

Increasing the Productivity of GEM Avocado Orchards Using High-Density Planting

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To remain profitable and competitive within the marketplace, California avocado growers must maximize productivity and lower production costs. However, several factors limit the productivity, profitability and competitiveness of the California avocado industry. These include the rising price of irrigation water, soil salinity and toxicity, shortage of qualified labor, and pests and diseases. One business model used by several crops within the agricultural industry is to increase productivity per acre by planting trees at a higher density.

California growers have traditionally planted at a 20' x 20' spacing (109 trees per acre) and have thinned trees when the canopy closed. Several countries have shifted the industry standards towards high density planting for avocado. The conceptual background of HDP in fruit growing was pioneered in temperate fruits and first practiced in California in the 1960s. Since then, there has been a rise in establishment of commercial HDP orchards throughout the world. HDP systems are normally understood as a system in which a higher number of plants are accommodated per unit area in comparison to the conventional planting density. However, the exact limit of planting density is yet to be determined, as HDP is not well defined. It varies with growing regions, species, variety, rootstock, management system adopted and economic return from the orchard.

In Chile, there are approximately 70,000 acres of avocados planted in a range of latitudes similar to those in California. Chile has pushed for higher levels of production efficiency by increasing tree density and lowering labor costs. Planting at 7.5' x 7.5' (774 trees per acre) is the current standard density in Chile for new plantings. Densities as high as 4' x 4' (about 2,700 trees per acre) also have been observed. Obvi-

ously, at that spacing trees are very crowded, compact and short. Tree height is managed from the time of orchard establishment. Orchard management practices include removal of water shoots, tree topping and cutting side branches to reduce shading. A significant difference where most HDP is practiced is the availability and use of plant growth regulators, such as paclobutrazol, which aid in reducing plant growth. These materials are not and may not be available in the U.S. in the foreseeable future.

Pruning is commonly done in spring right after harvest and again in the fall to ensure that vegetative growth is not stimulated during summer and early autumn as that can affect flower bud induction. Failure to follow those guidelines results in the need for severe tree pruning later, which in turn would have a short-term negative impact on productivity. But with tree heights of only six to eight feet, fruit harvest is more cost effective. At 5-6 cents per pound (vs. 25-30 cents per pound for California), pickers can make \$50 per bin (versus \$80-100 per bin in California) and at these attractive prices, owners can secure and retain their workforce.

At an ultra HDP (4' x 4') grove, trees come quickly into production (20,000 pounds per acre, two years following planting in one orchard) with yield expectations of over 30,000 pounds per acre at full production after four years. At lower planting densities, maximum productivity is reached after six years with yields of at least 10,000 pounds per acre.

Research on orchard crops in general and more specifically in South African avocados has determined that the height of the trees should be about 80% of the in-row spacing for optimum production. Therefore, our 10' x 10' planting should have a height of eight feet. (A 20' x 20' spacing should have a height of about 16 feet.) This height allows sunlight to pass



High density trial with full coverage mulch and microsprinklers – three different densities.

over the top of a neighboring tree and shine light on the lower canopy of the next tree. This arrangement tends to keep leaves on the trees all the way down to the ground, which in turn allows the fruit low in the tree to be picked without using ladders.

A high density trial with Hass on Toro Canyon was established at Pine Tree Ranch in Santa Paula in 2014. Blocks of trees were planted in four densities: 7.5' x 10', 7.5' x 15', 10' x 15' and 15' x 15'. The trees also had a pruning regime imposed on them: two-branch removal yearly, top and one side yearly and whole canopy pruning. Because of irregular weather patterns and resultant poor bearing, it was difficult to get good yield data. It also allowed for vigorous vegetative growth. The trial was terminated in 2019 when it was determined that it was becoming too difficult to keep the closer plantings from shading neighboring trees.

Emeritus Gary Bender, UCCE Subtropical Horticulture Farm Advisor conducted an HDP trial in 2012-2017 in Valley Center, CA, with Hass. Instead of the traditional 20-foot spacing of avocado trees, Bender planted his experimental grove with 10' x 10' spacing of small Hass trees grafted to Dusa rootstock from South Africa, which is root rot tolerant and high producing. He also planted a Zutano tree in the middle of every nine trees. The Zutano avocado tree, like Bacon and Fuerte trees, is a pollinizer. During his career, Bender observed that Hass trees located near Zutanos were heavy with fruit. Within three years Bender's high-density yield average was 19,173 lbs/acre, while the San Diego County and best-managed groves average 5,925-9,000 lbs/acre.

After the harvest in the third year, the trial required pruning of the tops and the sides in order to maintain the struc-

ture of the trees. We intend to evaluate the GEM variety in a similar trial. GEM has a more columnar growth habit, better lending itself to HDP. It is more precocious and bears its fruit in the canopy interior. It has a slower growth habit as a result of its early and heavy fruit production. If the GEMs require less pruning than Hass, that would be a real boost for the economics of the grove.

Significant work has been done on the 'Hass' avocado variety, but very little published work exists on GEM, a new variety with very different growth habits. We propose a comprehensive evaluation of HDP in avocado with the variety GEM at three different spacings: density 1 (7.5' x 7.5' ft), density 2 (spacing 10' x 10'), and density 3 (8' x 12'). Replicated field experiments have been established at Pine Tree Ranch in Santa Paula, CA. Fruit yields from each treatment will be determined. The study will thus determine the most economical spacing for commercial growers. This will be a long-term study, approximately 4-5 years. This will provide critical, science-based information to the California Avocado Commission and all California avocado growers. Additionally, we will author educational posts containing distilled versions of our research on the Topics in Subtropics blog and Newsletter after the completion of our second- and third-year data collection. Finally, we will submit articles to *California Fresh Fruit* magazine and the Commission's *From the Grove* and technical manuscripts to science publications, such as *American Society for Horticultural Science*. We also will host field days and share information with the California Avocado Commission and California Avocado Society.

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