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INTELLIGENT USE OF FERTILIZER

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Will Rogers remarked recently that the widows around Los Angeles had lost some three million dollars due to poor investments. Possibly the same thing is taking place in the way many of our avocado and Calavo growers are buying fertilizers. I could take time to develop my theme by giving you a long talk on soil physics, chemistry and plant physiology, but you remember the old saying, "There are no souls saved after nine o'clock." I doubt if we can save any souls on the fertilizer question after four o'clock this afternoon.

Fertilization is a business proposition pure and simple. It is easy to write a formula for financial success or failure in farming. *Yield times price less cost of production gives you a profit or a loss.* That is all there is to it. Yield per acre or tree, times the price your association gets for you, less what it costs you to produce the crops shows you whether you are going to make a profit or suffer a financial failure.

Fertilization is one of the factors that enters into yield and costs. How much fertilizer should you use? What is the cheapest fertilizer? The problem is very simple. The cheapest fertilizer is the one that costs the least to get the best yield. That is really all the problem simmers down to from the business standpoint. The question is what and how much.

There are certain fundamentals in tree growth, plant physiology, soil physics and chemistry, you should have in mind. Let us get one thing clearly in mind. What is plant food—what is it that the plant uses to grow with, to produce fruit with? You know what animals use—starches and sugars—carbohydrates, fats, and proteins. Well, the plant uses exactly the same thing. The only difference is that the plant makes its own food in the leaves and distributes it through the rest of the tree trunk and roots. All the food the plant lives on, it makes itself. It doesn't find these fats, carbohydrates, or proteins in the soil. But from the soil the plant gets certain essential minerals that help it to manufacture these plant foods. Of these eight or ten substances that it takes from the soil, some are materials that it uses to combine into some of these food products, others are simply tools it must have in order to go ahead with the manufacturing processes.

There are three things that have been used for fertilizer as long as men have been growing things—Nitrogen, Potash, and Phosphorus. Those are the three things that are offered to you in fertilizers. Some other things are offered to you as soil minerals but the State Department of Agriculture won't let them be called "fertilizer." Quite a number of

dollars have been spent in San Diego on worthless soil minerals and fertilizers. It may be a good thing for the people who made it, the railroads who shipped it, and the salesman who sold it, but it didn't give *you* much profit.

Another essential is organic matter in the soil—that is, organic matter that is actually decomposing. If it is inactive, it is of no particular value.

Fertilizer practices differ on different soil types. Soils differ because of certain climatic conditions, and because of the different materials from which they have been built up. The Middle West and Far East have entirely different types of soil than we have in the far West, due to the fact they were developed from different rocks, under different climatic conditions, some under an abundance of rainfall which means an abundance of organic matter growing. In our semi-arid West we have an entirely different situation. Our soils have developed from our nearby mountains many of which contained quite a few alkalies. Some of our soil has been built up under the ocean and then raised and it contains a good deal of salt. Due to our low rainfall, we have no great development of organic matter. You know we have no great peat or coal beds here— you will find these in the regions where there is a lot of rainfall. So you can see that fertilizer practices here are going to be different from fertilizer practices in the Middlewest. Many of you have come from the Middlewest. You brought your ideas of soil and fertilizer practices with you. You knew what you were doing back there and tried to do the same thing out here but it hasn't worked any too well, due to the difference in soil types. Back in the Middle-west, for instance, liming is valuable to improve the soil conditions. You are unable to grow many things because the high rainfall has leached out the lime from the soil. Here we do not have that situation—our soils are not generally sour nor acid and there is no particular use for lime unless the lime is totally gone from the soil which *rarely* happens out here. In many cases we have too much lime in the soils, particularly in those soils laid down under the ocean. Of course, the tree must have some lime but sometimes some of our soils have too much of a good thing.

The general principles of fertilization on soils of the type we have in San Diego are that most of them need active organic matter and many need some additional nitrogen. Our soils are built up largely from granitic rocks. A good deal of potash and phosphorus occur in a form not readily available. It is a peculiar thing about these materials in our soils. Apparently no matter in what soluble form you place potash or phosphorus in the soil, it immediately becomes locked up in the soils. It is there but can't possibly do the plant any more good than if it remained in the sack out of which it came. The way these things are made available is by the decomposition of organic matter such as manure or the roots of cover crops decaying in the soils. The soil is full of bacterial life that develops acids which help to break down these insoluble essential minerals.

The farmer has a tendency to do a lot of experimenting—in fact, I think farmers are the greatest experimenters in the world. If you can afford to do it, that is fine, but if it is necessary for you to make a little more money than you have been making, it is needful to watch the pennies and to follow good established orchard practices. If you must experiment, do it in a limited way and not over the entire orchard.

General good practice is the application of organic manures in the form of cover crops, the use of alfalfa hay, bean straw to provide a supply of *decomposing* organic matter in

the soil. The other good practice is to supply additional nitrogen to get maximum growth from your trees.

What these materials will be will depend somewhat on circumstances. If you can get a good lima bean-straw without its being full of morning-glory seed, it is as fine a material as you can get. Alfalfa hay at eight or nine dollars a ton and fairly free from weeds is a good buy. You can't depend on animal manures entirely for there are not enough animals. But if you can afford to pay a fair price for good barnyard manures—again not full of weeds, that is a good buy.

Sesbania is a good cover crop—it is a legume. In general, I do not believe it is very well suited to San Diego unless we have such hot summers as the last for it grows best in very hot weather. Here is a piece that was planted since the 21st of June. It is not as bulky as it looks for it has a hollow stem. It is probably going to get pretty hard. It would be a good soil improver for hard heavy soils from the physical standpoint as well.

That brings us to the other possibility—maintaining our organic matter by growing it. Sometimes the materials you buy are pretty expensive. We think if we put on ten tons to the acre that we are doing pretty well and that that is heavy fertilization. Really that is not very heavy but it is all we can afford from the business standpoint. If you can get enough of that material at reasonable prices, you could get along pretty well without the addition of any commercial fertilization.

Question: Is a summer cover crop advisable?

Mr. France: Yes. If you have plenty of water, it might be profitable to grow summer cover crops. Ordinarily in the older groves in most of our sections, water is expensive. So we depend on rainfall to grow winter cover crops as much as possible. We have had quite a number of different things used in the past and still are used to provide material for winter cover crops. Melilotus Indica (Bitter Sweet Clover), Purple Vetch'—both are standard cover crops. Those two crops are both legumes and have to be started rather early in the Fall. Normally we do not expect to get much rainfall before November and December and if you are going to get your cover crop started, you are going to have to use some additional water. These crops have the disadvantage of growing very slowly at the start. It takes them a long time to get under way. About the time you ought to be cutting them down to prevent tree competition, they are growing so fine you hate to do it. Then as the trees get older, they are affected by shade. There is a recent development—Chinese Mustard, which has the advantage in that it does not need to be planted before October 15 or November 1, some years even later. It makes rapid growth. It isn't so badly hurt by shade. It produces a heavy tonnage early so you can knock it down about the time your trees are beginning to come into competition with it. Burr clover is a good crop, though again it does not get away to the fine rapid start as does the mustard. Alfilaria—the same thing holds true. Malva or cheese-weed is a good crop. However, there has been difficulty in getting a supply of seed though I think we have located some over in Arizona. One man told me he has had difficulty in getting it started from seed. It has the same advantage as mustard in that it grows very rapidly at the start and makes a heavy tonnage.

One of the revolutionary things in agriculture was the discovery that the leguminous crops were able to take nitrogen from the air. Air is full of nitrogen and these bacteria

have gotten nitrogen from the air in the soil. It was mighty important to agriculture as a whole because in grain countries, where crop rotation is practiced, you can greatly increase the nitrogen content of your soil and organic matter and gain your free nitrogen from the air. Out here the situation again is a little different from the business standpoint. The smaller tonnage you would get by cutting down these legumes at the time your cover crops must be cut, as compared with mustard or malva, shows you that it would be better to take the greater tonnage and buy the additional nitrogen

you would have gotten from the legumes at a total cost of about $1.50 per acre for the additional nitrogen. It is not worth while to depend on the legumes when some of these other crops give you so much more tonnage.

Question: How about barley?

Mr. France: It is all right—a good cover crop provided you handle it right. If barley goes in and is turned under while it is still quite green and succulent, it is a better cover crop than no cover crop.

Question: What locks up the potash and the phosphorus?

Mr. France: Probably the zeolites.

Question: What is the source of potash in the granites?

Mr. France: From the feldspars.

Question: Is seed inoculation for legumes as desirable in California as in Michigan?

Mr. France: Apparently for most of our leguminous cover crops it is not required. We have a great many wild native legumes that have been growing here for years such as wild alfalfa and a number of others and they are pretty well supplied, naturally, with these bacteria. You might get some results from inoculations when they are first started, especially if the land has been in barley which would possibly deplete the nitrogen content. But ordinarily after you grow your legumes for two or three years, they come back all right.

Question: What is the best time to apply fertilizer?

Mr. France: Organic matter, manures, preferably in the late Summer or early Fall, not the late Winter as your cover crop is going to go under in the Winter. Your more rapid nitrogens will depend on what you use. Sulphate of ammonia, which is low in price and high in nitrogen, though not as rapid as nitrate of lime or soda, should be applied in February or late January broadcast on the cover crop and around the trees, letting the rains take it in. As to-what further nitrogen program you should follow, I think that depends on tree condition and tree growth, and particularly in the case of the avocado, on the amount of fruit it carries. You know in the orchard you kind of get the "feel" of things—you get a hunch when extra fertilizer is needed.

Question: Is there any advantage in putting fertilizer on trees heavily loaded?

Mr. France: I would say "yes," especially if they have been under-fertilized. We are carrying on a number of fertilizer tests—one in the orchard just below you. We calipered all of these trees and had very careful tree records of the amount of fruit borne. It was rather striking to see that the trees that had borne the crop had made quite small growth

as compared with those that had not borne. I believe when the tree has a good crop, it is going to pay to feed it. Another thing noticed, which as yet is just a pure theory or hunch, that those trees that tend to become defoliated in the Winter and early Spring would be benefited by a supply of nitrogen in the Fall.

Question: Do you think a lack of fertilizer will cause fruit to drop?

Mr. France: There are a number of causes of drop. One of the causes is too much set, another is too much water.

Question: What about nitrate of lime?

Mr. France: It is a good form of nitrogen.

Question: What is your opinion of Amophos?

Mr. France: It is a commercial preparation but I am inclined to think it is pretty good, at least on some things. Our fertilizer information has been developed from experimentation and carefully kept records. So far we haven't any carefully kept records that show the advantage of the use of phosphorus on citrus or avocado trees. We have kept test records for a number of years on potatoes and the potato crop requires pretty heavy fertilization. We have used potash and phosphorus and this year we used Amophos. The potash plot, which is supposed to be the fundamental fertilizer for potatoes, showed nothing and the superphosphate plot showed a little increase. The Amophos gave very good results. This was repeated several times so it wasn't just one little piece of soil. Whether it will work on avocados, I can't say. Normally, there is no indication with our trees either in tree growth or fruit that they lack phosphorus. Apparently enough is becoming available at all times.

Question: Might the results from the potato crop experiment vary from year to year, affected by different climatic conditions?

Mr. France: Yes, it might. That is exactly why we want to check further.

Question: How did Amophos compare with straight nitrogen?

Mr. France: Both are very similar in their results.^

Question: Mr. France, I suppose in referring to the potato experiments, you are talking about your own personal experiments—not the experiments that have been carried on through a period of years by the University?

Mr. France: Yes, the potato experiment is my own. These tests here and on Mr. Kepner's place are carried on in cooperation with the University. I might tell you briefly what the tests consist of. We are using nitrogen in different amounts—also potash, sulphur, and phosphorus trying out practically all the things that are being offered to you as fertilizer in varying amounts. We are going to carry these tests out for a number of years if we can keep these boys happy while we are using their crops for our experiments. You know it is something of a nuisance to them.

Question: Would the heavy application of nitrate of lime over a period of years tend to dwarf the trees?

Mr. France: I am inclined to think not if plenty of organic material is used.

Question: Would an application of sulphate of ammonia cause young fruit to drop?

Mr. France: A toxic dose might cause the leaves to drop and possibly young fruit but I doubt if a normal amount would have any such effect.

Question: What fertilizers, commercial or otherwise, can be used to improve the soil that has an excess of lime?

Mr. France: The man who gave me this question wouldn't have done so if he had known I was going to answer it because he knows my answer. Organic matter first, for fertilizer. You know you can have a headache because your stomach is a little bit upset. You can take an aspirin and lose your headache but you still have your upset stomach. Now your organic matter will help to overcome the condition somewhat and that is your fertilizer. Now besides that you can give your trees a dose of aspirin, so to speak—you can use a little copper sulphate or some sulphate of iron and get a temporary relief. But that is about the limit you can expect from dosing.

Question: Are soil bugs that live under the mulching injurious to the trees? Are they any benefit?

Mr. France: Now they are not injurious to trees but ordinarily are of benefit—all life working in the soil is beneficial. These little bugs live on de-

composing organic matter and as they may help it to decompose faster, we consider them a good thing.

Question: Which is the highest in fertilizer value, alfalfa or lima bean straw?

Mr. France: The alfalfa is a little higher. They are fairly close together.

Question: Where a soil has inorganic matter, will decomposing organic matter release it?

Mr. France: Yes, that is the purpose of applying organic matter.

FERTILIZER PRACTICES

Fertilization: Beanstraw

November 22,1930

Question: How should beanstraw be used.

Dr. Coit: In the first place you should be careful that your beanstraw does not contain the seeds of the wild morning-glory. When that becomes established, it is quite a pest. Beanstraw is commonly applied by mulching over the surface of the ground or filling the basins around young trees. Spread it in between and around the trees and leave it on the surface during the winter. In those groves where cultivation is practiced, cultivate it in with the spring cultivation.

Fertilization: Basins

November 22, 1930

Question: What kind of fertilizer would you recommend putting around basins of trees four to nine years of age?

Dr. Coit: I should suggest any good fertilizer—horse or cow manure or even poultry manure though the latter is pretty strong and should be put on lightly. If you live in town and have a tree in your yard and don't want to buy a lot of manure, spread your lawn clippings out until dry and dead. Then spread around your tree with a little sulphate of ammonia. This combination makes a very good substitute for barnyard manure.

May 16, 1931

Question: Will fertilizer help a tree to hold its fruit?

Answer: There is a general feeling among many growers in which I share that a sustained nitrate concentration of soil in Summer and Fall builds the kind of tissue in the foliage of the tree which puts it in condition to set a good crop, the weather conditions permitting. I have had a number of orchards, several in fact under observation, where the conditions were such that the available nitrate concentration in the soil in the late Summer and Fall, was very low or almost nil, those trees have failed to set good crops even though the weather conditions were favorable. So I am convinced that a sustained nitrate concentration is a potent factor in setting good crops of avocados, and particularly the Fuerte.

May 16, 1931

Question: I propose to improve a place east of San Diego, on sloping ground, and plan to use a basin system of irrigation similar to the one developed by A. H. Anthony at Fallbrook. I plan a management that entirely eliminates cultivation. In such a case would it be practical to grow winter cover crops and simply mow them down and leave them to rot on the surface? In so doing would there be any appreciable loss in the fertilizer value?

Answer: If a steep hillside is grown to avocados in the basin system, it is not necessary to cultivate at all. I have one grove in mind on a very steep hillside where beautiful trees are grown in basins seven or eight years old and there has never been any possibility of cultivating. It takes considerable labor climbing around those hills, dragging around your hose and making sure each and • every tree gets its water. It is very difficult to transport fertilizer materials to a steep slope of that kind. In this particular case we have never used any manure because the expense would be prohibitive. The only way we would have to get it there would be to put it into sacks and carry them up on men's backs. We have, therefore, encouraged the growth of weeds and grass and clover in between the trees, cut it, and let it lie. The trees themselves produce a large amount of leaves, all of which are carefully kept in the basins around the trees and we have used nitrates exclusively. So far the results have been quite satisfactory. But I am afraid that the humus content may be getting low. So far we have been able to get away with the situation with luck without using any manure or bales of hay. But I don't know how long we can continue with that. We plan to continue it and use nitrate only with the leaves and what we can grow between them until we have some very definite evidence of lack of humus or damage from lack of humus.

Question: Is there any combination of winter cover crops and inorganic fertilizer with

fish meal and blood fertilizer that will equal in every way the use of barnyard or stable fertilizer? I am seeking to avoid contaminating my soil with the noxious weeds and grass so prevalent in stable and barnyard fertilizer.

Answer: You can use wild-oat hay for humus and a chemical nitrate for nitrogen together with covercrops.

Question: Is there available today any reliable information on the relative merits of peat as an organic fertilizer to replace stable or barnyard fertilizers? Also we have another question: Has the Experiment Station ever made a growing test with peat and fertilizer combined?

Answer: Why, yes, there is a lot of information to the effect that humus and plant fertility in stable or barnyard fertilizer is good and relatively available within a reasonable time. But the bulk of the nitrogen and humus which occurs in peat is that which the bacteria have failed to break down and have given up as a bad job after five or six hundred years of effort. To use that in the hopes of getting nitrogen and humus out of it, you have to be more optimistic than I am in regard to longevity. Peat does have a certain purely physical value. It is spongy and does take up moisture and, therefore, has some value from the physical standpoint but I am unwilling to allow it any value from the chemical standpoint.

See McCulloch's article, page 125.

Wahlberg's article, page 131.