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# Nitrogen and Organic Matter Turnover"

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In studying the problem of maintaining the organic matter of the soil, the Missouri Agricultural Experiment Station tested a series of cropping systems to discover to what extent the nitrogen and carbon supplies of the soil were either built up or torn down under each. It is the carbon and nitrogen, or the combustible portion, that distinguishes the organic part of the soil from the inorganic, or ash. Of course, there is some ash in all that grows. Thereby all plants put some inorganic matter into their organic residues, and into the humus resulting therefore by decay of them in the soil.

I

This research on soil organic matter, extending over fifteen years, suggested that we cannot expect to build the organic matter of the soil to a high level. We do well to maintain it under cultivation at even a modest level (4)*. That level is controlled by the Climatic setting of the location. That holds true even for soils under no cultivation. For that reason good soil management aims to provide what is called a regular "nitrogen-turnover", or an "organic matter turnover", by putting some crop residue into the soil as regularly as the best soil management in the best farm plan will afford. This carbon and nitrogen of atmospheric origin, buried under the highly mineral soil, represent energy-containing substances for microbial combustion of some—and creation of other—organic compounds. They make the difference between a "living" and a "dead soil".

The "turnover" of organic matter is taking on more significance now that we are learning more about such organic compounds like the antibiotics originating in soil. They are unusual organic substances created by living cells through which they protect themselves from being consumed by other cells or taken into other protein compounds. Research in soil organic matter is already pointing to this combustible but dynamic part of the soil, as the neglected half of plant nutrition. We have forgotten to study soil organic matter as plant nourishment while studying only the inorganic elements and compounds of them in that function for our crops. We have emphasized the "ash" contents, but have forgotten the organic compounds contained in the crop resulting from the soil's contribution of that "ash". We have not realized that the soil was fertile in terms of both the inorganic and the organic essentials for the growth of the plants.

Only recently has it been demonstrated that the inorganic soil fertility elements serve in plant nutrition more effectively when combined chemically with organic compounds than when used as simple salts. Nature seems to use this procedure of combining the metallic, or inorganic, with the organic to lessen the "salt effect" on the plants of the former, as it were. This organic "tool" seems to help the plant to take out of the soil some inorganic nutrient elements which the root would not take so well otherwise. Metallo-organic compounds have now been chemically synthesized and listed which will "hide away" some inorganic elements within their highly complex organic structure (3). By that they make those inorganic essentials become more effective for serving as plant nourishment. This putting of the simple inorganic fertility element into the center of a large organic molecule, to result in higher fertilizer values thereby, has taken the trade name of "Chelation".

This chelation process makes the feeding of iron, for example, via a spray on the leaves, a very effective cure for the plant's iron shortage or "chlorosis". Chelation is a means, also, of using the trace elements, manganese, copper, and zinc as plant treatments. It is help in more accurate control of the amount of trace element used when this is but a

small part of a much larger molecule or unit. It is an accurate way of diluting, and thereby giving more nearly correct measure, of the amount applied. It lessens the dangers of using excesses. It is a case of the organic matter being the "shock absorber" for applied inorganic salts.

II

More significant than the technical manipulation of the special chelating compounds now being manufactured, is the recognition of the fact that the soil organic matter has been a natural chelating agent for better plant nutrition during all these past years without our recognition of that special physiological service by this small combustible fraction of the soil body. The decay of organic matter has always been giving organic acids like acetic, lactic, citric, malic, tartaric, and others. Organic decay may be viewed as the production and delivery of these organic agencies for chelating the inorganic elements. On combining with the metallic nutrient elements, like calcium, magnesium, potassium, iron, manganese, copper, zinc and others, they make these inorganic essentials function in plant nutrition with less interference from each other in entering the plant and in functioning there. The *organics* "balance" the combination of the *inorganics* as it were. This balancing via this "natural" chelation serves the soil fertility to the plant better than any prescription writing by nutritionists for the crops. We use the same principle when we put calcium gluconate into the bloodstream with benefit but might do so with damage by using calcium chloride.

Of course, any chelating effect on the inorganic fertilizers we may get from plowing organic matter into the soil with them is only a temporary or transitory result. Microbial activity soon decays the acetic, lactic, gluconic, or other parts of the chelated combiantion as we well know, for example, when vinegar loses its acetic acidity to be like water. We need, then, to keep putting organic matter into the soil regularly if we are to get these beneficial effects in "mobilizing" the inorganic fertility into organic, chelated combinations for better balance of plant nutrition. We need to maintain a continuous organic matter "turnover".

Recent trials of several specific organic compounds fed to seeds grown into young plants under sterile conditions showed that the plants take up organic substances promptly (5). They use them in the form of compounds rather than as elements. Some of the dry-product compounds of digestion excreted by animals are taken up by plants. They suggest themselves as "starter" compounds in the plant's production of its own hormones; in its formation of some commonly deficient parts of protein; and, possibly, in its synthesis of other organic essentials for the growth of the plant (1).

Not so recently an experiment was reported for sunflower plants of which the root system of each plant was divided between two containers. The inorganic nutrients put into one were taken up and used most efficiently by the plant when some humus extracted from soil was put into the other container (2). This fact gives the suggestion that the plant has its own tools for chelating some inorganic elements by the root system as a whole. That is possible provided the organic compounds for that chelating action are found somewhere in the soil by at least some few roots. The soil organic matter acts as a kind of container within which the soil's inorganic fertility may be gathered and shipped from the soil into the respective place of its function within the plant. Here again is the suggestion that the organic matter of the soil is a decided help in "balanced" nutrition—both organic and inorganic—of the crops we grow.

That the organic matter of the soil in its chelating service is more than a kind of "shipping crate" for the ash elements, is a new fact which will probably emphasize itself more as we study crop quality in relation to soil organic matter, especially in relation to chelated fertilizers. Just what these chelater compounds make within the plant, or just what happens to their by-products, is still unknown. But when potatoes turn black on cooking, supposedly because some element remains in simple inor-

ganic form through failure to be organicly combined into another unit, we may appreciate deficiencies of the organic soil fertility as well as that of the inorganics of common fertilizers. The food quality of what we grow may be much more closely conected with the organic matter of the soil than we are now ready to believe. That may be especially true for the quality of the proteins in terms of the complete array of the amino acids required for animal and human nutrition.

While we have been cultivating our soils so intensively and "burning out" their organic matter so rapidly, we may have been depleting a very important safety factor for quality as well as quantity of production, namely, the organic part of nutrition required by plants. Research in soil organic matter is now studying the effects on soil microbes and on crops by the chelated or the metallo-organic compounds, to say nothing of those by the organic compounds alone. These are the neglected part of plant nutrition research emphasizing their significance much as trace elements were coming in for such some ten or so years ago. There is the suggestion that careful research on the importance of the soil organic matter as a fertility factor in plant nutrition will do much in giving higher quality in what we grow as feed and food for ourselves, to say nothing of higher quantity.

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°*Numbers in parentheses refer to respective references cited below.*

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