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Non-Traditional Soil Additives:
Can They Improve Crop Production?

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Agricultural producers are constantly seeking the most efficient and economical production systems. The use of soil additives such as soil conditioners, soil activators, wetting agents, soil inoculants, microbial enhancers, soil stimulants, etc., has been promoted since at least the late 1800s. Increasing production costs, especially for fertilizers, have renewed producers' interest in these materials. However, many of these products have not been investigated scientifically and their benefits are unproven.

Soil and plant additives may be classified in a number of different ways based on criteria such as intended use or function, application method, quantity to be applied, or origin of the material. For consistency, most soil scientists and agronomists classify these products under three main categories: 1) soil conditioners; 2) soil activators and biological inoculants; and 3) wetting agents.

In general, soil additives can be distinguished from fertilizers in that they usually have little or no nutrient content. Unlike fertilizers, additives are commonly not marketed with, nor are they required to provide, a guaranteed analysis (e.g., 10-34-0 or 32-0-0). Instead, manufacturers often suggest that adding these materials to the soil will enhance crop production by improving water and/or nutrient availability and uptake by plants. These enhancements are generally said to occur when standard fertilizer applications are made to the crop at recommended or near recommended levels, although some additives claim to replace or significantly reduce the need for fertilizers.

Most traditional soil amendments and commercial fertilizers have been tested extensively through research trials to document both their benefits and limitations. Unfortunately, adequate research funds often are not available to investigate the many new products being marketed, including non-traditional additives. Nevertheless, consumers should be aware of the types of products available and have some knowledge of their potential to benefit crop production.

Soil Conditioners

Soil conditioners usually are defined as materials that improve a soil's physical condition or structure and, in turn, the soil's aeration and water relationships. Certainly, maintaining and/or improving soil structure is highly desirable in crop production. Adding organic matter to the soil is the most common method for improving soil structure. Traditional additives include crop residues, livestock manures and sewage sludge. Non-traditional soil conditioners include both organic and inorganic products such as:

1) Composted organic materials which also may be supplemented with inorganic materials such as unprocessed rock phosphate or ground limestone. The composition of these materials is quite variable. Such additives may be marketed as liquid extracts of livestock manure or other organic residues.
2) Mined mineral deposits that are unprocessed except for grinding. Again, the composition of these materials can be highly variable, but may include granite, glauconite (a mineral high in unavailable potassium), and gypsum or sand.
3) Mined humates or humic acids. These are prehistoric organic deposits in the advanced stages of transformation into coal which are normally discarded during mining. Liquid humates also have been marketed and are, presumably, a concentrate of humic acids.
4) Various inorganic solids such as evaporated sea water or sulfates, which may be combined with organic extracts of materials such as kelp (sea weed) or whey.

Humates and/or humic acid are good examples of non-traditional soil conditioners, and a number of

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Table 1. Effects of humate on yields of irrigated corn.[1]

Treatment	Grain yield (bu./acre)			
	1978	1979	1980	Average
Control (no fertilizer)	211	152	170	178
50 lbs. 18-46-0/acre	213	149	177	180
50 lbs. 18-46-0/acre + 250 lbs. humate/acre[2]	208	162	172	181
50 lbs. 18-46-0/acre + 500 lbs. humate/acre[2]	210	162	172	181

[1]Adapted from Lawless et al., 1984 (see References).
[2]Rate of humate reduced by one-half in 1979 and 1980 applications.

research trials across the United States have evaluated their effects on soil properties and crop growth. Studies conducted in Kansas (Table 1) showed that humate did not significantly improve corn grain yields over a 3-year period (1). Similar results were observed in research on a related material called leonardite, an organic, coal-like deposit reportedly high in humic acid (2). Research in Illinois (3), North Dakota (2) and Canada (4) showed no significant improvement in yields of corn grain, corn silage, wheat, barley and field beans when various soil conditioners were applied alone or in combination with commercial fertilizer. In contrast, most studies showed consistently improved yields with the addition of irrigation water and traditional commercial fertilizers.

Soil Activators

Soil activators are marketed on the basis that they stimulate existing soil microbes or inoculate the soil with new beneficial organisms. Some manufacturers suggest that such products may improve soil physical properties (increase structure, reduce compaction), increase fertilizer and soil nutrient uptake, improve crop yields and/or quality, correct soil "toxicities" (such as salinity), and provide disease and insect resistance (5). Most soil microbiologists agree that to significantly increase the activity of soil microbes for more than a few hours, a minimum of several hundred pounds of organic material must be added to the soil. However, these products often are applied at rates of only a few pounds per acre, which may add as little as 1 pound of microbes to soil that already contains 2,000 to 4,000 pounds of microbes per acre (6).

Numerous studies have been conducted across the United States to evaluate various soil activators. In general, these studies have shown no significant beneficial effects of these products on crop yields or quality. Table 2 presents results of field studies conducted in Texas using two soil activator products (5). In both fertilized and unfertilized plots, neither product increased yields of grain sorghum or cotton above the check plot. Laboratory evaluations of these products also indicated that they did not increase the numbers or activity of soil microbes and thus, would not be expected to increase the rate or extent of crop residue decomposition.

Other field trials using these two products were conducted on forages, peanuts, rice, soybeans and tomatoes by researchers in Texas, Alabama, Louisiana and Oklahoma (5). These studies consistently indicated that neither product significantly affected yields of the various crops under the different soil and climatic conditions. This work is extremely important, particularly because it included 22 different soil series ranging from fine sands to clays (pH range 4.8 to 8.4), and because the work was continued at the same locations over a 2- to 3-year period to verify results.

Certainly, inoculation to stimulate the development of certain types of beneficial microogran-isms is not uncommon. In certain sewage treatment processes and composting operations, a portion of the treated material may be used to provide "seed" organisms to unprocessed material. An example in agriculture is inoculation of seed with *Rhizobium* bacteria to promote good nodulation in legume crops. However, these biological

Table 2. Grain sorghum and cotton yields at three locations as affected by application of two soil additives and fertilizer.[1]

Fertility treatment	Sorghum grain yield (lbs./acre)			Cotton lint yield (lbs./acre)		
	Beeville	McGregor	Temple	McGregor	El Paso	Lubbock
Unfertilized						
Check	175	2057	2218	194	806	290
Product A	140	1854	2233	199	842	301
Product B	217	2036	2202	193	777	310
Fertilized						
Check	1110	2543	2237	265	743	393
Product A	900	2514	2352	240	766	370
Product B	1041	2365	2352	240	749	397

[1]Adapted from Weaver et al., 1974 (see References).

Table 3. Effects of two wetting agents on yields of corn grain over a 2-year study period.[1]

Treatment		Grain yields (bu./acre)		
Nitrogen fertilizer rate (lbs./acre)	Product A rate (qts./acre)	Year 1	Year 2	Average
0	0	140	126	133
0	2	131	107	119
200	0	183	167	175
200	2	171	155	163
Treatment		**Grain yields (bu./acre)**		
Nitrogen fertilizer rate (lbs./acre)	**Product B rate (qts./acre)**	**Year 1**	**Year 2**	**Average**
0	0	140	126	133
0	1	139	120	130
200	0	183	167	175
200	1	182	166	174

[1]Adapted from Wolkowski et al., 1985 (see References).

processes have been thoroughly investigated and the potential benefits reasonably well documented.

Wetting Agents

Wetting agents and surfactants have long been used in agriculture in combination with herbicides and insecticides. Their primary function is to reduce the surface tension of water droplets and improve leaf surface coverage by foliar sprays. How-ever, many related products are marketed on the basis that they will loosen tight or compacted soils, improve water infiltration and retention, enhance nutrient availability and increase crop yields. Some research has shown that certain non-ionic soil wetting agents do in fact increase water infiltration rates on hydrophobic (water-repelling) soils. However, these materials have either no effect or an adverse effect on normal (wettable) soils (7). Obviously, using results from one type of soil to predict response on another soil is often inappropriate.

Studies in Wisconsin evaluated the effects of three wetting agents on growth and yield of corn, soybeans and potatoes (7). Each product was evaluated over a 2- or 3-year period and at up to three different locations. Table 3 shows the effects of two products on corn grain yields. Both products were soil applied according to label recommendations either preplant or preemergence. In both studies, plots were carefully installed to include checks with and without fertilizer, in addition to plots receiving the wetting agents. In this way, the response of the crop to fertilizer and to the wetting agents could be compared. There was no increase in grain yields from the addition of wetting agents, whereas adding commercial fertilizer significantly increased corn grain yields compared to the unfertilized plots. Leaf nutrient content (N, P, K) also was not increased by soil application of the wetting agents.

In several other states, research on the effects of various wetting agents on the growth and yields of potato, soybean, wheat and grain sorghum (8, 9) has shown no significant benefits. However, one field study in Kansas (10) did report a significant yield response in 1 year of a 4-year study.

Making Decisions

Soil scientists and agronomists are often asked to provide recommendtions on the use and effectiveness of new and non-traditional products. However, many such products have not been scientifically evaluated. As a result, the best advice that can be given to growers is to evaluate new products carefully and insist upon local or regional research data (not testimonials) demonstrating product effectiveness and value. If there are no such data, consider conducting small-scale field trials on your farm. Figure 1 shows an example layout for a product trial. The following factors should be considered when evaluating new products in farm and ranch production systems:

1) Use a small area, but one of adequate size to obtain reliable harvest data.

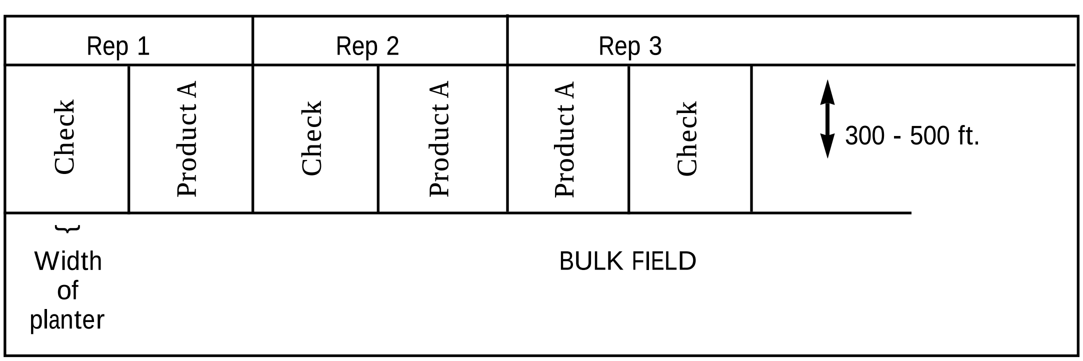

Figure 1. Example plot layouts for small-scale product or management practice comparisons.

2) Select a field or a location within a field that is uniform in soil, slope and management history.

3) Always compare the plots receiving the amendment to check plots that are not treated.

4) Install at least three or four replications (separate plots) of each plot or treatment.

5) Manage all plots in exactly the same way during the season, except for the difference in treatments.

6) Monitor crop growth and development during the season to detect treatment differences.

7) Harvest each plot separately. Compare the yields for all replications of a particular treatment to look at variability. If yields for a particular treatment are not consistent, it may not perform consistently, or the test site may have hidden variation.

8) Finally, use the average value (crop yield or quality) for each treatment to compare the different treatments to each other. Then, evaluate input costs for each treatment compared to anticipated returns.

If product and application costs approach or exceed returns, the treatment may not be a sound investment.

The purpose of this publication is not to suggest that all current and/or future non-traditional soil additives are of no value. As new inventions and new products are developed they may have the potential to improve crop yields, crop quality and/or production economics. However, proper product testing and evaluation are critical to verifying the potential benefits of new and unproven materials.

Farm managers should understand the requirements of their lands and crops, and thoroughly assess the benefits and costs associated with various production practices. Achieving "maximum economic yield" depends upon using only those inputs which will, with reasonable certainty, provide a return on that investment.

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