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"ORGANICS" IN THE SOIL MANAGEMENT PROGRAM

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In recent years an increasing number of people who term themselves "organic farmers" or "organiculturists" have been proclaiming the benefits to be derived from organic matter on the one hand, and on the other, asserting that soils are being ruined by the use of inorganic, or as they refer to them, "artificial" or "synthetic" fertilizers. It is further indicated that animal and human health is being impaired by the use of commercial fertilizers and this of course has attracted the attention of a wide group of people including many of the medical profession. To persons not trained in soil and plant science, the persuasive language, references to scientific data, and quotations from soil scientists as to the importance of humus and organic matter, makes impressive reading.

This propaganda is a "natural" for the sellers of high-priced organic fertilizers, composts, or other materials having some organic base.

Since organic matter with its multiple functions in soils has long been recognized by farmers and scientists as of paramount importance in the soil management program, it is small wonder so many people have been strongly impressed by the writings and testimony of the organic matter enthusiasts.

ORGANICULTURISTS CLAIMS

First of all what are the claims being made for organic fertilizers and composts? As already mentioned, it is stated that, by failing to conserve and return to the soil all possible organic matter wastes, thereby placing dependence upon synthetic fertilizers to restore the fertility gradually dissipated by cropping, erosion, and leaching, our soils are being depleted; quality of forage and foodstuffs produced is reduced and in turn animal and human health are being undermined. Hand in hand with this is the idea that plant diseases and insect infestations are on the increase as a result of using inorganic fertilizers and poisonous insecticides and the panacea for all these is the use of organic wastes and composts. This practice will, according to the organiculturist, restore the soil to its former productive level, quality of foodstuffs will be improved, plant, animal, and human diseases will decrease, insect infestation will lessen, and therewith the need for "poisonous" insecticides and inorganic fertilizers. In addition of course, the well-recognized functions of organic matter are brought in as further reasons for their use, e.g. the role of organic matter in tilth maintenance, erosion control, water conservation,

its content of plant nutrients, and beneficial effects on plant food availability. Its assumed content of growth-stimulating substances is also stressed.

WHAT ARE THE FACTS?

In the light of these many claims, what are the facts in so far as we know them, and what is the place of organic matter in the soil management program?

Organic Matter Not Indispensable for the Nutrition of Most Green Plants. Considering first of all the fundamental or basic plant food requirements of green plants, there is no evidence at present that most green plants require any kind of externally supplied organic substance, e.g. vitamins, growth substances, hormones, etc., for their nutrition. The green plant *does* require at least 15 different elements, namely, carbon, oxygen, hydrogen, calcium, magnesium, potassium, nitrogen, phosphorus, sulfur, iron, manganese, zinc, copper, boron, and molybdenum. The carbon comes from the carbon dioxide of the air, the hydrogen and part of the oxygen from water, and the rest from the soil. With a proper supply of these and in suitable *inorganic* form, and under proper light and temperature conditions, the green plant elaborates all of the complex organic substances which it needs. That plants can grow on a completely inorganic diet has been demonstrated repeatedly. For example, we have at the Citrus Experiment Station, orange trees which have been grown continuously in water cultures for 14 years. No trace of any organic substances is ever added to these cultures. All of the aforementioned elements as various inorganic salts and in proper concentration and proportion are added and the water cultures are aerated continuously to supply oxygen. The trees so grown are vigorous, green, and produce fruit which by every test or criterion we have thus far applied are equal to fruit grown under field conditions. Similar evidence with other horticultural field and truck crops is available and it therefore appears that so far as the intrinsic or basic requirements of the plant are concerned, these can be met by supplying an exclusive diet of inorganic substances.

So much for the purely plant side. *Is organic matter important or indispensable to the maintenance of top soil productivity?* Let us examine the essentials for the maintenance of soil productivity.

1. From the chemical side it is necessary in the long run to maintain a sufficient supply and a proper balance of all the elements required by the plant. These elements, save for nitrogen, are derived basically from the inorganic silicates, oxides, sulfides, and carbonates of the soil, and losses due to plant removal, leaching and erosion must eventually be largely restored, by one means or another, if soil fertility is to be maintained.

Soils are extremely variable, and in some there are sufficient available supplies of certain elements to last hundreds of years, while in others the same elements may be so low or so unavailable as to require immediate supplementing to insure satisfactory crop performance. The whole science of fertilization and the fertilizer industry is based on this all important principle, and to claim that we are ruining our soils by restoring through "inorganic" fertilizers, those plant food elements removed from the soil, is absurd. This is not to say that the use of organic fertilizers, the conservation of manures

and other wastes is not good, but the point is, not enough organic materials can be retrieved to restore the fertility of all of our cropped land. Hence, we will have to rely on inorganic fertilizers and agricultural minerals for the major job of soil fertility maintenance.

It is easy, however, to over-emphasize the factor of soil depletion, particularly with some of our western soils. In table 1 is shown the removal of the plant food elements by an annual crop of oranges in relation to the total supply in an average granitic derived soil and in the last column of table 1 is calculated the per cent of the total plant food in an acre 2 feet of soil which would be removed in 100 crops. You will note first that there are great differences in the supplying power of the soil for the different elements. Thus, with nitrogen, the total supply would be removed in less than 100 years whereas with iron only .005% of the total supply in the soil would be removed in a like period. Of course plants would probably show deficiency symptoms long before the *total* supply of any of these elements was exhausted and in many soils the supply is so unavailable by reason of soil alkalinity that supplemental supplies or other means of furnishing the plant with sufficient nutrients must be resorted to very early. The point I want to emphasize here is that on the one hand, in terms of what the plant uses, the total potential supply of most elements in California soils is large. On the other hand, and looking at the problem in reverse, the soil supply of elements is not inexhaustible. As a farmer I would momentarily, for a few years at least, not be disturbed about failure to restore such things as potassium, calcium, magnesium, etc., if for one reason or another, it was not economically feasible for me to supply these relatively abundant elements each year. Conversely, it is not good husbandry to exploit a soil indefinitely. Hence an occasional application of organic matter, especially when it can be purchased at reasonable cost, affords a certain amount of insurance against soil depletion.

TABLE 1

Removal of Plant Foods by 40,000 Pounds of Oranges, and Per Cent of Total Supply in an Average California Soil Which Would be Removed by 100 Such Crops

Element	Pounds removed by 40,00 lbs. fruit	Per cent of total soil supply removed in 100 crops (*)
Calcium	42.0	3.09
Magnesium	8.0	1.62
Potassium	90.0	7.40
Phosphorus	11.0	13.70
Sulfur	5.0	6.20
Nitrogen	47.0	117.00
Iron	0.11	0.005
Boron	0.10	12.50
Zinc	0.03	0.37
Manganese	0.03	0.044
Copper	0.02	0.83

(*) The total amount of the elements in a 2-foot depth of a typical California soil—one acre in area—was used in calculation of these percentages.

2. A second essential for the preservation of soil productivity is the maintenance of good soil structure or tilth. In all save pure sands and certain very special types of soil, the

natural granular structure is easily broken down by cultivation. We have come to believe that, where cultivation is practiced, it is desirable to grow green manure crops regularly or add bulky organic materials of one kind or another. Organic materials exert a restorative influence on soil structure and with certain soils and under certain conditions of management, bulky organics are indispensable for the maintenance of top soil condition. The question arises at this point whether, under noncultivation, organic matter is needed. No final answer can be given as yet but many of us are inclined to feel that with the natural return of the leaf and twig litter (as occurs under forest conditions) no additional organic matter will be required. With the cessation of cultivation, organic matter decomposition is slowed down and certain slow but natural granulative processes come into play and the soil therefore has a chance to return to something like its virgin condition.

3. A third *must* in irrigated regions in soils is to prevent salt accumulation in soils, if we are to maintain soil productivity. Salt can accumulate either by capillary rise from ground waters if the ground water is close enough to the surface or by the incomplete leaching of salt residues from irrigation waters or both. Organic matter has a bearing on this question in so far as it helps to keep the soil in an open permeable condition.

4. A fourth principle of soil conservation is to prevent erosion. It is estimated by some that it requires 10,000 years of weathering of parent rock material to produce one foot of soil. Hence the very great importance of preventing erosion. Winter covercrops, organic matter applications, sod culture in orchards, and noncultivation will aid in this matter, and so on hillside lands or slopes, particularly where cultivation is practiced, I would strongly recommend winter covercrops or organic mulches of one kind or another to reduce the erosion hazard.

5. A fifth and exceedingly important item in the preservation of soil productivity is the control of soil borne diseases and insects. There is some evidence that, with certain root diseases of plants, organic matter additions have proven helpful. However, with other plants and diseases, organic matter is detrimental. Obviously, no blanket statement or recommendation can be made at this juncture. All that can be said is that the problem is a highly individual one; on some soils and with some plants, certain diseases may be lessened or controlled by certain types of organic matter and vice versa. Therefore, the broad statement of implication of the organiculturists that plant diseases and insects will be controlled by organic matter is a gross exaggeration. There is even less support for the claim that animal and human health will improve under organic farming. It is true that in some calcium, phosphorus, or cobalt deficient regions, animals subsisting on the forage produced develop deficiency diseases. However, this situation can and usually is, in practice, corrected by the use of inorganic fertilizers and feed supplements. This is not to say that organic fertilizers and composts are of no value in this connection for if available, and supplied in sufficient amounts, they would also be helpful, but in general, it is cheaper and easier to use inorganic sources.

Pros and Cons of the Organic Matter Question. The foregoing can be summarized as follows:

1. Organic matter is not required for the basic nutrition of most green plants. The plant

does require 15 chemical elements, all of which can be supplied in inorganic form.

2. Commercial inorganic or so-called "synthetic" fertilizers will not harm our soils if properly used. The entire lime and fertilizer industry is based on the principle that the plant food elements which are removed from soils by cropping, leaching, and erosion, must in due course and to some degree at least, be replaced if soil fertility is to be maintained. Organic fertilizers are also valuable for the purpose, but not indispensable.

3. Insofar as plant and animal deficiencies arising from some lack in thesoil is concerned, these can be corrected just as easily and usually more economically by inorganic fertilizers than by organic fertilizers.

4. With certain root borne plant diseases organic matter is helpful; in other cases it is detrimental. The idea that most plant diseases and insect infestations can be controlled by organic materials has no solid base of experimental data.

5. Organic matter is an aid to tilth maintenance in soils and is indispensable for this purpose on certain types of soil where cultivation is practiced.

6. On certain soils, decomposing organic matter is of decided benefit in making plant food elements more available.

7. Regular applications of organic matter help to restore plant food elements removed by cropping, leaching, and erosion. It is to some degree insurance against soil depletion.

8. Covercrops and organic matter additions help control erosion under many soil conditions.

9. To some degree organic matter may increase water-holding capacity but the extent to which the organic matter of soils can be increased is so slight in many western soils that this point is of doubtful importance.

10. Organic matter will to some extent reduce leaching losses of nutrients from soils.

PRACTICAL RECOMMENDATIONS

In the practical management of orchard soils, my advice on the use of organic matter would hinge first, on whether noncultivation is practiced. If it is, and water penetration is good, organic matter for its tilth maintenance function, is probably not required. Its chief value therefore would be for its plant food content and possibly erosion control on critical slopes. Since the plant food requirements of avocado and citrus can largely be met by inorganic nitrogen plus nutritional minor element sprays, where these latter are lacking, the need or value of organic matter for the plant food it furnishes is doubtful. If and when a good "buy" on organic matter can be made, it would probably be worthwhile to purchase it occasionally as insurance against plant food depletion but as a regular or annual practice the use of bulky organic material under noncultivation is not indicated.

On the other hand, on most soils where cultivation is practiced, the regular addition of some kind of bulky organic material is highly desirable; in some cases indispensable. This is mainly for the purpose of counteracting the tilth impairing action of cultivation. On slopes subject to erosion, covercrops, or winter application of bulky organic matter will

be of additional benefit in reducing erosion.

In evaluating the worth of any organic material, insist on a reliable analysis for nitrogen and organic matter. Allow 12 cents a pound for the nitrogen and one-tenth of one cent for the organic matter. For example, if a manure analyzes 1 per cent nitrogen and 36 per cent organic matter, 1 ton would be worth a little over $3.00. The other constituents, phosphorus, potassium, and minor constituents would of course add something to the value of the manure, perhaps up to 50 cents and thus total value on a plant food and organic matter basis would be around $3.50 to $4.00 a ton. However, from this should be subtracted the cost of hauling and spreading in comparison with equivalent amounts of commercial fertilizer. Any additional values are difficult to estimate and depend upon the particular complex of circumstances involved.

For additional aid in arriving at the possible need for and value of organic materials under your particular orchard condition, seek the advice of your county farm advisor.