Eight questions to ask:

Evaluating soil and turf conditioners

Independent investigation of a product's effectiveness will enable turfgrass managers to make sound decisions.

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Soil modification traditionally has referred to the modification of soil physical properties with physical, or sometimes chemical, amendments (1). Within turfgrass management, the introduction of other products that may alter soil and/or thatch properties has further broadened the definition of the already general term "soil amendment."

Now popular literature contains many references to soil amendments, soil conditioners, soil modifiers, turf conditioners, stimulants and enhancers. None of these terms, however, has been clearly defined, and many are used interchangeably in certain situations. This has led to confusion among turf managers about the many products sold as amendments and their diverse claims.

Soil amendments and turf conditioners are promoted to improve the physical, chemical, biological and thatch properties of soil, or some combination of these factors. These improvements are in turn expected to enhance turfgrass growth and health.

It is beyond the scope of this article to critically review each product based on scientific literature and its use in turfgrass culture. Instead, eight questions are presented that should be used when evaluating any product. If the product is beneficial, there will be clear and concise answers to these questions.

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Table 1. "Traditional" soil amendments used to modify soil physical and chemical properties

Modify soil physical properties	
Inorganic materials	
sand	pumice
calcined clay	sintered fly ash
diatomite	slag
expanded shale	vermiculite
perlite	gypsum[a]
Organic materials	
peats	
composted organic matter	
- digested sewage sludge	
- aged sawdust	
- animal manures	
- organic byproducts	
- rice hulls, cotton burrs, etc.	
Modify soil chemical properties	
fertilizers[a]	
gypsum[a]	
lime[a]	

[a]Chemical amendments. All others are classified as physical amendments.

Is this product needed in my situation?

Turf managers must be skilled at recognizing primary problems that hinder turfgrass growth and be able to choose management practices that will correct these problems. For example, specific soil physical problems of fine-textured (2) or coarse-textured (3) soils must be determined before proper cultural practices can be selected to correct them. Thus, whether a particular product is "needed" in a particular situation depends on proper identification of the problem that the product could potentially correct.

Sometimes an amendment does add a potentially useful compound to the soil, even though the soil-turf system already may be producing an abundance of the material. If this is

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the case, there isn't a true need for or expected benefit from use of the product.

Turfgrass growing in a soil, for example, produces organic matter, which decomposes to produce "natural" humus and humic acids (4). A soil with just 1.0 percent organic-matter content within the surface 8 inches would have 13,300 lbs. of organic matter per acre on a dry weight basis with most of this as humus (60 to 80 percent), and only 1 to 4 percent of this soil organic matter decomposes per year.

With a growing turfgrass and clippings returned, 2,000 lbs. of crop residue (shoots plus roots) can easily be produced, which would decay to approximately one-third humus, or 660 lbs. of new humus added each year to replace any lost humus. In addition, a half-inch thatch layer would contribute 28,000 lbs. of organic matter per acre with one-third to one-half as potentially humus in nature. Thus, 16,000 lbs. per acre of humus, consisting of about 50 to 70 percent humic acid, may be present in a typical turfgrass soil from "natural" means.

Soil microorganisms are another example of inoculation being unnecessary because components are already within a soil. Recently, this was demonstrated on a USGA golf green, where the thatch had very high natural levels of microorganisms (5).

A third example is various plant hormones that are not in the soil but within the plant. A healthy turfgrass plant produces its own hormones (auxins, abscisic acid, gibberellins, ethylene and cytokinins) and maintains a proper hormonal balance, which is important since hormones interact with one another.

Hormonal levels and balances can be adversely affected by environmental and cultural stresses. When a turfgrass is subjected to a stress, cultural practices to correct or prevent the stress will restore a proper hormonal balance.

Sometimes a stress cannot be avoided, such as in sodding where plant roots are removed for transplanting. Richard Schmidt and colleagues at Virginia Polytechnic Institute have consistently demonstrated better rooting on transplanted sod (roots removed) pre-treated with cytokinin.

However, this response may not be extrapolated to field situations where cytokinins are applied to turf, and existing roots are left intact — especially since root tips are the primary site of normal plant synthesis of cytokinin. Data supporting positive rooting responses from plant hormones under normal field conditions remain very limited and the long-term effects of an applied hormone remain unknown.

Recently, Schmidt indicated that effects could be present 10 months after application (6). If an applied hormone is present when a turf is healthy, the potential exists for adversely influencing normal plant hormonal levels and balances.

Are independent test results available?

Federal and state laws require that valid experimental results be available for only a few turfgrass products:

- Pesticides. Test results must be available for safety but not for efficacy. (California and Canada are exceptions. They require efficacy or effectiveness data.)
- Fertilizers. The minimum nutrient content and general classification of slow-release or fast-release nitrogen are required.

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Table 2. Other amendments and their primary claims (see Table 1 for traditional amendments)

Algae-based soil conditioners - improve soil structure
Enzymes - improve soil structure, remove salt or other toxicities
Hormones (Biostimulants) - promote root growth
Humus - improves soil structure, nutrient retention
Humic acids - improve soil structure, nutrient retention, growth stimulation
Inoculated composts - organic composts inoculated with various microorganisms. Some have added nutrients and are also classified as fertilizers. Claims are to improve soil structure and disease suppression, provide better nutrient retention and thatch control, and increase soil organic matter.
Polymers (starches, PVA, PAM) - enhance soil water retention, improve soil physical conditions
Porous ceramics - enhance water retention, improve soil aeration status, improve wetting
Seaweed extracts - hormones act as biostimulants
Seaweed plant meal - increases soil organic matter, increases nutrient retention, acts as biostimulant
Root zone stabilizing agents (mesh elements or mesh blankets) - stabilize soils, alleviate compaction
Thatch control agents - some are similar to inoculated composts, while others are organic-rich liquids. These may or may not contain added nutrients to be classified as a fertilizer. Claim is to control thatch.
Wetting agents - wet hydrophobic soils, improve soil structure, improve drainage
Zeolite - increases CEC and improves soil physical properties

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• Seed. The germination level and grass/weed contents must be available.

For all other products, the turf manager must rely on four other sources: sales/manufacturer claims, testimonials, personal evaluation, and university or commercial lab independent testing.

Up until 10 to 15 years ago, most products were evaluated through university testing programs for effectiveness and consistency. This was especially true for fertilizers and pesticides. The manufacturers selling these products paid for the evaluations and had them conducted prior to promotion of a product.

Currently, many products are promoted and sold within the turfgrass industry without any independent evaluation. It is the author's opinion that there are several reasons this has occurred:

• Many turfgrass managers do not insist on valid test results before purchasing products.

• Certain manufacturers will not provide sufficient monies to evaluate their products.

• A few university scientists have not remained unbiased in their testing and interpretation of results. This has reduced the trust by turf managers for "unbiased" university evaluation.

Society provides funding for salaries and facilities for university research scientists in agriculture because it recognizes the benefits of basic/applied research and the role of university scientists in obtaining unbiased scientific results.

Table 3. Potential effects of amendments added to turfgrass soils or thatch

1. Modify soil physical properties
   - alter distribution of macro (large) and micro (small) pores in the soil
   - reduce soil strength
   - alter water-holding capacity (i.e., increase water retention in sands; decrease water retention in fine-textured soils)
   - improve infiltration, percolation, drainage
   - improve soil aeration status
   - enhance soil structure formation/stability
2. Modify soil chemical properties
   - change soil pH
   - change nutrient retention/cation exchange capacity
   - improve nutrient levels and/or balances
   - reduce total salts and sodium levels
   - alter levels of metals or non-nutrient elements in the soil
3. Modify soil biological properties
   - alter microorganism levels and population balances
     Examples are:
     - to suppress a disease population
     - to stimulate microorganism activity and foster greater organic matter breakdown or structure formation
     - to stimulate or inhibit a soil microorganism population so that a particular process will not occur (i.e., nitrification inhibitor)
   - increase biochemical concentrations or activities (enzymes, hormones, growth factors, catalysts)
   - alter levels and balances of nematodes, insects, weeds and disease organisms
   - influence earthworm populations
4. Modify thatch
   - inoculation with microorganisms
   - altering chemical or physical properties of thatch to enhance natural microbial populations and/or earthworm activity

However, society also expects any commercial enterprise to share in evaluation costs for its products. This is true in all phases of agriculture or any other area, such as physics.

Turfgrass research scientists at universities are allowed freedom to do product testing if:

• The manufacturer provides sufficient funds.

• Evaluations are sufficiently in-depth to contribute to science and be potentially publishable in scientific literature.

• Such evaluation fits into the program's overall research goals and objectives.

Since manufacturers generally are not required by law to provide sound scientific evidence of product performance, the best means of ensuring such evidence is for buyers to insist on it.

The best evidence for product effectiveness is found in peer-reviewed scientific literature, though it is not unusual for a scientist to publish general results in popular literature before detailed scientific results are published. Trade magazine articles that are focused on a type of product and include a review of turfgrass research are especially useful (for example, the "Biostimulants" article in the March 1993 issue of *Golf Course Management* (7)).

In most research studies, negative results are more frequent than positive results, and knowledge of which products or treatments do not work is important. Unfortunately, negative results are difficult to publish. The absence of research results in the literature for a particular product does not necessarily mean no research has been conducted — it may indicate that no positive benefits were found.

Good information sources for negative results are university research/extension scientists and USGA agronomists. Also, presentations at turf conferences often include data on products that did not work. Some research scientists routinely report both

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positive and negative results in grower presentations. Unfortunately, these individuals are sometimes viewed as "negative" by segments of the industry, but in reality, they are presenting valuable information.

Another form of scientific evidence related to a product's performance is reports from the scientist performing the research for the manufacturer. Sometimes a manufacturer will finance research testing, but then will selectively use the data to ensure a positive response. This is unethical and misleading. Growers should insist on full reports — not selected parts of a report — and the names of scientists conducting the research. A call to the researcher may provide a different insight.

What is the magnitude of response?

Turf managers often use products that have very high effectiveness. These products would include herbicides for weed control; fertilizers that provide a rapid, observable response; and fungicides for control of a disease. Thus, when statements are made such as "suppresses disease," "reduces thatch" or "enhances rooting," we can easily assume that these responses are large in magnitude, when in fact, they may be small. Turf managers are encouraged to ask, "How large of a response occurred?"

For example, in five research studies over a six-year period on materials to control thatch (i.e., either inoculated organic nitrogen carriers, or organic bio-dethatch agents inoculated with bacteria and other organisms), I observed a statistically significant reduction in thatch by one treatment after two years — but the magnitude was a 4 percent reduction. Although this product could be said to "significantly reduce thatch," is 4 percent what the buyer envisions as significant thatch control?

In several of these studies, we also investigated disease suppression by organic nitrogen carriers inoculated with various organisms. Occasionally, a 10 to 30 percent reduction of disease activity was observed, but this was far from an adequate level of control.

Almost any material applied to the soil will have some effect on the soil properties and/or turfgrass. Because of this, it is not so much a question of whether a response occurs, but of its magnitude and whether it is a positive or negative response. General statements such as "influences soil structure" can be made by many products, but products that have a dramatic and significant effect are far fewer.

A classic example is gypsum, which can cause notable improvement in soil structure on sodic soils. On non-sodic soils, gypsum results in only very minor effects on structure (an exception is the reduction of surface crusting in kaolinitic soils without turf cover).

Does this product provide consistent results?

Turf managers often use products that claim to give consistent results, but this isn't necessarily true for all materials. In the studies previously mentioned on organic nitrogen carriers inoculated with various microorganisms, disease effects were erratic, with responses ranging from suppression and no effect to enhancement of a particular disease — all from the same material at different times.

An inoculated material applied just as a disease population is beginning to increase may suppress that disease organism. However, the same material applied before this period may have little influence on a disease population if soil environmental conditions were unfavorable for survival of the inoculated organisms.

Added organisms are subjected to the same factors that influence natural microbial populations: temperature, moisture, pH level, oxygen level, food source and presence of competitive organisms. In addition, the nitrogen in organic nitrogen carriers may have more influence than the organisms. Effects on dollar spot from certain nitrogen carriers were best correlated to the nitrogen release rate where adequate nitrogen reduced dollar spot, or limited release of nitrogen promoted dollar spot.

Claims made for some amendments are based on theoretical responses that could occur under certain ideal conditions. Inoculating the soil with an algae that is efficient in polysaccharides production, such as *Chlamydomonas mexicana,* theoretically could enhance soil structure, reduce soil compaction and improve drainage. In fact, if this material is applied to a poorly structured soil low in organic matter, it can result in visibly better soil aggregation — if ample sunlight and water are present for algae growth.

However, a turfgrass system differs from a theoretical system in several ways, including:

- Close mowing and frequent irrigation are required to favor algae growth.
- Algae scum may be promoted.
- Many routine chemicals applied

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Table 4. Questions to ask when evaluating a product

1. Is this product needed in my situation?
2. Are independent test results available?
3. What is the magnitude of response?
4. Does this product provide consistent results?
5. What is the duration of response?
6. Are there better alternatives?
7. Do benefits justify costs?
8. Should I try this product on a trial area?

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in turf management kill this organism.

• Turfgrass soils normally have ample organic matter for structure formation, but any structure formed cannot withstand the traffic pressures of recreational sites.

Therefore, a product that performs well under ideal or controlled situations may be much less consistent in real-world conditions. Dr. Marty Petrovic at Cornell University evaluated algae-based conditions as a graduate student and found no beneficial responses in field situations where traffic occurred (8).

. . . cost encompasses not only money, but also time, labor and personal choices.

What is the duration of response?

Duration refers to how long a treatment is expected to last. Many chemicals used by turf managers have a relatively short duration of effectiveness (fungicides last five to 21 days), while others are longer (preemergence herbicides last two or three months). The primary concern is whether an applied material will remain effective for as long as the product claims.

The previous example of an algae inoculum that may be killed by routine turfgrass chemicals would be an example of an unexpected short duration of a product. Also, the adverse effects of the soil/thatch environment may rapidly reduce microbial populations in inoculated composts or organic nitrogen carriers.

Are there better alternatives?

As previously mentioned, a good turf manager is able to correctly identify problems that hinder turfgrass growth. Then, the turf manager can choose among several alternatives to resolve the basic problem.

Successful turf managers employ good basic management practices, consistently work to reduce adverse soil factors that impede turf growth, and usually use new products for one of two reasons: to provide an additional "edge" or positive response, or to replace products they have been using with a better product.

They do not expect this material to be the "magic bullet" that will solve all their problems without attention to the basics. Application of untested materials on a "shotgun" approach in the hope that something positive will happen is, at the least, costly.

Whether a particular amendment is a viable alternative for correcting a problem depends upon sufficient information about the product's performance to adequately compare it with other alternatives. If the turf manager cannot confidently predict the performance or expected results of a material, then it is probably not the best alternative.

Do benefits justify costs?

Cost-vs.-benefit comparisons are dependent upon individual situations because cost encompasses not only money, but also time, labor and personal choices. However, predicted or expected benefits are a part of the decision-making process.

If a product has a high cost, but very limited or no data to support expected results, then common sense would recommend caution.

Should I try this product on a trial area?

If doubt remains after asking the first seven questions, but there is still interest, consider a trial area to test the material. To gain valid information, include a non-treated control, as well as at least one other alternative material for comparison.

Simply applying the material without a comparison can be very misleading. For example, favorable weather or a good rain after treatment may produce a turfgrass response completely unrelated to the product.

These eight questions are valid for any new product — whether a soil conditioner, a new fertilizer or a new piece of cultivation equipment. Many turfgrass-related manufacturers have expended considerable monies and effort to provide the answers to these questions. Such companies are in the industry for the long term.

It is a disservice to these companies when competitive "alternatives" are marketed without any attention to providing growers with solid evidence of performance. Turfgrass managers hold the key to a more responsible industry — all they need to do is ask the right questions. □

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