California Avocado Association 1936 Yearbook 21: 185-189

Fertilizer and Irrigation Problems

W. R. Schoonover
Extension Specialist in Citriculture, Citrus Experiment Station, Riverside.

Talk given at Avocado Institute, March 13, 1936.

A. W. Christie: We now come to the subjects of fertilizer and irrigation problems. Relatively few of us do not have to irrigate and not very many can maintain a successful grove without resorting to fertilizers. The principal soil management questions have always been when and how much to irrigate and when and how much to fertilize. I know groves only a mile from here where there is definite evidence of damage from over-irrigation; grove either dead or in very sickly condition due to over-irrigation. Others in the immediate vicinity are not in any better condition because they have not been adequately irrigated. Fortunately we have, in the Extension Service, a man who has devoted years of study to soil moisture and fertilizing problems in the citrus industry and, so far as we know, there is a good deal of similarity between citrus and avocado culture, so at this time we will be glad to hear from Mr. Warren R. Schoonover, Extension Specialist in Subtropical Horticulture, who will talk to us on "Fertilizer and Irrigation Problems".

Warren R. Schoonover: I am going to take a little time to outline some of the fundamentals, and leave it to Mr. Compton to talk in greater detail about one of the practices, namely, irrigation.

SOIL'S TWO FUNCTIONS

The soil, as you realize, has two important functions. The first of these functions is to serve as a reservoir for the storage of available water and the second is to serve as the source of supply of the raw nutrient materials that the tree uses in its growth. There are other functions of the soil but these are the two most important. If the soil had sufficient water holding capacity to serve as a reservoir throughout the entire long, dry season between rains, we wouldn't have to irrigate but, as the Chairman said, there are very few growers who find themselves in that position. We do grow some kinds of fruit trees in California without finding irrigation necessary or profitable but we do have to irrigate because, under our climatic condition, the soil does not perform the function of being a storage reservoir for water so completely as to meet the entire requirements of the trees. So we have to fill the reservoir from time to time because it is not large enough. Further discussion of that phase of the subject will be by Mr. Compton.

OUR SOILS NEED NITROGEN

Now, similarly, if the soil performed the second function fully, meeting the nutrient requirement of the trees, we wouldn't have to fertilize. We don't fertilize avocado trees, strictly speaking—we fertilize the soil. If the soil didn't supply anything, fertilization would be very much simpler than it is, but also very much more expensive. If we used sterile sands instead of soil, we could learn just what to supply and how much and if we could afford to pay the bill, it would be alright. When we endeavor to make recommendations with regard to fertilization, we realize that we never will have exact information as to what we should supply because that information is not possible to obtain. We do endeavor to examine the lines of evidence available to us and that enables us to make better predictions as to what line of procedure is most likely to give good results. We do not wish to spend money unnecessarily by applying materials which are not likely to give good results or even to apply those from which we do get a response in larger quantities than may be economically sound. In short, what we are out to discover is what constitutes a complete fertilizer for avocado trees in various situations where they are grown, or rather, what it is that will make the soils completely able to meet the requirements of the avocado trees in these various situations. Some of you may think that is simple. In the past it has been assumed that a complete fertilizer is one containing nitrogen, phosphorus and potassium; and that, while it may be expensive, it takes care of everything. Really, a fertilizer which contains nitrogen, phosphorus and potassium is far from being complete. If we grew trees in sand and made nutritional studies, we would have to add, besides those three, calcium, magnesium, sulphur, iron and perhaps some manganese, a little bit of boron, zinc, some copper and we might run the list on up to twenty or thirty elements—some of these in very small traces.

THREE ELEMENTS NOT "COMPLETE"

And so, from the standpoint of meeting the requirements of the tree, a fertilizer containing nitrogen, phosphorus and potassium is in no sense "complete" and we have no business talking about it as a "complete fertilizer" even if that is the custom in the fertilizer industry. It would fall far short of meeting the requirements if the soil supplied nothing. On the other hand, it may go way beyond meeting the requirements of the tree if the soil supplies everything. That is just as logical. There is a good reason why we have called fertilizer containing nitrogen, phosphorus and potassium "complete" in the past. In the eastern part of the United States and in Europe they found, by field experience on soils that had been farmed over a long period of time, it required all three of those elements to make those soils completely able to meet the requirements of the crops they were growing. There is no other reason for calling a fertilizer a "complete fertilizer". Since agriculture has gone on several more decades in those regions, they are finding now, first here and then there, increasingly large areas where they must add other elements; sometimes copper, sometimes manganese, to make the soils completely able to meet the requirements of the crops. In most parts of California, where we grow fruits, our experience has indicated that nitrogen alone is a complete fertilizer because, with the addition of nitrogen alone, the trees do just as well as they would with the addition of from one to a dozen other elements. Just as experience of people in Europe indicated decades ago that nitrogen, phosphorous and potassium

were the elements required to make a complete fertilizer, our experience indicates that we may define a complete fertilizer as "any material or mixture of materials which makes a given soil completely able to meet the requirements of the crop growing thereon". For you, it is anything which makes your soil completely able to meet the requirements of your avocado trees.

ZINC SOMETIMES USED

We might broaden that just a little bit and say "any material or combination of materials which makes the environment completely able to meet the nutritive requirements of the trees". I say that for this reason—we have a few places with avocados and many places with citrus where the first limiting element isn't necessarily nitrogen. It is zinc, which is required in very small quantities. There are some places where there are two elements limiting and for those locations a complete fertilizer would be nitrogen and zinc. We don't apply zinc to soil at all because it isn't efficient. We apply it as a spray—make it a part of the environment of the tree by putting it on the leaves. The leaves of citrus and avocado trees readily absorb the small amount needed. Our problem today is to examine the lines of evidence available to us as to what really does constitute a complete fertilizer. We don't have time this afternoon to go into all of these but we have certain suggestions to make that may be of interest to you.

NITROGEN FIRST ELEMENT NEEDED

In California it is safe to assume, for the sake of argument, that, for most situations, nitrogen is the first limiting element and we look for symptoms of deficiency. If nitrogen is deficient, the ability to grow will be interfered with. There may be sparse foliage of pale color, short length growth, or just reduced yield, because we don't have enough of the element to permit development of new living material. Apply some nitrogen fertilizer in an experimental way and what do you learn? What evidence do you develop with regard to fertility of your soil? If the tree responds with a satisfactory growth of good, healthy foliage, you learn two things—not just one thing. You learn, in the first place, that you didn't have enough nitrogen and, having made up the deficiency, the tree was enabled to grow. The second thing you learn is that the soil is able to supply the additional elements required to support that growth. If you apply nitrogen to a soil from which the tree is unable to get enough phosphorus you wouldn't bring about any growth. If you apply nitrogen to a soil from which the tree is unable to get enough zinc, you may get a little growth but it will not be healthy. There will be a condition of little-leaf or mottle-leaf which is associated with deficiency of zinc. If potassium were markedly deficient, the leaves would show some abnormal symptom. So, if you apply nitrogen and get good healthy, vigorous growth, you are bound to conclude that the soil itself is supplying the other elements required to support that growth. Now, if you only get partial growth you may conclude something else is holding you back. You investigate further. It may be found that some unfavorable moisture condition is interfering with the development or some toxic element is present, or something else of the sort. What do you learn if you supply nitrogen and get no growth whatsoever? If the tree is vigorous, you may conclude that you had enough nitrogen and didn't need the additional supply. If

the tree isn't vigorous, and you didn't get growth, lack of some other element may be restricting that growth. So you see, by making a simple experiment, you really get a lot of knowledge. Such simple experiments all over the state indicate, as I have already pointed out, that for most orchards, nitrogen alone constitutes a complete fertilizer.

ORGANIC MATTER NECESSARY

We know something else when we know that much. We know what is the next step in developing a fertilization program. Nitrogen is not stored in the mineral fraction—only in the organic fraction of the soil. Soil organic matter contains approximately 5% nitrogen. That amount is practically constant. You cannot permanently increase the nitrogen supply without increasing the organic matter supply and vice versa. That means that these two things go together. If we are going to use nitrogen efficiently, we can't always buy all of it from the cheapest source which may be concentrated mineral source, because we won't have it strung out throughout the entire growing season, made available by slow processes of decay of organic matter. Without organic matter in our soils, many of them would soon become impervious to water. We have recognized this for a long time in the citrus industry and must recognize it in the avocado industry. Even though the avocado tree is different, the soil conditions are the same. Organic matter is a problem and is associated with the nitrogen problem. The big question we have is—can we produce the organic matter on the land or must we buy some of it and bring it in? We can produce it on the land in part as we grow cover crops. In addition to the cover crop, we have the foliage from the avocado tree, and when trees get large and shade the ground where we can't grow cover crops, that is the only organic matter that we produce on the place. The leaves are good organic matter which helps to improve the soil very materially. Whether or not this constitutes an adequate supply we don't know but at present we are of the opinion that it does not supply an adequate amount and will not maintain soil fertility. This means that we should be utilizing such materials as dairy manure, poultry manure or manure from other domestic animals. We also have such material as bean straw, alfalfa hay or alfalfa straw and, now that we have learned how to use it, with supplemental nitrogen—cereal straw. We ordinarily recommend that at least a part of the fertilization come from these bulky organic sources and that they supply perhaps one-third to one-half of the nitrogen. The other half can come from more concentrated sources.

AMOUNTS OF NITROGEN TO APPLY

I don't know how much total nitrogen should be applied to an avocado tree for the best results. We know pretty well how much should be applied to a citrus tree and know that a citrus tree doesn't use all we supply. Our use of nitrogen is very wasteful. Apparently, it pays to maintain a soil solution so high that some is bound to be lost through natural process in order that the tree may get enough at all times. I believe we have pretty good evidence that the avocado tree does not require a higher level of nitrogen in the soil than citrus and may thrive very well on a lower level. At any rate, we have found from fertilizer trials and from orchard management surveys, that full bearing citrus trees do very well for a period of years with total nitrogen supply somewhere between two

pounds and three pounds per tree per year. We eventually get to the stage where soil itself doesn't furnish much from the original supply. We eventually must put on practically all the tree uses even when we start with good soil and with poor soil we are at that stage in the beginning. Amounts don't vary a lot under different conditions. When I say two or three pounds, I mean actual nitrogen. Such materials as sulphate of ammonia and Calnitro contain approximately 20%; nitrate of soda, approximately 15%; nitrate of lime, 15%; blood, 13%. The bulky materials that we classify as organic matter contain usually not more than two or two and one-half per cent as a maximum and as low as one-half per cent or less at times. So we divide materials in two classes—concentrates and bulky ones which I have already referred to.

SUMMARIZING

To summarize: We know we have to apply nitrogen on most soils. We use it most effectually if we use organic matter along with it. The organic matter also carries other elements which we may or may not need.

The next question is: What do we know, after we start with that as a basis, about the other elements? I want to emphasize "after we start with that as a basis," because in a region where it is pretty generally known that nitrogen is the first limiting element, it is foolish to try the other materials without making sure of an adequate nitrogen supply. In parts of the mid-west they know they must take care of the phosphorous adequately first and try other materials in addition to phosphorous. Phosphorous is their first eliminating element. Nitrogen is usually ours. Let us examine the evidence with respect to the need for phosphorus here. We know that trees in general have a big root system and long growing season. Therefore, they are able to get along on a lower level of availability of phosphorus than quickly growing plants, like cover-crop plants, including mustard, melilotos or purple vetch. So we can use those quick growing crops as indicators of phosphorus availability. If you find the application of a phosphate fertilizer increases your growth of cover-crop, that is, by no means, conclusive evidence that it will help your avocado trees but on the other hand, if you find that your cover-crop makes no response to phosphate fertilizer you can take it as a thousand to one bet that phosphate will have no effect on your trees. If you get good response from cover-crop you may afford to apply it for the sake of getting the additional organic matter even though you may not get a response from your trees.

With potash, the evidence is not quite so clear because potash is not an element required for growth in the way that nitrogen and phosphorus are. It is not a part of the living substance of the tree. It serves to regulate the life processes of the tree and symptoms will be an unhealthy type of growth—not necessarily a restricted growth. If your cover-crop and trees are good and healthy, the leaves vigorous and not deformed in any way, you have pretty food evidence that you are not up against potassium shortage.

For zinc deficiency we have the definite symptoms of mottle-leaf and little-leaf. We have, in some places, a copper deficiency with citrus trees and we may correct it by spraying bordeaux mixture which contains copper. I don't know what copper deficiency symptoms on avocado trees look like or if they have ever been discovered, but we have

to be on the look-out for symptoms.

RECOMMENDATIONS

I would suggest this: The safest thing for you to do, in the light of the best knowledge available, is to stick to a program of nitrogen supplemented with organic matter. Then if your trees don't grow, call in the Farm Advisor and see if he can recognize some other symptoms. You may want to make some trials.

I want to leave some time for irrigation which is just as important. We will now hear from Mr. Compton on irrigation.