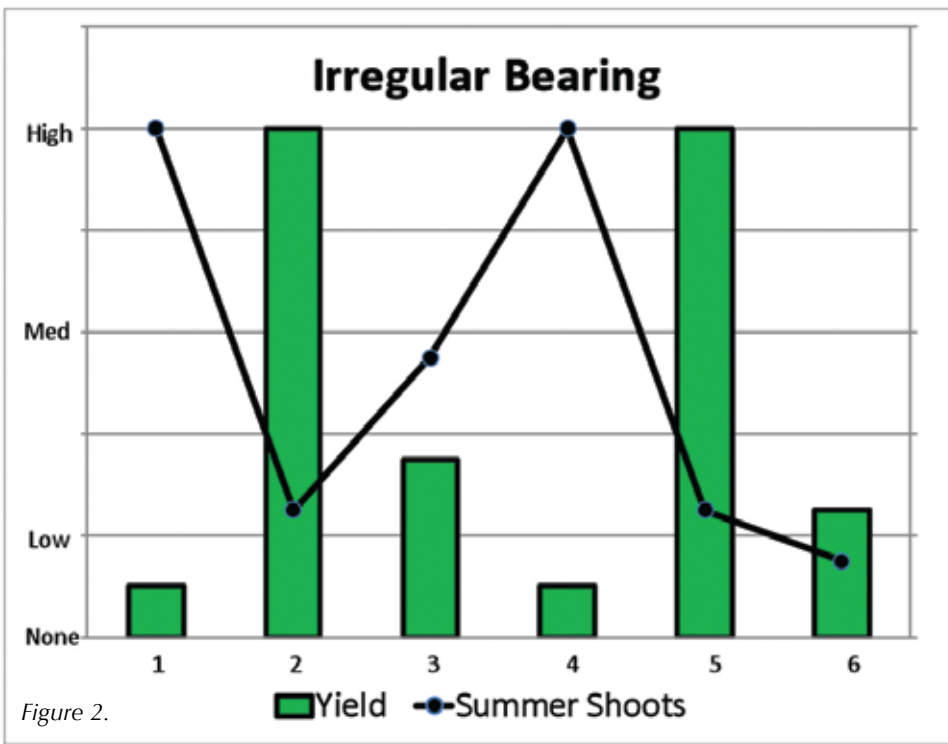


Figure 2.

set a heavy crop even though they were exposed to the same weather. Additionally, if fruit set depends solely on warm temperatures it leaves unexplained how winter set fruit are possible when night temperatures are colder than in spring. In my opinion, avocado fruit set is not solely explained by warm or cold temperatures at flowering. Temperature is important in a general sense because avocado trees are exothermic, like all plants, but is not the only determinate of fruit set. This article outlines my thinking on what may be controlling the avocado fruit set process and how cultural management helps to achieve good fruit set.

### The Avocado Fruit Set Process

This article does not describe in detail the full complexity of avocado flowering as there are a number of excellent reviews on flowering to be found on [www.avocadosource.com](http://www.avocadosource.com).

Avocado fruit set is a complex process composed of many sequential steps, some of which may form critical control points (see table on page 27). When the steps in the fruit set process are identified it becomes

apparent there are factors other than temperature to consider, such as: how many flowers the tree produces, how readily is pollen transferred, and will the new fruit be held by the tree until harvest? Failure to adequately achieve the best result at each critical control point will result in poor fruit set. For best management of fruit set, the critical control points need to be

identified along with the best cultural management activities.

In briefly describing the fruit set process, I have defined a starting point as the breaking of the vegetative buds for the new summer flush. In the Fall 2012 issue of *From the Grove* I described a two year growth cycle using the same starting point for possible best practice for high yields. The mature fruit on the tree strongly influence the flowering potential of the tree, and the harvest of mature fruit has been chosen as the end point of the fruit set process. Between the starting and ending points, intermediate fruit set steps have been added to describe fruit set more fully.

### Cropping Patterns

In a classic alternate bearing cropping pattern (Figure 1) on and off crops are preceded or followed by low or high amounts of summer flush. The amount of summer flush determines fruit set as the flush sets how many flowers are produced in spring each year. If flower numbers are low then the fruit set is poor irrespective of other factors. From year

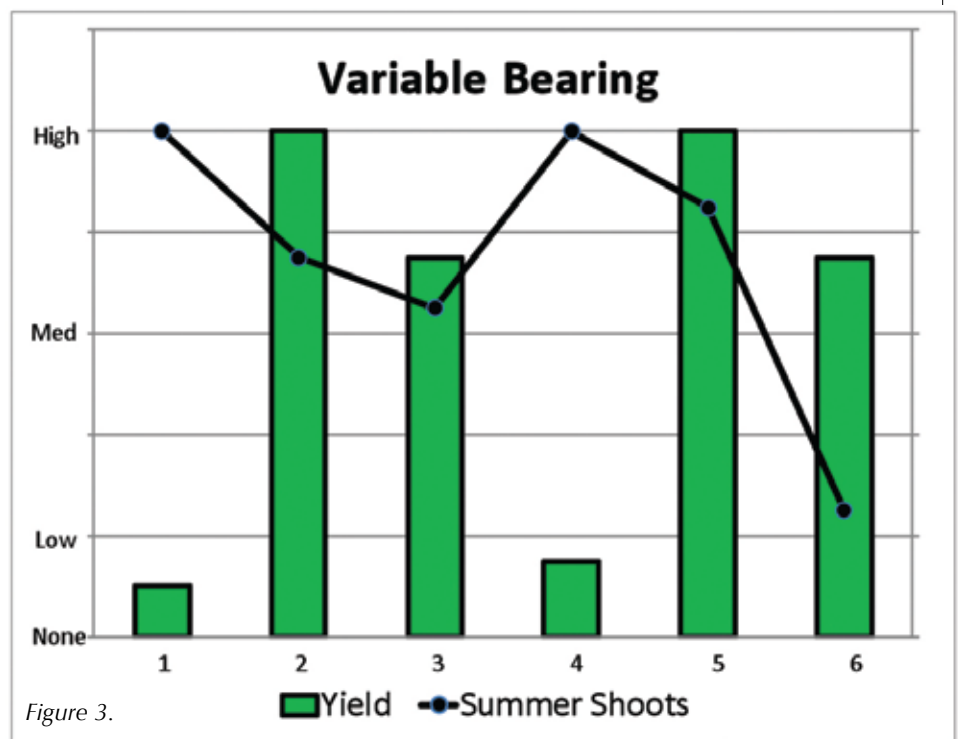
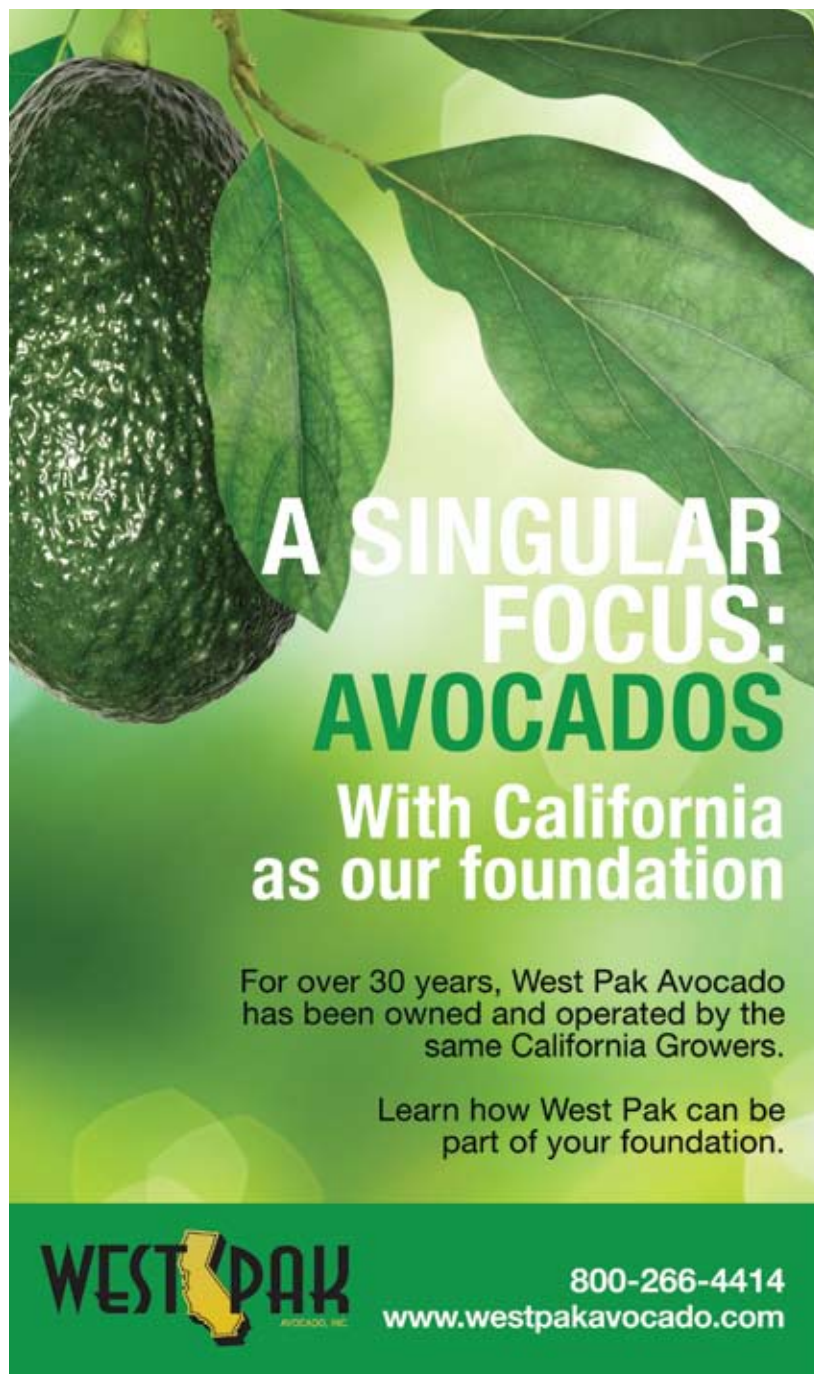


Figure 3.

to year the percentage of flowers setting fruit is similar. The critical control point in this pattern is the amount of summer flush the trees produce. Cultural management practices that result in a similar amount of summer flush each year will result in more consistent crops.

Irregular bearing is a cropping pattern where fruit set is variable and there is a general alternate bearing pattern that occurs across more than two years (Figure 2). The amount of flowers is determined by the amount of summer flush for the first couple of years. Then there is a year when the fruit is held longer than usual and the fruit set is much poorer than expected. The summer flush is also reduced as a result of holding the fruit longer. The result is two years of low fruit set.



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Variable bearing is a cropping pattern where the amount of summer flush is generally managed well so the flowering potential is usually good but other factors are now more important in affecting fruit set (Figure 3). A low fruit set may be due to poor pollinator (bee) activity or the fruit retention was poor. Trees not well-managed for nutrition, water or which were pruned to remove a large amount of summer flush can have a lower fruit set than would be indicated by the amount of summer flush alone.

## Conclusions

In the avocado fruit set process, there appears to be at least three critical control points: 1) create flowering wood, 2) flower opening and 3) pollination, and new fruit growth and retention. Creating flowering wood does not appear to be well related to temperature and as the first step in the creation of flowering shoots defines the fruit set potential for the year when those shoots flower. If there are few flowers, the weather during flowering, pollinator activity or high sink strength embryos doesn't really matter. A small number of flowers means a small crop. Effective pollen transfer requires bees to be present in large numbers and very active when the flowers are receptive to pollen and again when they are shedding pollen. When there is little bee activity or the flowers have a small overlap in time between the genders, little pollen transfer occurs and fruit set is poor. The last critical step is for the newly created embryo to be a strong sink so that the new fruit will accumulate resources (carbohydrates, nutrients), grow quickly and be held by the tree until harvest. Large numbers of poor embryos results in a large fruit drop and poor fruit set.

Avocado fruit set is not simply enough warm days during flowering. By following the cropping history and observing the growth pattern of the trees, in particular noting the amount of summer flush, a reasonable guess of the fruit set potential should be possible. An understanding of why a particular cropping pattern has occurred should also allow identification of the most appropriate cultural management activities needed to improve fruit set. 🥑

Generalized Avocado Fruit Set Process

Year	Step	Description	Cultural Management
Year 1 starting June/July	Create flowering wood	Vegetative bud break in summer and growth of summer shoots.	Summer flush is controlled through the use of fertilizer, pruning, plant growth regulators and harvest of the mature fruit before June.
	Critical control point: The amount of summer flush determines the amount of fruiting wood available to initiate and develop flowers in fall and over winter.		
	Initiate flowers	Summer flush stops growing and the vegetative buds are converted to flower buds.	Flower bud development can be forced by girdling and plant growth regulators.
	Create flower buds	Flower buds develop over winter until early spring.	
Year 2 March to May	Flower growth	Flower buds “break” and grow into flowering panicles.	Ensure trees are well-watered and fertilized.
	Flower opening and pollination	Flowers open in a pattern mediated by the weather with more flowers open under warm conditions and pollen is transferred from flower to flower by an insect agent.	Avocado flowers are best pollinated by insects. Honey bees at 2 – 4 hives per acre will ensure large numbers of bees will be available at flowering time.
	Critical control point: Pollinator activity determines the amount of pollen transferred. Few bees forage below 60°F. In cool weather avocado flowers will still open but the bee activity will be too low for good pollen transfer.		
	Create new fruit	Creation of a new embryo through the merging of the pollen and egg.	Ensure trees are well-watered with good nutrition.
	New fruit growth and retention	New embryo growth along with the rest of the fruit.	Avoid water stress by good irrigation practice.
Critical control point: Fast growing fruit with high sink strength embryos (seeds) are required for good fruit retention. Slow growing fruit, those with a probable poor genetic makeup, are the most likely to be shed.			
Year 3 from March	Harvest	Remove a significant portion of the crop early.	The amount of mature fruit affects potential flower number during flower bud development, fruit set through competition for resources with flowers, and reduces the amount of summer flush after flowering is completed.