SOIL MEDICINES ??

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WHAT ABOUT SOIL MEDICINES?

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Before you spend money for soil medicines, consider what they are and the research information available. The chances are poor that there will be any economic return from applying them to soils or crops.

The soil medicine movement is fraught with misconception, misinformation, misinterpretation, misdirection and misrepresentation. Although sincere people have been involved, their good intentions have never improved the value of any product. Moreover, fantastic false statements and supposed benefits cannot substitute for the real facts of research.

Soil medicines have been available at various times for many years. They are appearing in increasing numbers; however, their longevity is limited by economic realities and the tests of truth.

The purpose of this publication is to look at the basic ingredients in soil medicines, to review some of the research involving them and to evaluate the benefits claimed from their use.

Questionable products carry a variety of names, but a few symptoms will usually identify them. These include:

1. The product is sold as a "cure-all." It is represented to be good for practically all soils and crops. It may also be recommended as a livestock feed additive and a cure for disease, pest and nutritional problems in animals.

2. The product and the sales program associated with its use are built almost entirely on testimonials. There are no scientific or factual data to support the claims. Scientific proof is usually implied by quoting research statements out of context.

3. In many cases, the product has the backing of professionals, respected businessmen or other well-meaning leaders in the local citizenry, but the backers are generally uninformed on the fundamentals of soil fertility and crop production.

4. The remarkable results claimed are usually attributed to some "unknown" natural process or property inherent in the product.

5. Frequently, the local distributors are committed to an emotional crusade to emancipate agriculture from the agchemical industry and its "henchmen," the agricultural researchers.

Nature of Soil Medicines

The principal source materials for soil medicines can be grouped into (a) microbial inoculants, (b) organic materials -- composts and fermentation formulations, and (c) crushed rock or minerals -- including granite, alunite, hot spring deposits, clays and coal-like minerals.

Microbial inoculants have involved nitrogen-fixing bacteria, nitrifying bacteria, phosphorus bacteria, and others. The organics are invariably associated with microbes and the materials resulting from microbial decay processes. The crushed rock and "natural minerals" cover a wide array of generally unprocessed materials dug from the earth.

Benefits Claimed

The sales literature "supporting" soil medicines is usually a conglomeration of scientific jargon, unrealistic assumptions, wildly fantastic assertions, and emotional misrepresentations. These are "seasoned" with enough misplaced facts to make the "package" palatable to the consumer.

Table 1 lists the most common benefits claimed from the application of soil medicines. Most of these claims are not correlated with the nature of the product. Surprisingly, widely differing materials are promoted, presumably to produce the same effects in soils or crops. For example, similar benefits would supposedly result if you applied any one of these four: (a) a lime deposit from a hot spring, (b) an "organic solution" containing more than 99.9% water, (c) a patented bacteria in manure compost, or (d) a gypsum-rock mixture.

Table 1. CLAIMED BENEFITS FROM THE APPLICATION OF SOIL MEDICINES TO SOILS OR CROPS

Plant Nutrient Supply in the Soil	**Biological**
Chelation of plant micronutrients	Increase numbers of earthworms and microbes
Supply nutrients in natural form	Increase microbe activity
Balanced nutrition	Add beneficial microbes
Exert favorable affect on trace elements	Favorably effect soil organic matter
Release "locked" in soil minerals	
Reduce or eliminate fertilizer need	**Crop**
Soil Physical or Chemical Conditions	Increase yields
	Increase root growth
Improve soil structure and aeration	Improve water use efficiency
Increase water holding capacity	Reduce or eliminate crop disease
Improve soil-water relationships	Reduce insect infestation
Reduce soil "breakdown" due to fertilizers	Improve crop quality
Aid alkali soil reclamation	Improve storage or keeping quality
Reduce or eliminate "drug addiction" in soils	Improve nutritional value
	"Unknown Factors"
	Stimulation of microbes
	Activation of natural minerals

Evaluation of Results Needed

Since supposed benefits are not correlated with the type of product, it should be obvious that factors other than the product materials are involved. This should alert people to a more realistic appraisal before they buy; however, the success of the soil medicine movement is evidence that the untrained layman is not always equipped to make sound evaluations. Results claimed can and do occur. *The problem is not in measuring results, but in identifying causes.*

Realistically, we know that "things happen" whether products are applied or not. In any growing season, certain crop symptoms or yields can be different from previous seasons. Farmers can be alerted to some common growth pattern or soil characteristic of which they had not previously been aware. Then, in looking for an answer to the cause of the observed results, some erroneous conclusions can be drawn.

In the many years that soil medicines have been available, none have emerged to give economic benefit to farmers. Whenever a soil medicine is exposed to the valid tests of research, the fantastic results fail to appear. The

soil medicine "trail" is lined with disgusted buyers and strewn with postponed expectations, revised formulas, altered recommendations and broken promises.

FACTORS THAT GIVE APPARENT CREDIBILITY TO CLAIMS

The question may be asked: How can the distributors obtain such glowing testimonials if the products have so little value? The answer lies in the fact that several well known but often forgotten crop growth patterns can give *apparent* credibility to any treatment. These factors are involved in (a) the cyclic nature of crop yields, (b) normal yield variability within fields, and (c) liberal use of fertilizers. Farmers may overlook these when they try out new products.

Crop Yield Cycles

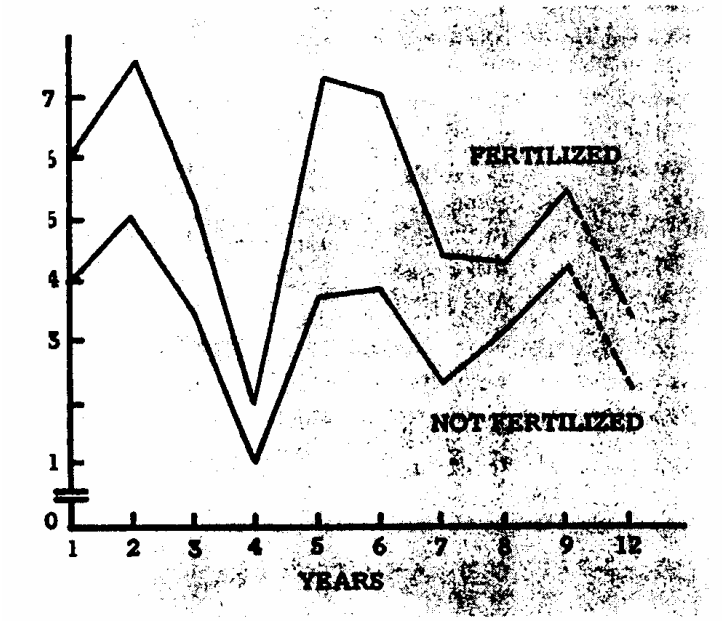
Crop yields go through cycles due to variations in weather, crop diseases and insect infestations. Downward yield trends are followed by upward trends. Consider Figure 1 (9). This shows the yields of alfalfa from fertilized and unfertilized plots in Cache Valley over a twelve-year period. Note that the alfalfa yields reflect three cycles, whether fertilizer was applied or not.

Suppose that a farmer is faced with a "bad year" similar to year 4. No matter what treatment he applies before the next growing season, yields will almost certainly be better. In addition, insect infestation may be reduced or eliminated, crop disease corrected, or crop quality improved. He should keep this in mind when he tests a new product or tries out a new practice.

Farmers should *always leave untreated strips or areas in the field* at the time the new treatment is applied. This will provide a realistic basis for evaluation. The treated area can then be compared with the untreated during the same growing season. In Figure 1 it can be seen that no matter where the yields were in the growth cycle, there was always a response to the fertilizer.

Figure 1. YIELD OF ALFALFA-

RESIDUAL EFFECT OF ONE HEAVY APPLICATION OF PHOSPHATE



Yield Variations in Fields

Crop yields can vary widely within the same field, even in "uniform" areas. It is important to account for these differences when looking for the effects of soil treatments. Failure to recognize these normal yield variations can be a major obstacle in arriving at realistic conclusions.

As an example, Table 2 shows the yields from twelve alfalfa plots treated alike. The experimental area in a field near Tooele covered only 0.28 acre. Total yields ranged from 3.4 to 4.6 tons per acre. The average yield for the twelve plots was 3.9. Half the plots yielded below the average. Five of the six remaining plots yielded above the average.

When looking at yield results from field trials, be sure the differences are consistently in favor of the treatment, and large enough to be economically feasible. If these factors are not considered, there is almost a 50-50 chance that the results will appear to show a response to the treatment.

Liberal Use of Fertilizer

Liberal use of fertilizers has indirectly provided the "proof of value" of some essentially worthless products. Field experiments have shown that on well-fertilized fields there will be no yield increase from currently-applied nutrients. Table 3 shows data from a field test on alfalfa at Delta. Heavy rates of concentrated superphosphate and ammonium phosphate were applied to a highly fertile field. There was no yield increase from the fertilizer.

Farmers who are liberal users of fertilizer can, on some crops, usually go at least one year without fertilizer with no loss in yields. If they try a soil medicine in place of the fertilizer, they can be convinced it would substitute for fertilizer. As indicated in Figure 1, phosphorus carry-over in highly fertilized soils can maintain good yields for several years. This is not the case with nitrogen; however, nitrogen can sometimes be omitted one year without yield loss.

Soil medicines cannot take the place of needed plant nutrients. The supply of each nutrient must eventually be replenished, or crop growth will decline.

Table 2. TOTAL YIELD (THREE CUTTINGS) OF ALFALFA ON TWELVE PLOTS TREATED ALIKE - 1975

Tons Per Acre		
3.9	4.0	4.3
4.6	4.1	3.8
3.8	3.7	3.4
4.3	3.8	3.4

Average Yield 3.9

Table 3. YIELD OF ALFALFA (FIRST CUTTING) ON HIGHLY FERTILE* LAND AS INFLUENCED BY FERTILIZER TREATMENTS - 1970

Treatment	Tons Per Acre (Average of six replications)
None	2.54
300 pounds concentrated superphosphate	2.42
281 pounds 11-48-0	2.53
600 pounds concentrated superphosphate	2.48
562 pounds 11-48-0	2.50

*Soil Test: Phosphorus (P) 59 ppm (Very High)
Potassium (K) 820 ppm (Very High)

RESEARCH AND FIELD OBSERVATIONS

Although the agronomic journals have abundant data to refute the claims of the soil medicine peddlers, local pressure has provided the incentive for research on a number of different products. A prime example is a recent eight-state cooperative project (6) (11) discussed below:

Soil Activators

Soil and crop scientists from the USDA and universities in eight states (Alabama, Florida, Georgia, Kentucky, Louisiana, North Carolina, Oklahoma and Texas), using standard research procedures, evaluated two "solutions" or soil "activators" in field, greenhouse, and laboratory experiments. The tests involved chemical analyses of the products, enumeration of microorganisms in the activators and in treated and untreated soils, soil incubation experiments, plant disease studies, and crop experiments in the field. The products were applied to twenty-two soils, varying from clays to sandy loams, with the pH ranging from 4.8 to 8.4. The researchers concluded:

"Chemical analyses of the soil activators . . . showed them to contain low levels of plant nutrients common to all soils. Amounts of these elements that would be contributed by the activators to a soil or growing crop are negligible in view of nutrient requirements.

Numbers of microorganisms present in the activators are too low for these materials to be considered as inoculants for soils or plants. Applications of these activators to soils in both the laboratory and the field at the manufacturers' recommended rates did not alter the number of soil microorganisms already present in the soil, nor did the activators affect microbial activities such as respiration, decomposition of plant residues, or nitrification.

Neither . . . (soil activator) had a significant effect on yields of various crops under different soil and climatic conditions. Soils were sandy to clayey, acidic to alkaline, high to low in organic matter, and in areas of dryland to irrigated or submerged cropping systems. Food, feed and fiber crops were used, but no crop showed a response to . . . (the activators). Where successive harvests were made from treated crops, there was no indication of delayed benefit from the application of soil activators. The evidence accumulated in this research indicated that . . . (the activators) did not produce statistically significant increases in crop production."

Fermentation Formulations

During the past 10-15 years, fermentation formulations from various sources have appeared. These include fermented manures, desert plants and seaweed. Their "virtues" cover most of the list in Table 1. Several have appeared in Utah, but have not "survived the tests."

In cooperative field experiments in the Columbia Basin, D. W. James and Don Kidman (7) tested a product apparently derived from fermented cow manure. The spent fermentation solution was used as the "concentrated

starter," which was diluted several thousand times before spraying on the soil in the field. Since the product was probably more than 99.9 percent water, the total application of organic matter to the field was less than one ounce per acre. The yield results indicated no treatment effect. The yields reflected only the usual field variation. Recent field research using the same product in the Columbia Basin (5) showed no yield increases in corn silage or potatoes. See Table 4.

Table 4. YIELDS OF CORN SILAGE AND POTATOES IN THE COLUMBIA BASIN AS INFLUENCED BY THE APPLICATION OF FERMENTATION SOLUTION

	Crop Yields	
	Corn Silage	Potatoes
Treatment	Tons per acre (dry weight)	tons per acre
Check	4.85	24.2
Fermentation solution alone	----	24.0
Nitrogen alone	5.75	-----
Nitrogen plus fermentation solution	5.74	-----

Bacterial Inoculants

This discussion does not include specific inoculants, which are essential for use on soybeans, alfalfa, clovers, and other legumes.

Studies (2) (10) have involved nitrogen fixers, nitrifiers, phosphorus bacteria and others. The microorganisms include Bacillus ellenbachensis, Bacillus megaterium, several species of Azotobacter, nitrobacter and so-called "universal culture." Soviet scientists have given substantial effort to this area of research. One report (1) indicated that five million cropped acres in Russia were treated with Azotobacter in 1942.

Extensive greenhouse and field trials in the United States, using Soviet strains of microbes as well as our own have shown no response to treatment. The possibilities are extremely remote that any benefit is derived from miscellaneous addition of microbes to the soil.

Crushed Rock

Crushed rock comes in many varieties from granite to lime deposits associated with hot springs. Justification for the use of crushed rock centers on balanced crop nutrition, the application of trace elements in natural form, and the addition of humus or humates (in the case of coal-type materials). Research in Utah on crushed rock products gives no evidence to recommend their use. Consider the following:

Alunite

A miscellaneous fertilizer trial involving two rates of phosphorus and a combination treatment of alunite was established in 1960 (8). The principal purpose of this study was to evaluate the alunite material. Table 5 lists the yield data for first and second cuttings, in addition to a two-year summary. The data from this study show a marked response from phosphorus with the effect of the higher rate being more pronounced the second year. There is no evidence that the alunite material had any effect on the yield of alfalfa.

Table 5. ALFALFA FERTILITY TRIAL – PANGUITCH (Yield in Tons per Acre Dry Weight)

Treatment	Summary –Average 4 Replications 1960 Cutting 1st	1960 Cutting 2nd	1961 Cutting 1st	1961 Cutting 2nd	Total
lbs/acre					
None	.58	.89	.79	.72	2.98
90 P_2O_5	1.11	1.40	1.78	1.15	5.44
180 P_2O_5	1.23	1.58	2.30	1.48	6.59
90 P_2O_5 + Alunite	1.08	1.41	1.83	1.26	5.58

Crushed Rock-Gypsum Material

In 1975-76, two field experiments were established on grain fields in Utah (4) using a crushed rock consisting of gypsum and other materials. In a well-fertilized barley field, the crushed rock was applied at two rates. In a wheat field, the crushed rock was added with and without ammonium sulfate. There was no increase in yield resulting from the application of the crushed rock. The yield data from the wheat plots are shown in Table 6. The yield differences reflect only the normal crop growth variations in the field.

In the fall, 1975, the same material was also applied to a sodium affected (black alkali) soil. The treatment produced no measurable effect on the soil or the crop in 1976.

Coal-Type Materials

There has been considerable interest in coal-like materials. The sales promotion for these products centers on the association of the materials with humus. Apparently, some people assume there is "magic" in anything that will add "humus" to the soil.

Considering the nature of coal, its chemical composition and its relative resistance to microbial decomposition, there is little to suggest it be used, particularly at the recommended rates of application and the costs.

Table 6. YIELD OF WHEAT AS INFLUENCED BY NITROGEN FERTILIZERS AND CRUSHED ROCK (Gypsum-Rock Combination)

Treatments*	Bushels per acre** (average of 4 replications)
Check	41.8
Crushed Rock (250 pounds per acre)	41.8
Ammonium sulfate (N 50 pounds per acre)	47.5
Ammonium sulfate (N 50) plus crushed rock	46.8
Ammonium sulfate (N 100 pounds per acre)	50.2
Urea (N 100 pounds per acre)	49.6

*Fertilizers and Crushed Rock applied November 19,1975
**Wheat harvested August 6, 1976

Recently, a coal-like product was applied to three potted soils in the greenhouse (3). No yield response was evident in corn or sorghum. Since the material was being pushed on its trace element content, the levels of trace elements in the product were compared with the content of the same elements in several topsoils in Cache Valley. The data presented in Table 7 show that the topsoils are better trace element mixtures than the product in question.

Table 7. CONCENTRATION OF TRACE ELEMENTS IN COAL-LIKE MATERIAL AND 1N TOPSOILS FROM CACHE VALLEY, UTAH, 1974*

	Coal-like	Topsoils			
Elements	Crushed Rock	Alfalfa Field	Poor Pasture	Grain Field	Dryland Wheat Field
Copper	0.00097	0.0022	0.0022	0.0022	0.0017
Iron	1.81	2.1	1.8	2.4	1.5
Manganese	0.022	0.069	0.060	0.07	0.048
Zinc	0.0053	0.012	0.010	0.012	0.0059

*Analysis by State Chemist, Utah Department of Agriculture

DISCUSSION

The soil medicine movement has demonstrated the need to increase educational activities with farmers and the consuming public. It is not possible to "save" all from misconception and fraud, but there must be a continual drive to raise the level of public understanding of fertilizers and soil fertility.

At the present rate of appearance of questionable products, it is not feasible to evaluate them all by research procedures. The limitations in experiment station personnel and funds make it impractical and undesirable to carry out the tests. It is, therefore, necessary to render judgments on some products based on the closely related research information that is available.

Obviously, considerable research has been aimed at evaluating questionable materials. Furthermore, there is a great reservoir of research data relating directly or indirectly to them and to the claims made concerning their use. It follows, therefore, that scientific judgments on questionable products are made, not on speculation but on well-informed considerations. Paradoxically, those who produce soil medicines and make the claims for their use appear to be unaware of some of the basic realities in soil fertility and plant growth.

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REALISM NEEDED IN EVALUATING PRODUCTS

Farmers and others can avoid wasting money on questionable products if they realistically explore the answers to the following questions:

1. As a buyer, have you checked beyond (a) the group selling the product, or (b) individuals suggested by the sales group?

2. Is the sales promotion based on testimonials?

3. Has the product *in fact* been tested by unbiased, reliable researchers?

4. Does the material contain any *available* plant nutrients?

5. Is the product supposed to result from some secret or mysterious formula?

6. Are you simply responding to high-pressure salesmanship?

7. Have you asked your county agent or University researchers what they know about the product?

Requests for Information

People who are interested in information about specific products can contact their local Extension office or the Department of Soil Science and Biometeorology, Utah State University, Logan, Utah.

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