

GROWER OPINION:

Avocado Productivity: an Overview

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Productivity is influenced by many factors:

1. Factors which are totally beyond our control such as weather and rainfall.
2. Factors which are inherited by us when we buy an existing grove such as geographical location, water quality, rootstock, and the grafted variety.
3. Factors which we can manipulate for higher productivity such as pollination, irrigation management, tree spacing and fertilization.

The following is a more detailed discussion of some of these points:

We saw how favorable weather conditions produced, almost universally, a bumper crop in 1992-93. This current crop year is a clear demonstration of the opposite, poor set in most of the growing areas. The same varieties produce differently in distinct geographical locations. Hass, which is highly stress sensitive, is less productive in inland valleys while Bacon, Zutano and Reed are very productive in these same areas. Having a single variety industry, especially a sensitive one like the Hass, is almost guaranteed to affect productivity negatively. **We must do research to find new varieties, which are Hass like, will bloom later in the year and will do well under inland conditions.** Rootstocks which are salt and particularly chloride sensitive, like the majority of rootstocks utilized in California, are also major deterrents to high productivity. Real problems occur when the chloride level in your irrigation water is above 200 ppm. Just because tip burn is not visible, do not assume that damage to the manufacturing capabilities of your leaf is not taking place. It is likely that significant leaf damage and yield depression may occur prior to visible tip burn. **Different rootstocks must be found which are not only root rot resistant but salt tolerant and compatible with the top worked variety for high productivity.** Local research scientists should look at some of Dr. Ben-Ya'acov's West Indian clonal rootstock selections. Water quality is a very important variable. Only with substantial leaching in cases where water quality is poor can we expect acceptable production.

We can adapt to some adverse variables with a good understanding of the avocado tree

and sound management practices. Short of changing variety and rootstocks, which in my opinion is a must in certain conditions such as inland groves with high salinity water, the astute farmer must adhere to the following:

Your trees must be spaced in such a pattern as to allow maximum light to hit the greatest possible surface area. It is **not the number of trees but canopy volume and area that produces large quantities of carbohydrates necessary for high productivity** and may minimize the alternate bearing characteristic of the Hass variety. Soils which are bathed with sunlight in the spring, are warmer by a few degrees than totally shaded soils. This allows for earlier and greater nutrient uptake when soil temperatures are too low for roots to be active.

Without bees and other insects, pollination and ovule fertilization will not take place. However, the bee has avocado pollen near the bottom of it's menu. Since the Varroa Mite has significantly reduced wild bee populations throughout the avocado growing areas of California, it is of utmost importance to have commercial hives brought to your grove as early as possible. The beehives, one to two per acre, must be placed throughout the grove in strategic locations as far away as possible from wild flowers and citrus. It might cost money to have this service done, but the money will be well spent.

Having bees alone does not cover all the elements relating to pollination. If your grove is inland, and the spring weather is normal, i.e. unpredictable, it is likely that you will have a poor set unless you have interplanted some pollinizer trees. In the coastal areas, and in some cooler inland areas, during a few hours in the middle of the day, the Hass variety has an overlapping bloom of both male and female flowers, which in turn produces self pollinated fruits. If this condition does not occur often in your grove, you must introduce 'B' flower pollinizer trees. There are several 'B' flower varieties available. Unfortunately, most to date were green skin types which do not bring good economic returns. **However, some new Hass-like 'B' varieties (some even black in color) being tested at South Coast Field Station in the Avocado Breeding Program might be the answer for profitable pollinizers.** A good practice in my opinion, is that when you thin your grove, top work a portion of the cut trees to pollinizers, at least every fourth tree or every fourth row. If you can, introduce multiple varieties of 'B' types per grafted tree, and I believe you will have a better chance for cross pollination. The pollinizer tree's bloom needs to reach maximum bloom at the same time as the target tree. Nature went through extremes to produce these flower types, and in order to have high productivity in our environment which is foreign to the avocado, we must simulate as closely as possible the native habitat.

During bloom, particularly in our inland valleys, day and night temperatures can differ greatly and the weather can turn hot and dry at any time. Such conditions can strongly affect pollen tube growth and ovule viability. Carol Lovatt's work with boron and low biuret urea application to the emerging bloom may influence your production if adverse conditions occur. I don't feel that where the weather is favorable such an expensive application is justified.

Irrigation management is the most significant single factor that you can manipulate to affect productivity. The Hass variety is extremely sensitive and prone to stress. You must know your soil and water before you embark on any irrigation practice. It is not

enough to just apply so many gallons a week and expect high productivity. You must know the kind of salts in your root zone, so that you can plan the best leaching program. (For example, with water EC at 0.9 dS/m, your soil EC is likely to be 1.3 dS/m. You will have an 8% leaching requirement in order to maintain 100% production relative to salinity. At the high level of 2.4 dS/m of water EC, you will find the soil EC at 3.8 dS/m. Even with a 20% leaching requirement you will at best end up with 50% reduction in yield). You would also make an effort to access evapotranspiration information for your area so that you can be sure that you are irrigating to the grove's requirements. The quantity and frequency of your irrigation is dependent on your water quality, the efficiency of your system, soil type, exposure and weather conditions. As a rule of thumb, a 100% ETo, (ETo is the number reported by CIMIS), should be sufficient in most cases to take care of both irrigation and leaching requirements for a 78% 80% efficient grove (ETo X square feet of spacing X 0.623 = number of gallons per tree per day). You should be able to increase efficiency by adding pressure regulators. In situations where your laterals are not level you can use pressure compensating sprinklers. It is very advantageous to pre-irrigate and continuously cycle water throughout the grove when hot, dry and windy conditions are predicted, particularly during bloom.

During bloom, the canopy surface area is dramatically increased because of the large number of flowers, and the trees are much more vulnerable to stressful conditions. You cannot just hope for rain to take care of your water needs during the winter and spring. **If you critically examine the data from the Covey Lane irrigation research plot, you must conclude that before the bloom, during the winter, if there has been no significant rain, major leaching should take place. Do not wait for the rain, it might come too late. Even after early rains it is wise to leach so salts do not migrate back to your root zone.**

In order to produce more, it is necessary to duplicate as closely as possible the native ecosystem of the avocado. In a tropical area, decaying organic matter is the main source of nutrients for the avocado tree. If you are skirting or pruning, make sure you leave all the pruned materials under the canopy; do not remove leaf litter. Protect fallen leaf litter from being blown by the wind by managing the skirts in wind prone areas. A good practice, although labor intensive, is to add at least every other year, additional mulch or compost (about 300 pounds of compost per tree). Advantages of doing this include:

- 1) Feeder roots will grow right into this organic matter and will be able to absorb nutrients more easily.
- 2) By adding organic matter, you will increase the cation exchange capacity of your soil (CEC is the total quantity of cations; mostly Ca^{2+} , Mg^{2+} , K^+ , NH_4^+ , Na^+ and FT which a soil can absorb by cation exchange), which is very low in the decomposed granite soils of most of our hillsides. In the case of clay soils high in organic matter CEC values are already high. Mulch here will help break down tight soils to increase aeration and water penetration. Increased CEC will both sustain a higher level of nutrients in your root zone and reduce the quantity of chemical fertilizers you need to apply. Nutrients, which could potentially leach out, will be absorbed by soil particles and will be available to the soil solution and the trees when needed.

3) Organic materials can also enhance bacterial activity which are suppressive to phytophthora root rot. This organic matter will be the medium in which new populations of bacteria and fungi can thrive and reproduce. Mycorrhizae, which live symbiotically with the avocado roots could also be enhanced with certain carbon containing mulches. By penetrating into root cells mycorrhizae can assist root nutritional uptake. Additionally, when soils are either acidic or alkaline, the roots growing up into a mulch may have a better chance to pick up nutrients in a more favorable pH range.

Fertilizers are a necessity and a curse. Avocado trees, just like any other living thing, require a certain amount of nutrients in order to remain healthy and produce well. All the nutrients must be within a relatively narrow optimum range and in balance with each other. When, for example, one of the nutrients such as calcium, potassium or magnesium get out of balance with respect to the others, predictable deficiencies occur. When elements go either below or above the optimum range they become limiting and affect the system as a whole and production in particular. Therefore, you must understand your soil, and monitor your leaf analysis, so all your nutrients are within their optimum range and in balance with each other. Learn to understand lab results; look at them as trend indicators and always compare them to previous analysis. Once you have a handle on your soil pH, your soil CEC, and your soil and leaf analysis, only then should you proceed with a fertilization program. Timing is critical for nitrogen application. Over fertilizing with nitrogen during late winter and early spring is not advisable. Nitrogen promotes vegetation growth. The new growth, during the time when soils are cold and nutrient uptake is very low, receives nutrition mainly from stored nutrients which are limited in quantity. Deficiencies may occur due to competition for nutrients and carbohydrates among bloom, leaves, old fruit and the new developing fruit. A large amount of carbohydrate translocation takes place during bloom or new flush growth, particularly from the surrounding photosynthesizing leaves. The photosynthetic capabilities of nutrient deficient leaves may be highly reduced and they themselves may become a sink for available nutrients. The longer you keep these old leaves healthy and green, the more production you are likely to have, providing all other factors discussed above are optimally met.

One new twist to all this is the Persea Mite and its affect on tree health and production. We haven't seen the extent of the damage yet. An infested grove is likely to either drop much of its spring flush or have a significantly reduced photosynthate manufacturing capability. Some growers have indicated that predators were taking care of their Persea Mite problem. I haven't seen such a result yet. If you should see the need to spray, do it early, before the bloom and spring flush. Omite, in my experience is a poor choice as a miticide. Since it is neither an ovicide nor systemic, your timing of application must be very precise. The population of mites must be mostly in the adult stage with the least number of eggs possible. Otherwise the treatment will not be very effective and will need to be repeated after a short interval. Growers, who intend to spray should try to convince the authorities that an ovicide is also needed.

The major elements, especially nitrogen must be applied periodically rather than at once. Applying nitrogen in small quantities at the end of the irrigation cycle will reduce the amount required, limit nitrates from contaminating ground water, and will not negatively affect your productivity. I think that potassium and other nutrients, if not

abundant in your soils, should be supplemented not only to bring the soil to optimum levels but also to replace lost nutrients due to crop removal. For example, if ten thousand pounds of Hass avocados are produced per acre, the fruit harvested contained about sixty pounds of actual potassium, this amount needs to be replaced accordingly. As far as micro-nutrients are concerned, there is no scientific evidence that high levels which are recommended by some, especially zinc, will increase your production significantly. If your numbers fall much below the optimum level for a certain nutrient you can make a foliar application. You must keep in mind that not all foliar nutrients are created equal, i.e. they are not all equally or even remotely as effective as one another. You should have plenty of young expanding leaves when you do make a foliar application. A good time to apply micro-nutrients inexpensively is during aerial application of Omite or a frost protection program. If your soil conditions are right, you can introduce all these elements with your irrigation water. If your soil pH is high, uptake of certain elements, particularly metals, can be very poor. By combining your micronutrients with certain acids, acidic fertilizers, or by inserting these metals in the root zone in four corners of your trees with some acidifying agent, you can affect their uptake.

We have some knowledge about plant growth regulators and their interactions in the different processes relevant to production. Hormones may regulate carbohydrate partitioning and influence all other aspects of growth and production. During stressful periods, the ratio of some essential hormones, which are growth promoters, decline in respect to abscisic acid which is a growth inhibitor. This in turn may produce abscission of fruit and hence lower production. By using materials such as cytokinins, we could potentially influence this balance and reduce fruit drop and enhance productivity. Carol Lovatt has a hypothesis where fruit born on leafy inflorescences have a better chance to set and survive when compared to fruit born on leafless inflorescences which tend to abscise early. Here again plant growth regulators appear to be of utmost importance.

In conclusion, I suggest that doing your homework and applying the results to your particular condition will significantly enhance your productivity.

Books to have and authors to read:

1. Western Fertilizer Handbook: Fertilizers, soils, water.
2. Plant Analysis Handbook: Leaf and soil analysis.
3. Carol Lovatt: PGR, floral expressions, boron and urea.
4. David Crowley: Zinc, soils, mycorrhiza.
5. William Casale: Biocontrol agents for Phytophthora.
6. Mary Lu Arpaia: Irrigation and fertilization management, clonal rootstock production, avocado phenology.
7. Avraham Ben-Ya'acov: Rootstocks, salt tolerance, productivity.
8. Gad Ish-Am: Avocado pollination by honeybees, pollinizer spacing.
9. G. Martin: Varieties, rootstocks, pruning.
10. Guy Witney: Tree spacing, varieties, irrigation, phenology.

11. Ben Faber: Mulching, irrigation, fertilizing.
12. Shmuel Gazit: Pollinizer trees.

Tools to have for field testing:

The following tools are to be used only as indicators of what is going on with your soil and your trees. Since there are no established standards, you need to make your own charts.

1. Your local CIMIS station phone number
2. pH meter
3. EC meter
4. Soil extract tubes and syringes
5. Tensiometers
6. Soil probe
7. Variety of field testing meters for soil and petiole extract analysis.