Let's Live Magazine, January, 1963

HIDDEN IDEAS IN UNOPENED BOOKS

Weeds Suggest Low Nutritional Values

by William A. Albrecht, B.A., B.S., M.S., Ph.D.
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The following article is presented because, a few weeks ago, the thought flashed clearly to my mind that we need to be reminded of the poor nutritional quality of a crop that "gives up" to the low physiological level exhibited by weeds. The article also allows me to point an accusing finger at "herbicides" as a pseudo-solution to the real problem of "weeds." --Author.

Twenty-five years ago Korean lespedeza was widely accepted throughout the country on the report that it was "an acid-tolerant legume." (*Lespedeza is the name of a large group of shrubs belonging to the pea family and called "bush clover."*) Lespedeza seed salesmen claimed that "One does not need to lime the soil to start this new crop. In this respect it is not as expensive as alfalfa and red clover." These claims said nothing of what improvement this new legume crop would show (a) in thicker stands to eliminate weeds, (b) in higher yields of forage and hay, and (c) in greater nutritional values as feed, if it were given limestone and rock phosphate or other rock-mineral treatments, which had proved beneficial for the better known legumes over which lespedeza's virtues were claimed.

Outstanding trials

Trials of this new crop from the Old World were decidedly marked. These stood out, first, in terms of the improved stand of the seeding corresponding to increased soil fertility resulting from higher levels by phosphate. Still more improvement was obtained by better balance of that fertility from added calcium (magnesium) of limestone. This improvement of the stand was visible at a long distance because of the exclusion of weeds. While the added phosphorus brought partial elimination of weeds, it was the combined treatments of rock phosphate and limestone that swept out the weeds and gave a pure stand of lespedeza.

Possibilities for life

We ordinarily admit that any crop which grows well is simply too much competition for the fertility of the soil to permit weed crops to grow in the same limited areas. Yet, since we recognize an antibiotic output created by increasing certain kinds of lower life forms as a means of excluding others (particularly if the latter are still lower in the scale of biochemical complexities) , should we not envision the possibility that a crop properly nourished on balanced fertility may be producing its own particular organic chemical means of excluding others? Shall our minds remain closed to such possibilities for life in the soil in nature when these are now recognized even for the life in the sea? *

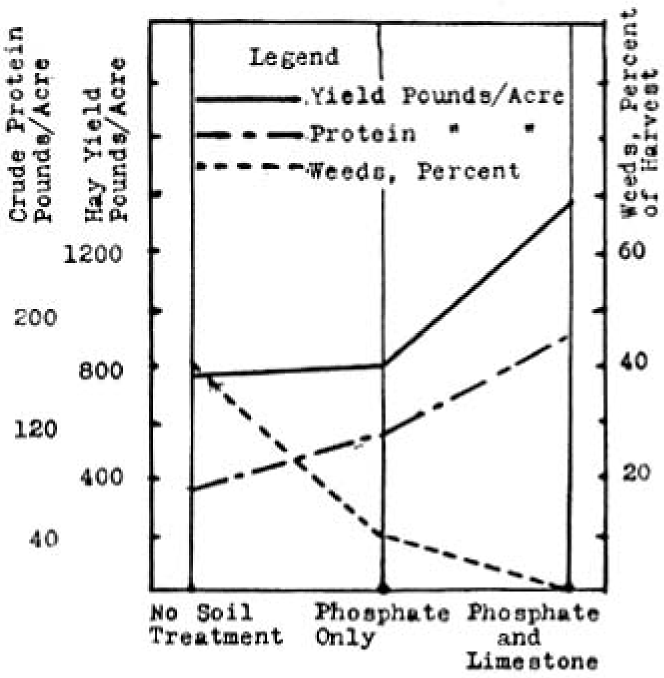

FIGURE I . . . The complete elimination of weeds from the stand of Korean lespedeza was a by-product of growing more (and better) protein through soil treatments of limestone and rock phosphate.

A natural effect

The extent to which weeds, as a percentage of the total crop, appeared on Putnam silt loam when Korean lespedeza was first introduced is shown graphically in Figure I. The elimination of weeds was a natural by-product effect along with the resulting increased yield as bulk of hay and as crude protein. It was for the latter values that this legume was desired as a supplement in animal rations commonly too high in carbohydrates. These trials were early demonstrations of the natural law telling us that the incidence of the weeds, or competitive crops at lower physiological requirements, was due to our failure to nourish properly the more complex physiology of the desired crop with higher nutritional values as its output.

* Antimicrobial substances from marine organisms.
1. Ross R. Nigrelli, Trans, N. Y. Acad. of Sciences, 24:496-7, 1962.
II. John McH. Gieburth and David M. Pratt, Ibid. 498-501.
III. Leon S. Ciereszko, Ibid. 502-503. IV. C. PLi, B. Prescott, W. C. Johnes, and E. C. Martino, Ibid. 504-509.

(Continued in February)

Let's Live Magazine, February, 1963

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Weeds Suggest Low Nutritional Values

by William A. Albrecht, B.A., B.S., M.S., Ph.D.
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(Continued from January)

In the preceding instalment we discussed the widespread acceptance some 25 years ago of Korean lespedeza or bush clover as an "acid-tolerant legume." It was claimed to be less expensive than alfalfa and red clover on the grounds that "One does not need to lime the soil to start this new crop." Yet these early claims made no mention of the improvement that could be shown in the new legume crop--particularly in thicker stands to eliminate weeds--if it were given rock-mineral treatments.

Early trials

The early trials with the lespedeza brought marked results as the soil fertility was brought into higher levels by the addition of rock phosphate and limestone. Through this combined treatment the weeds were eliminated, giving a pure stand of bush clover. Most important, however, was the increased yield of bulk hay and crude protein. The legume was a welcome supplement in animal rations predominantly carbohydrate.

The experiments were demonstrations of the natural law, showing that the incidence of weeds was due to man's failure to nourish a crop properly at its outset.

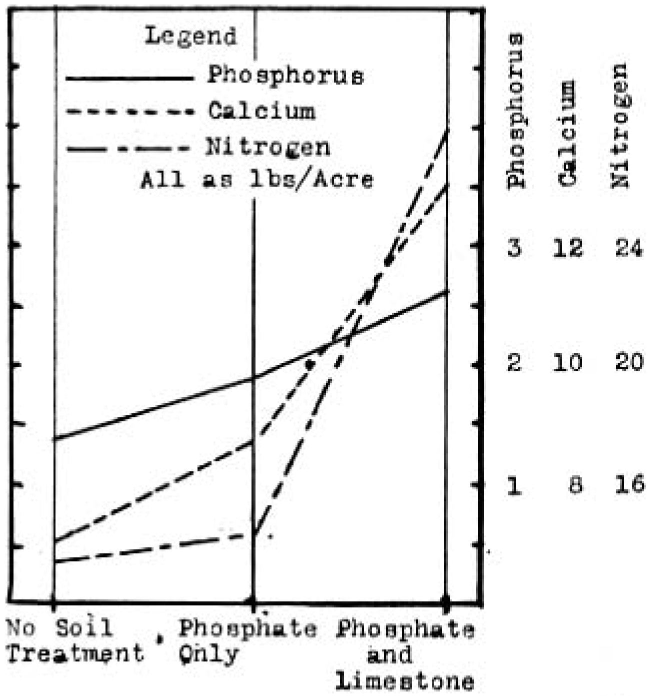


FIGURE II . . . The uplift of nutritional values in Korean lespedeza by soil fertility treatments, which also eliminated weeds, would not have been obtained had the latter resulted from the use of herbicides.

The experiments were also a demonstration of the fact that, had we chosen to eliminate the weeds by herbicides, the result would not have been an increase in nutritional values (Figure II) such as that obtained by phosphate and limestone treatments, which were simultaneously and incidentally the eliminators of the weed pests. Herbicides do not raise feed values of the crop, especially since plants take up poisonous organic compounds, even those of a greater degree of complexity in chemical structure. Improvement of the nutritional service of a crop is more valuable than waging a "fight" on weeds. Why not use the funds for fertility, rather than for poisons?

Significant finding

Most significant was the demonstration of the soil's need for more balance in its fertility supply. It had been widely recognized that for grain crops and legumes phosphorus is the foremost requisite on most Missouri soils. But many tests restricted by such belief to phosphorus alone demonstrated very clearly that, even for this reportedly "acid-tolerant legume," calcium (possibly also magnesium) as a plant nutrient applied by limestone serves to do much more to improve the harvest. This improvement was not only in vegetative bulk, but also in more protein, calcium, nitrogen, and phosphorus mobilized as higher organo-inorganic feed values when the combined mineral fertility treatments of limestone and rock phosphate were offered.

TABLE I . . . Much larger increases in yields of lespedeza hay resulted from better glance by the two soil treatments than from one only. Percentage Increases per Acre's Harvest (in Terms of --)					
Soil Treatment	**Hay**	**Crude Protein**	**Calcium**	**Nitrogen**	**Phosphorus**
Phosphorus only	5	17	23	6	16
Phosphorus and Limestone	83	113	85	114	75

It was the soil treatments, not the foreign pedigree, which made this imported legume such significant summer grazing in so many needed places. Phosphate alone gave increases, but the effects were small as compared with those obtained by the combination of the two treatments. Percentage increases for the effects by limestone are shown in Table I.

Need "living" soil

We are slow to appreciate the fact that the growth of a feed crop, like the legumes, requires a truly "living" soil with active microbial life in its many forms. We need their action of decaying organic matter to mobilize large quantities of the fertility elements that animals and man must have from the soil source. We, seemingly, still take the soil for granted.

Although we have gained in yields per acre in some aspects, such as high starch output per acre for fattening services, nevertheless, the declining health and reproductive aspects of both plants and animals call for better nutrition in proteins, and all that goes with them, via properly fertilized soils, rather than those dosed by powerful poisons in our war on weeds, fungus diseases, insects, and other pests commonly serving naturally to eliminate higher life forms not fit to survive in the competition.

Unfortunately our minds, like many good books, remain closed and nature's facts stay hidden from us all too long.

Let's Live Magazine, March-July, 1963

These issues were, regretably, missing from the Library of Congress collection. The names of the articles are known and are listed immediately following. It would be much appreciated if patrons of the Soil and Health Library would investigate their local libraries for these holdings. Soil and Health will be pleased to pay any costs of photocopying and postage so they can be included here.

MISSING ARTICLES:

Animals Choose Feed for Quality-Not for Tonnages Per Acre. Let's Live, March 1963.
"Rule of Return." Let's Live, April 1963.
Soil Fertility: First Concern for Human Survival. Let's Live, May 1963.
Organic Matter Makes "Healthy" Soils. Let's Live, June 1963.
Soil Organic Matter Under Time and Treatment. Let's Live, July 1963.

Let's Live Magazine, August, 1963

HIDDEN IDEAS IN UNOPENED BOOKS

Changes in Quality of Soil Organic Matter

by William A. Albrecht, B.A., B.S., M.S., Ph.D.
Prof. Emeritus of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

In a previous discussion of the properties and performances of soil organic matter on Sanborn Field of the Missouri Experiment Station, the chemical analytical data showed the serious decline of the quality of organic matter in the soil during a 25-year period. The depletion of this important dynamic part of the soil was pronounced under no more tillage than that for a wheat crop. There was a marked loss of nitrogen, even under a continuous sod, in a timothy crop unless manure was applied.

This loss of nitrogen, under removal of timothy hay and no soil treatment, took place even though there was an increase in the carbon of the soil. Accordingly, by using carbon as the basis for determining the soil organic matter, one falls into serious error, since the quality of the organic matter cannot be a constant if the carbon is under accumulation while the nitrogen is under depletion and both are its major components.

Effects of treatments

The extensive changes in quality (as well as quantity) of the original matter of the soil under various treatments is an outstanding fact established by this old experiment field. The use of commercial nitrogen only on wheat did not maintain (much less increase) the soil's stock of it. Quite the opposite, it reduced it by nearly 45% in 25 years. This resulted from using either ammonium sulfate or sodium nitrate. Yet, during that same time, the carbon reduction by either of these salts was near 20%, or less than half that of the loss of the nitrogen supply. When both nitrogen and carbon are constituents, such shifts in chemical composition suggest an approach to coal, an organic matter of little support of microbial activity.

In an attempt to establish that fact about changes in quality of the organic matter under tillage and cropping, a test was used on the soils under wheat and timothy to measure the lignin part, or the degree of lignification as it changes toward coal-like lignite. The data for the lignin in percentage of the soil organic matter is assembled in Table I. Also given here are the quantities of organic matter after 25 and 50 years, based on the carbon by calculation.

Table I Soil Organic Matter After 25 and 50 Years Lignin as Percent of Total Organic Matter (calculated from carbon of soil) (Sanborn Field)				
Plot Number	**Crop Period**	**Soil Treatment**	**Organic Matter (%)**	**Lignin %**
2	First 25 yrs.	Wheat, Com'l Fertilizer	1.94	
	Second 25 yrs.	Wheat, Com'l Fertilizer	1.75	39.5
5	First 25 yrs.	Wheat, 6T Manure	2.62	
	Second 25 yrs.	Wheat, 3T Manure	2.18	48.9
20	First 25 yrs.	Wheat, 6T Manure	2.37	
	Second 25 yrs.	Wheat, Am. Sulfate	1.84	46.1
30	First 25 yrs.	Wheat, 6T Manure	2.77	
	Second 25 yrs.	Wheat, Sodium Nitrate	2.22	50.5
23	First 25 yrs.	Timothy, No Treatment	2.29	
	Second 25 yrs.	Timothy, No Treatment	2.49	40.5
22	First 25 yrs.	Timothy, 6 T Manure	2.91	
	Second 25 yrs.	Timothy, 6 T Manure	3.51	48.8

Elements aid microbes

According to the data, it is important to notice that the lowest percentage of lignin, or the more nearly complete destruction of this highly carbon part, occurred where more complete fertilizers were used for the 50 years. This suggests that the extra fertility elements helped the microbes digest even the lignin. The highest percentage of lignin remained where sodium nitrate was the soil treatment for the last 25 years.

Manure additions, seemingly, served also to retain a higher percent of lignin in the organic matter, even while the soil's supply of it was declining seriously. Manure with its high nitrogen content, in contrast to other elements, acted much like nitrogen salts to emphasize the lignin part and bring about an organic matter of less microbial activity or service to crop growth.

Starved soils

That these soils were not really dead, but only starved for organic matter, was demonstrated under laboratory tests of their transformation of applied green manure nitrogen for its accumulation as nitrate nitrogen. Samples of the soils under wheat and timothy were given (1) no treatment, (2) organic matter (leguminous), (3) limestone, and (4) organic matter and limestone. When kept under proper moisture and incubation for six weeks, the accumulated nitrate nitrogen was trebled and quadrupled by the applied combination of organic matter and limestone (Table II).

Table II

Nitrate Nitrogen (Pounds per 2 million) Accumulated in Six Week Test

Laboratory Treatment	**Wheat Continuous**	**Timothy Continuous**
None	59	48
Organic Matter	52	110
Limestone	102	104
Limestone Plus Organic Matter	172	183

Pertinent facts

Hidden in the soil's experiences of this old field, now approaching 75 years, are the following facts:

1. We are starving the soils into low productivity by neglecting to supply active organic matter.
2. We are not building organic nitrogen into the soil, but are depleting the supply of it more rapidly by adding only commercial nitrogen.
3. The remnant organic matter has changed in its quality to be more carbonaceous or coal-like and more deceptive in value when considered in the services the active organic matter renders to give nutritional quality to foods and feeds.
4. In our haste to look ahead we miss much without an occasional look back.

Let's Live Magazine, August, 1963

HIDDEN IDEAS IN UNOPENED BOOKS

Soil Humus . . . Chelator of Inorganic Elements

by William A. Albrecht, B.A., B.S., M.S., Ph.D.
Prof. Emeritus of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

Nature does not divide the chemical reactions of microbes, plants, animals and man into what was once called the *inorganic* chemistry and the *organic*. Instead, she carries on the chemistry of living matter (biochemistry) by reactions between large molecules containing both the ash elements (inorganic) and the combustible ones (organic). Because the science of chemistry began with the inorganic compounds, familiar to more persons now, and then came along later with organic chemistry, we are not prone to envision these *two kinds of chemistry joined* in the soil and in the growth processes of all life forms.

Molecular action

In what has recently been called "chelation," we recognize that biochemistry is often a case of the organic molecules combining with, or enshrouding, the inorganic ones. By this action there is little separation into ions--the common behavior of inorganic salts--in water to allow them to conduct electricity. Thus, we do not see the larger living parts mobilizing--and managing--the dead ash elements. The biochemical action is mainly a molecular one, and between much larger units to give slower rates of reaction. These make time a fourth dimension of the organic and living processes.

Insoluble elements

It has now been satisfactorily established that the fertility elements, like calcium, magnesium, phosphorus, iron and others, are moved from the soil into the plant root as insoluble parts within larger organic molecules. Also, the same elements are moved about within the plants in similar combinations, or chelations, of themselves as non-ionic parts within a large organic one. Then too, the nutrient elements taken from the soil by one kind of chelator compound may be shifted into other chelator molecules before they have moved very far up through the plant stem.

In these natural facts we recognize now that organic molecular compounds are taken from the soil into the plant as its nutrition as well as, or (possibly) better than, the plant takes from solution the same ions, namely calcium, magnesium, phosphorus, iron and others broken out of rock minerals by natural weathering processes. We now recognize the plant's intake of nutrient elements from the soil as both the soluble ionic forms and also their chelated combinations into large organic molecules.

Chelation demonstrated

These chelator services were first demonstrated by feeding the chelator compounds already combined with an element or by demonstrating the chelator uptake in one part of the root system and its effect on the chelation and mobilization of the elements from some other part of the soil by other roots of the plant. In similar experiments, the humus extracts from ordinary cultivated garden or field soils served as well to chelate and mobilize within the plants the fertility elements from the soil.

The research separation of the humus from soils on Sanborn Field at the Missouri Experiment Station and the chemical analyses of it from soils under various crops and soil treatments demonstrated clearly that calcium, phosphorus and even silicon were insoluble and non-exchangeable parts within the humus. (Table I)

TABLE I

Humus (Percent in Soil) and Its Content of Nitrogen, Carbon, Calcium, Phosphorus and Silicon Under Manuring and Different Cropping for Fifty Years.
(Sanborn Field, Mo., Expt. Sta.)

Crop	Soil Treatment	Soil Humus %	*N%	C%	Ca%	P%	Si%
Corn	Manure	3.280	7.40	14.15	2.24	0.710	6.05
	None	3.218	3.45	8.76	2.12	0.448	3.34
Timothy	Manure	4.712	7.09	14.11	1.71	0.648	3.44
	None	3.314	5.52	14.11	1.71	0.842	2.82
Rotation	Manure	3.958	5.34	18.09	2.74	0.724	5.70
	None	3.322	4.99	17.07	1.56	0.808	2.16

* These symbols refer to the following order of elements, N--Nitrogen, C--Carbon, Ca--Calcium, P--Phosphorus and Si--Silicon.

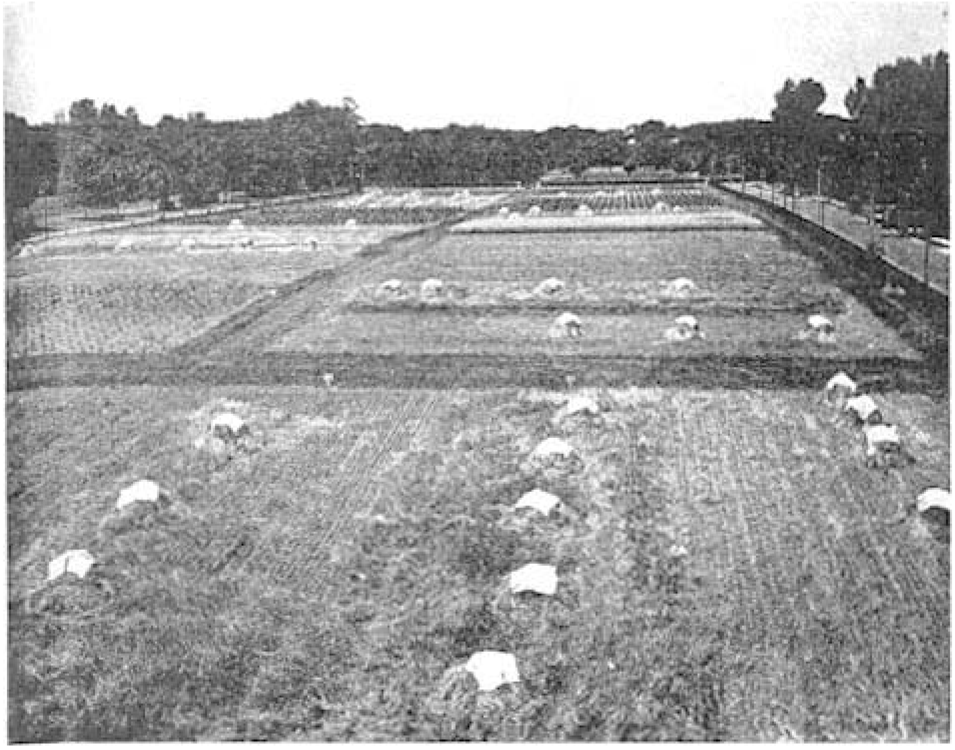
Better balance

Viewed as a colloidal chelator of plant nutrients, humus appears more important in providing a better balanced plant diet of fertility elements than if viewed as a random ionic mixture taken from the soil solution.

This balance value of humus has come about from the digestive activities of microbial life forms. It brings us to see that:

1. Plants can be fed by organic matter seemingly more effectively than by inorganic matter only, and

2. The organic matter, like humus, holds the inorganic elements as the insoluble, yet available, nutrition in more favorable balance for nutritrition of both microbes and plants.
3.



SANBORN FIELD . . . Report of 75 years' experience in soil changes at this Missouri Agricultural Experiment Station shows decline in both organic and inorganic fertility.

Let's Live Magazine, October, 1963

HIDDEN IDEAS IN UNOPENED BOOKS

Humus . . . Soil Microbial Product

by William A. Albrecht. B.A., B.S., M.S., Ph.D.
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In a chemical study of the varied nature of the organic part of the soil, the methods required for extracting the humus fraction for detailed analyses suggest some of its properties.

The methods consist of leaching the soil first with an acid until no more calcium appears in the leachings. This removes the exchangeable, or adsorbed, cations from the humus and clay, the colloidal parts of the soil. It also makes acid-humus and acid-clays. Hence, any calcium or other cations found by later analyses of the humus must have been a part within the humus and within the clay molecules and not merely adsorbed on their surfaces. Calcium, for example, would scarcely be available from this humus to the plants unless the organic part was first altered (as we expect from microbial digestion of it) to put the calcium into more available, but not necessarily soluble, ionic form.

Percentages determined

After being leached with acid, the soil is treated similarly with distilled water until it is acid-free. It is then shaken in an ammonia solution. This separates the black, colloidal humus from the soil as a suspension of ammonium-humate. This is poured off, more ammonia washing is given to it, and the resulting humus suspension is aerated and finally made acid to permit filtering off the precipitated humus. This product is washed, dried, and weighed to learn the fractional parts of the soils it represents. These percentages are given in Table I (see *Soil Humus . . . Chelator of Inorganic Elements,* September [1963] LET'S LIVE).

The weights of the humus fractions of the six different soils represented from over three to nearly five per cent of the dry weights of the soils. The humus separates were analyzed for their nitrogen, carbon, calcium, phosphorus and silicon, also reported as percentages of the humus and given in Table I (September) .

Benefits of manure

It was quite evident from the analyses that the manure served to maintain a higher humus content in the soil. Its benefit was not significant in connection with continuous corn, but amounted to 40% difference in the case of timothy grown continuously.

Manure held the nitrogen content of humus high by differences as much as doubling it. The manure held the carbon of the humus higher under corn and rotation, but not under timothy. These facts suggest the more coal-like nature of the humus under the two crops given tillage, and similarly high degree of carbonization of this organic fraction where timothy was given no fertility return as manure.

Ratios calculated

The chemical analyses of the humus were calculated in ratios between them (Table II). These ratios suggest the low quality of the humus as microbial nourishment after extended cultivation of 50 years.

TABLE II

Some Chemical Elements in Ratios to Each Other According to the Soils Under Manuring and Different Cropping for 50 Years
(Sanborn Field, Mo., Expt. Sta.)

Crop	Soil Treatment	Ratio C/N*	Ratio C/P	Ratio C/Si	Ratio N/P	Ratio Ca/P	Ratio Si/Ca
Corn	Manure	1.91	19.93	2.32	10.42	3.15	2.71
	None	2.54	19.95	2.62	7.70	4.73	1.57
Timothy	Manure	1.99	21.77	4.10	10.94	2.65	2.01
	None	2.99	19.60	5.85	6.53	2.04	1.64
Rotation	Manure	3.38	26.36	3.17	7.37	3.78	2.08
	None	3.42	21.12	7.81	6.17	1.94	1.38

* These symbols refer to the following order of elements, N--Nitrogen, C--Carbon, Ca--Calcium, P--Phosphorus and Si--Silicon.

The ratio of the carbon to nitrogen (C/N) tells us that, as a microbial diet, the wider ratio means less nitrogen or "grow-food." Also, according as that ratio approaches 2.00, going from the larger figures, the more nearly are the measurements reporting mainly microbial bodies rather than much additional organic matter. Hence, the data suggests the high stability of the chemical nature of the humus after crop removal and increasing deficiencies in fertility.

The calcium within the humus, reported either as percentage or as ratios to phosphorus and to silica, does not vary widely because of manure additions, save in the case of crop rotation. That no treatment has caused the humus to be low in calcium and that manure has given higher calcium is evident in both of these measurements.

Small variation

But most decidedly noticeable in the data is the small variation of the phosphorus in the humus, save where no treatment and cropping to corn continuously were combined. In that case, the ratio of calcium to phosphorus was lower; while for timothy it was higher for manure over no treatment. This raises the question whether the phosphorus as a nutrient element is so seriously deficient after 50 years that any available fraction of it is quickly taken by microbes for use in energy metabolism or in growth of cell tissue. Its ratio to carbon fluctuates very little, while its ratio to nitrogen does so to a greater degree. These facts suggest that the phosphorus in the soil organic matter (to say nothing of it as inorganic forms) is limiting the bacterial action in mobilizing the carbon and nitrogen in connection with itself as an active nutrient. Consequently, the soil is less support for crops in both quantity and quality as nutrition for higher life forms.

Results of cropping

After 50 years of cropping (a) these soils have gone down decidedly in their organic matter; (b) their seasonal cycle transforming it is at a low level; (c) their mobilization of the inorganic essentials into plant roots is reduced by less chelation services of the microbes; and (d) there is a failing natural balance of the plant diet of humus in both ash and organic parts. Are not such conditions reasons why crops on such soils are of low quality in (a) their value as food and feed; (b) their self-protection against pests and diseases; and (c) their capacity to reproduce with high yields; all of which the gardener boasts about when he applies organic matter plentifully in his practice of what he calls "Organic Gardening and Farming"?

Apparently we need more than chemical data on soil humus and more than 50 years of experience, hidden in the records, before we realize how rapidly tillage and salt fertilizers have burned out the soil organic matter, and how slowly it can be restored. Restoration of the soil becomes more difficult once it has gone too low to produce a crop of healthy soil microbes which must be fed first before the soil will feed any other living form.

Let's Live Magazine, November, 1963

HIDDEN IDEAS IN UNOPENED BOOKS
"Mycorrhiza"
I. Mobilizers of Organic Plant Nutrition

by William A. Albrecht, B.A., B.S., M.S., Ph.D.
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The term "mycorrhiza" carries the concept that soil fungi are symbiotically nourishing plants by the products of decomposition of the organic matter in the soil on which these microbes live. The plant roots are in close contact with the mycelia (threads) composing the fungi. These are the major microbes bringing about the early stages of decay of the fibrous, organic substances going back to the soil from vegetation grown on it.

Hidden away in the laboratory notebooks, microscopic slides, recorded observations in the field, glass house and laboratory, as well as in the visions and theories of a botanical naturalist of more than fourscore years, S. C. Hood (Hood Laboratories, Tampa, Florida), there is much to clarify the natural organic nutrition of our crop plants. Hood has collected, arranged and logically organized many facts about the dynamics of soil organic matter as it functions indirectly in plant nutrition via fungi, and by direct uptake through plant roots.

Expanding concept

The latter is now an expanding concept. It will welcome the support of Hood's reports. We are turning more attention to uptake through plant roots, with more appreciation of organic matter serving naturally during the past ages, since commercially-produced organic "chelators" are known to have moved and circulated iron, phosphorus, magnesium, etc. inside the plants. This attention was encouraged decidedly when organic extracts of soil were shown to duplicate the biochemical services of these proprietaries.

But the concept that fungi, living on decaying organic matter and in intimate contact with the inside and outside of the root, move organic nutrient compounds from the soil into the plant is one which many folks say "ain't so." This contradiction may be a confession of ignorance when the facts of careful research have been established to tell us more widely that "it *is* so."

Hood's records with their collection of many natural facts may well be cited in a series of articles to follow. These will be of particular concern to the multitude of organic gardeners who have seen the benefits of composting, organic fertilization and other similar practices in growing edible crops of more nutritional quality; and who are aware of the resistance to diseases and pests shown by crops grown on organically rich soils.

Cooperative bacteria

Ever since 1888 we have known that Rhizobia, the bacteria cooperating with plant roots in their specifically formed nodules, nourish the legumes by converting inert gaseous nitrogen from the atmosphere into plant proteins. Here, microbes in symbiosis with plant roots have synthesized the proteins required to supplement the carbohydrates so readily compounded by sunshine energy but so incomplete as nutrition for the plant serving as food for higher life forms. No doubt the legumes built up the ability of the virgin soil to support higher life forms with proteins.

We must remind ourselves that legume crops are successful only on soils that are rich in both the organic compounds and the inorganic elements like calcium, magnesium, potassium, phosphorus, sulfur, iron, manganese, copper, boron and possibly many others, known and unknown, necessary not only for plants but for animals and man. These essentials must be provided to man by the plants.

It is the dynamic organic matter that gives us the so-called "height of the growing season." This results from microbial processes attuned with rising temperatures, coupled with ample soil moisture to feed the plants more generously. It is a consequence of a doubling of the rates of living processes for every 18° F. in temperature. It is not due to the plant's biochemical response to temperature alone. Increased nutrition is the reason for it.

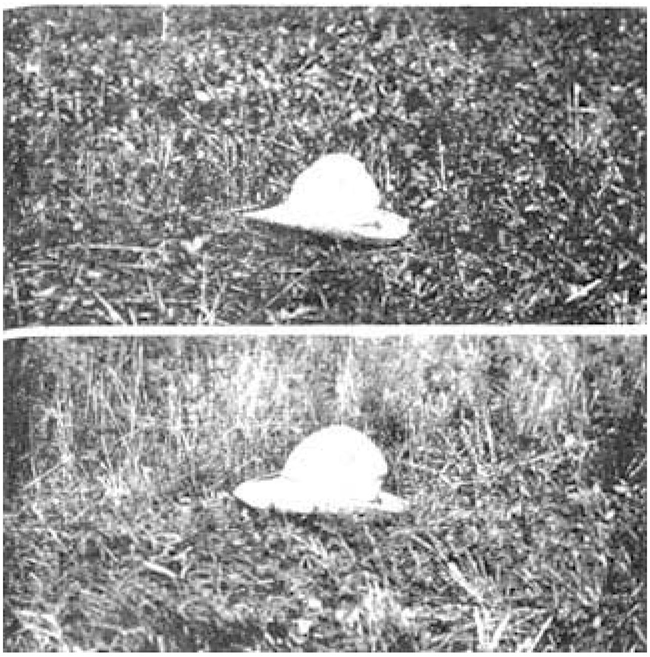
Action of fungi

This seasonal activity of decaying organic matter is dominated by the fungi. They precede the bacteria. Hood's research has demonstrated that *the roots of the non-legume plants, too, are cooperating with soil microbes for better nutrition and growth in terms of proteins.* However, *the microbes are the fungi in symbiosis with the roots, but only in soils which, like the virgin ones, are rich in decaying organic matter.*

We are slow to envision fungi in organically rich soils carrying on decay in order to obtain their own necessary energy foods and proteins while simultaneously extending their filamentous structure from the soil to, and into, the roots of plants as ministration to the latters' struggle for more protein through this symbiotic relation benefiting both plant and fungi.

A misconception

Because of the widespread belief that "germs are dangerous," we have closed our minds to their universal benefit through their bringing about decay of organic matter. Hood points to nature's "recoil" or "striking back," through declining food values and health, at our disregard for soil organic matter in which fungi become helpful microbes below the surface of the soil. Likewise, we fail to recognize these same fungi on organically poor soil when they have moved to the surface as parasites, and we combat them with poisons.



ORGANIC MATTER MAKES A DIFFERENCE . . . Upper photo shows clover crop in wheat stubble after wheat harvest. Lower photo shows portion of field in winter wheat after composted straw (six loads per acre) had been used as top dressing.

We hope to bring out of hiding Hood's thinking in connection with better soils for better nutrition.

Note--"Mycorrhiza" is a term first used about 75 years ago. It refers to the many fungi in close contact with--and entering into--the plant roots growing in virgin soil or in soil with ample organic matter. It has long been a question whether the fungi are "friend or foe."

Let's Live Magazine, December, 1963

HIDDEN IDEAS IN UNOPENED BOOKS
"Mycorrhiza"
II. Misconceptions Persist

by William A. Albrecht, B.A., B.S., M.S., Ph.D.
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That organic matter serves directly and indirectly via soil microbes in nutrition of plants is well shown by the studies of S. C. Hood, the Hood Laboratory, Tampa, Florida. Some of the facts reported in his recent manuscript [1] deserve wider acquaintance. We need very soon to be concerned with the high rate at which we are burning out the organic matter of the soil, and thereby lowering the nutritional qualities of what we are growing.

"Before we can have a clear concept of any symbiotic reactions between soil fungi (mycorrhiza) and plant roots," says Mr. Hood, "it is necessary to remove some current, though ancient and venerable, errors. For many years those errors were accepted as proven facts. They even served as premises for pseudo-investigations.

Errors still taught

"Some errors were so firmly implanted into our botanical thought that even when later investigations repeatedly had shown them to be errors, the new evidence was widely ignored. Some errors refuted more than 20 years ago are still included in recent textbooks and taught in classrooms.

"The oldest and most persistent of these errors may be referred to as the 'Liebig Complex.' Over 100 years ago Justus von Liebig announced that plants needed from the soil no more than proper amounts of nitrogen, phosphorus and potash in water-soluble forms. [2] This announcement came at a time when soil exhaustion had become a major problem. A few years later phosphate rock was discovered in South Carolina, and later in Florida, the phosphorus of which was made soluble by treatment with sulfuric acid.

New "plant foods"

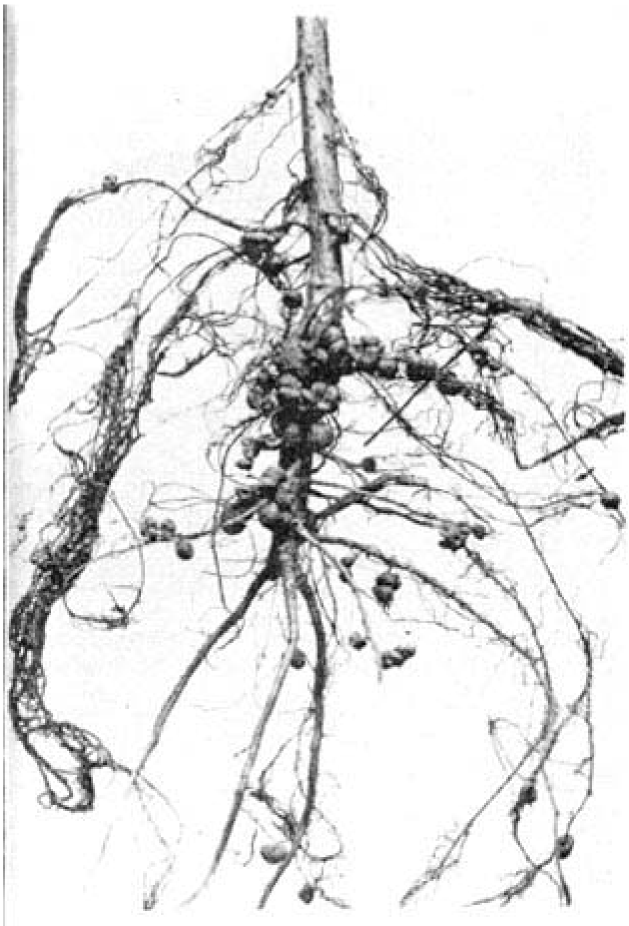
"The huge nitrate beds of Chile saltpeter provided soluble nitrogen, and the Stassfurt mines of Germany, the soluble salts of potassium. There was soon started the expanding industry for the mixing and manufacturing of chemical salts of commercial fertilizers to provide these new kinds of so-called 'Plant Foods.'

"While the Liebig theory of auto-trophic 3 plant nutrition was promptly accepted in America by farmers and scientists, probably due to its extensive promotion by fertilizer manufacturers, the acceptance in Europe was much less complete. Many scientists there demonstrated by experiments that some form of organic matter was needed for large yields and higher quality. Most of the European farmers continued to use barnyard manure and composts.

Manure vs minerals

"McCarrison, a British doctor in India, found in 1924 [4] that plants grown on fields fertilized with manure were richer in vitamins and other substances than those grown on chemically fertilized soils. 'Animals fed,' he reported, 'on fodder from manured fields were healthier and more resistant to disease than those fed from mineral fertilized fields.' In 1930 [5] Rowlands found that rats fed on clover from manured fields gained almost twice as fast as those fed on clover from mineral fertilized soils.

"Ressel and his workers showed in 1933 [6] that the organic substances of the soil stimulate the growth of plants and increase the yield. He concluded that no mixture of chemical fertilizers can be as effective as manure in maintaining a high yield of crops. But six years later, 1939 [7] Leong found that barley fertilized with manure had twice as much vitamin B-l as that fertilized with chemicals. In 1953 [8] Lebedev found that lucerne grown on fields fertilized with manure had 81 milligrams of carotene per kilogram, while on fields fertilized with chemicals there were but 27 milligrams.



ROOT NODULES ON SOYBEANS . . . Soil bacteria are help or hindrance via legume nodules, according as soil's mineral nutrients nourish the legumes.

Research summarized

"In 1961 [9] Krasilnikov reported a summary of the research work of a number of scientists who proved that chemical fertilizers alone did not give as high a yield as when manure was used. The active principles of humus and compost are not the mineral nutrients, but the organic substances and the biologically active metabolites of the microbes.

"It was found that this 'new wonder' chemical plant food was not entirely satisfactory. According as the soil organic matter was increasingly exhausted by its use, the yields and quality of crops were lowered. Lowered quality was recognized, in general, except in the case of the vegetable crops. Even today, inferior produce of that type is forced on the consumer because that alone is offered in the markets. Only when the yield is reduced is any trouble recognized."

1. Presented in private correspondence to the author.
2. Liebig, Justus von, 1846, Die Chemie in An Wendung aus Agriculture und Physiologic.

3. This term means "building their own nutritive substances by photo- and chemo-synthesis."
4. McCarrison, H., "Effect of the Manurial Conditions on the Nutritive and Vitamin Values of Millet and Wheat," Ind. Jour. Med., 1924.
5. Rowlands, M. and B. Wilkenson, "The Vitamin B Content of Grass Seeds in Relationship to Manure," Biochcm. Jour., 24:199, 1930.
6. Ressel, E, Soil Conditions and Crop Growth, Russian, 1933.
7. Leong, F., "Effect of Soil Treatment on the Vitamin B-l Content of Wheat and Barley," Biochem. Jour., 33:1397, 1939.
8. Lebedev, S. I., "The Physiological Role of Carotene in Plants," Trans. Crop. Section, Kiev, 1933.
9. Krasilnikov, N. A., Soil Microorganisms and Higher Plants." Trans. from Russian by Dr. Y. Halparin, Israel Program Scientific Trans., Jerusalem, 1961.

(Continued in January)