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The Benefits of Mulching Avocados

The Importance of Soil Tilthe

After moving from the Pacific Northwest to San Diego County in 1978, I was intrigued by the flourishing avocado industry. A recent graduate of Oregon State University, I was unfamiliar with the cultivation of avocados, so one of my first activities as a young agronomist was to learn everything I could about the cultivation and production of avocados.

I have always found it helpful to imagine a cropping system as a factory and then look at ways to make the factory more productive. It was an adventure for many years; each orchard was unique (as were the owners), so it was captivating to observe the trees, track the management practices, analyze soil and tissue samples and finally make suggestions on management practice modifications that made economic and agronomic sense.

I am honored to have this opportunity to share some of my observations on irrigation, fertilization, Phytophthora management, and how mulching of the avocado trees helps to mitigate some of the limiting factors in production by improving soil tilthe. My comments are based on my experienc-

es in San Diego County and may not apply to other growing areas.

One of the basic tenets of agronomy is to mimic the growing conditions of the plant's native environment. Upon arriving in San Diego, many hours were spent at the UC Riverside library researching the origin of the Avocado tree, its history, and the climate and soil conditions under which it developed. Data from Puebla Mexico, a possible origin of the avocado, shows temperature ranges from average lows of around 50º F to average highs of around 70º F, somewhat similar to our mild coastal temperature. Their developed soils and rainfall, however, differ significantly different from the partially decomposed granite soils and arid climate found in San Diego County. In fact, many of the orchards of the 1970's and 1980's were planted on heavily disrupted mineral soils that could barely support weed growth!

Irrigation

Puebla's rainfall of around 30 inches per year is concentrated from May through October, which is the active growing season of the avocado tree. San Diego's average 10" of rainfall occurs during the months of October through March, when the trees are in quiescence and have little uptake by the tree, necessitating the use of irrigation water, much of it imported from the Colorado River during the growing season. Unfortunately, this imported water is characterized by being high in salts, particularly the damaging ion chloride.

During my first few years in San Diego, the "water wars" were raging and growers were convinced that if water rates were raised from $75 per acre-foot the industry would become uneconomical. Many of the orchards in the mid seventies were still on spinner type irrigation, often in a solid set throughout the orchard. The relatively large quantities of water applied mitigated the excessive salts, moving them below the shallow root zone of the trees and help rapidly decompose leaf litter. These large quantities of water, however, moved the deadly Phytophthora cinnamomi readily throughout the orchard, at the time a death sentence for the trees.

The uncertainty of the water in the 70's made the introduction of drip irrigation timely, certainly better placement of water would help reduce the quantities of water needed.

Much interest had been focused on drip irrigation since the Israelis had pioneered its use in their arid environment. As with all good ideas though, some flaws became rapidly apparent. Although drip irrigation worked well for new trees since their root zone was relatively deep in relationship to their drip line, established avocado trees have a very shallow root system, no matter how much water is applied. Water concentrated in this small area also concentrated the roots into an unnaturally compact environment and caused a build up of salts at the edge of the drip pattern. During high evapo-transpiration periods, the roots would be exposed to these high salt levels, taking up large amounts of chloride ions and causing tip burning and premature shedding of the leaves.

Another problem was that fertilizer applied through the drip system rapidly acidified the poorly buffered decomposed granite soil, further stressing the trees. Moving to mini-sprinklers help mitigate the low pH and proved to be a very effective method of water application.

Unfortunately, the mini-sprinklers left a drip pattern that was very high in salts. The accumulation of salts, after under-irrigation, is perhaps the most common abiotic cause of yield loss in the industry. The hydrophobic leaf litter from premature drop, inhibited the fine irrigation mist from infiltrating into the soil. During the hot summer months the system could be running for several hours before the soil was even damp. This in turn led to higher evaporation rates, effectively increasing the salt level in the root zone and continuing the cycle of leaf drop.

My first experience, in the early 1990's, with mulch was an effort to cover the leaf litter with mushroom compost to allow for better water infiltration. This was done in the late winter while the trees were in quiescence. Even though the mushroom compost was salty, the 4 inches of rainfall received in March that year leached the salts beneath the active feeder roots. I was pleased to find the 2 inches of applied mulch helped break down the leaves that had dropped

during the previous season and that water infiltration was improved. Actually, I was pleased enough to go beyond research and to start my first of three compost facilities utilizing urban greenwaste to produce natural organic products that could be used both in landscape and agriculture!

Fertilizer

Prior to my arrival in San Diego, leaf analysis had been developed and established as a tool for determining fertilizer needs. It was surprising that soil tests were not recommended; I had spent much of my undergraduate work in soils and had not encountered farmers that did not use soil tests as a tool. It was also puzzling that the industry relied largely on dry fertilizer; much of it applied when the trees were in quiescence; a time when uptake would not generally occur. At the time, the industry standard was the application of nitrogen and zinc on an annual basis. Indeed, thousands of tissue samples that I analyzed showed no need for phosphorus or in most cases potassium. It wasn't until much later that I recognized the limitations of leaf analysis for evaluating phosphorus and potassium nutrition; just because the leaves show sufficient levels of a nutrient doesn't mean that other parts of the plants are adequately supplied.

After several years of performing leaf analysis and being dissatisfied with it's usefulness as the sole analytical tool, I started testing the soil in the root zone and was surprised to find levels of zinc that would be considered toxic and levels of phosphorus that would be considered deficient. Soil tests for nitrate nitrogen, the form utilized by plants, was found only in very low levels. Again, time was spent in the library and the literature showed that the fertilizer practices found in the avocado industry were largely anecdotal. The 2 to 3 pounds of actual nitrogen suggested by the industry literature were amazingly high amounts of nitrogen to add for any crop. Coupled with poor placement and poor timing, most of it was never used by the trees. Over the years, I observed many growers reducing the amount of nitrogen to as little as ½ pound per tree annually with no reduction in yield. It was all in the timing and placement. In fact, the

feedback from growers using mulch is that they reduce or eliminate the need for inorganic nitrogen with no reduction in yield.

Soil tests in my lab found zinc levels from avocado orchards to be routinely over 50 ppm. In other crops, levels over10 ppm have been found to inhibit root growth. This combined with the low levels of phosphorus, necessary for root growth, are a red flag to any crop and I have often wondered if this is connected to the expression of Phytophthora root rot in our slightly to moderately acidic San Diego orchards. I recommend using both leaf and soil analysis in conjunction with each other and do complete analysis, not just nitrogen and zinc!

Phytophthora Management

The move to efficient forms of irrigation in the 1970's slowed the progression of Phytophthora root rot in avocado orchards. Since the irrigation pattern from tree to tree does not overlap there wasn't a year round mechanism of moving the fungus through out the orchard. Although trees still declined once infected, major movement of the fungus was limited to winter months.

The management of Phytophthora root rot is a case study in successful Integrated Pest Management. Research combining a wide variety of disciplines and coordinated by the University of California, Riverside has been largely responsible for keeping the industry viable in Southern California. In addition, the efforts of the UC Cooperative Extension to educate growers on best management practices have been extensive and effective.

The combined efforts of not only plant pathologists, but plant breeders, nurserymen, plant and soil scientists and Rhone Poulenc, manufacturers of Alliete, the first licensed phosphite product have made the disease manageable.

It was actually during the first usage of these new fungicides that I noticed growth responses with their application on non-infected trees. This further reinforced my observations that phosphorus may be deficient in trees despite adequate readings from leaf analysis.

Mulch

The time I spent in orchards collecting samples for Phytophthora, soil and leaf analysis, was a unique opportunity to compare growth conditions and management practices of the trees. Over the years it became apparent that having good soil tilthe was important for good production. Although, our soils have been developed under arid conditions, the use of organic mulch can be applied to improve the soil tilthe. But remember that mulch is only worthwhile on orchards that have adequate irrigation practices.

Improving soil tilthe improves the physical, chemical, and biological characteristics of the soil; it brings our mineral soil much closer to the root environment to which the avocado is natively adapted.

Physically, the use of mulch supports aggregation of soil particles, improving both aeration and infiltration of water. Chemically, mulch provides a slow release form of nitrogen, as well as providing Humic acids to mildly chelate other nutrients available in the soils, such as phosphorus, to help increase their uptake. Biologically, mulch has a place as part of an Integrated Pest Management Program to control Phytophthora root rot, providing both antagonistic and competitive microbes.

Certainly mulching has its downside as it is costly and time consuming to apply. And in some steep orchards it is simply impractical. We are currently exploring new possibilities, such as using compost teas that can be injected through the irrigation systems to help break down the leaf litter as a cost effective alternative.

Conclusions

I do not pretend to have all the answers, but after several decades I am content to have much better questions. I do believe that one of the biggest mistakes I have seen in the avocado industry has been the “panacea mentality” of looking for one magic cure, whether it is for irrigation, fertilizer, or root rot control.

So, here is my summary –

There is no replacement for good quality water which is applied when the tree actually needs it. There is a great deal of information on irrigation management available from the UC Cooperative Extension and the Resource Conservation Districts. The bottom line is that if you can't meet the irrigation needs of the tree, no amount of fertilizer is going to counter the effects of tip burn and dehydration of roots.

Many growers in the California avocado industry have used excessive amounts of fertilizer, especially nitrogen and zinc. Most of our nitrogen leaches beneath the root zone rendering it useless to the trees and eventually contaminating ground water. Liquid fertilizer applied during the growing season at the end of an irrigation cycle is the best way to meet the nitrogen needs of the plants, save money, and to reduce ground water pollution. The zinc levels I have found in the soils would indicate that most orchards I reviewed should be good for at least a couple of decades. Don't apply zinc if your soil if levels are over 2 to 4 ppm. If your trees need zinc due to an alkaline soil pH, consider foliar applications.

Mulch offers an opportunity to improve soil tilthe by naturally improving the physical aeration and infiltration of the soil, chemical nutrient availability and uptake, and biological Integrated Pest Management aspects of the soil itself for horticulture and agriculture.

In closing, I have derived much pleasure from working within the avocado industry. My knowledge of agriculture has certainly increased, but the best part has been the wonderful growers and industry advisors I have had the good fortune of working with the past 30 years; I am grateful for their friendship and guidance. In particular I would like to recognize, Ran Matson, the original "Root Rot Randy" who allowed me to tag along with him on field visits and sparked in me a life-long curiosity for which I am truly appreciative.

Suggestions for further reading

Western Fertilizer Handbook (9th Edition) by California Plant Health Association (Paperback - March 15, 2002)
This handy guide is my all time favorite for quick and simple answers to fertilizer, soil and water questions. It is compact, easy to use, and a must for anyone using water and fertilizer. It can be ordered on Amazon.

Soil Food Web – www.soilfoodweb.com
This web site is the brainchild of Elaine Ingham, Ph.D. Especially helpful are some of her books including the Compost Tea Manual and the Soil Biology Primer. All of Dr. Ingham's resources are expertly written and easily understood by non-scientists.

Differential Effects of Mulch on Citrus and Avocado
http://ceventura.ucdavis.edu/ben/pubs/mulch/differential_effects.htm
This paper reports on research by Dr. John Menge and Dr. Ben Faber. Irrigation benefits when using mulch in Southern California are quanitified.

The Avocado: Botany, Production, and Uses
This textbook by Antony William Whiley, B. Schaffer, Bruce A. Schaffer, and B. Nigel Wolstenholme describes everything and more that you could possibly want to know about avocados, and is a great investment. It is available at Amazon.

The University of California Agricultural and Natural Resources Publications
http://anrcatalog.ucdavis.edu
This web site is simply addicting. Many of the publications are free to download and all are a great value. UC ANR publications can't be beat as a source for practical and well written pamphlets. One of my favorites is Water Quality: It's Effects on Ornamental Plants, Catalog #2995.