By Bill Nolde

Biostimulants and Humic Acids — What Are They?

Like many turf managers, you've probably heard of biostimulant and humic acid products but haven't had a chance *really* to understand what they are and how they work. Trying to manage turf on a daily basis while also being bombarded by advertising claims about the latest "cutting edge technology," you probably haven't had time to delve into the functional mechanisms of these products.

It is probably also safe to say that most reputable companies have done their best to formulate and manufacture products that will have some positive effect on turfgrass management. However, the questions you must ask are, "How long will the positive effects last after I apply the product so I get my money's worth?" and "What are the interactions between these new products and ones I already use?"

Biostimulants

Perhaps no other aspect of turfgrass management has been so confusing in the last five years as the materials generally defined as "biostimulants."

The concept of using plant hormones to stimulate certain plant responses was introduced in the early 20th century. Plant scientists — searching for explanations to the phenomena of stem and root growth, leaf and flower production, and abscission (autumn leaf fall) — concluded that chemicals, called phytohormones, carried physiological messages from one part of the plant to another.

Some of those naturally occurring chemicals that have very strong physiological effects in plants have been identified. Auxins, gibberellins and cytokinins are the most important to turf managers, who should be acquainted with the effects of these materials and how they interact with plant nutrients:

- **Auxins** enhance growth mainly of root and shoot tips but also in leaves and stems.
- **Gibberellins** enhance growth mainly by elongating cells in plant stems.
- **Cytokinins** stimulate cell division, particularly in plant shoots; help to conserve chlorophyll; and aid in seed germination.

Perhaps the best known natural extract source of turfgrass biostimulants is the sea kelp species *Ascophyllum nodosum*. This species has a high phytohormone content, and because it contains a balance of all three of the main biostimulants, it is more effective than a single synthetic biostimulant.

What They Do

Research has shown increased rates of photosynthesis and reduced senescence of turfgrass, enhanced germination and root growth, faster establishment of sod, and increased salt tolerance and drought resistance after applications of sea kelp extract. Treated test plots have shown from 67 to 175 percent more root mass than untreated plots (Schmidt, 1993). In turf trials at Clemson University, foliar applications of kelp biostimulant extract promoted faster turf establishment with stronger stem and

Culture medium	Plant organ	Fresh weight, mg/plant	Stimulation, %
Water	Root	93	0
	Shoot	185	0
Water + HA	Root	146	57.5
	Shoot	252	36.2
Hoagland	Root	182	96.3
	Shoot	342	84.9
Hoagland + HA	Root	203	119.0
	Shoot	390	110.8

Shown here is the effect of 50 mg L^{-1} of humic acid on growth of wheat in water or Hoagland's nutrient solution (after Vaughan & Malcolm, 1985).

continued on page 35

continued from page 32

leaf growth (Smitte, 1991).

All of these responses might seem reason enough to include biostimulants in a turfgrass management program. However, do not neglect a mineral nutrition program, which has an enormous effect on turfgrass performance and the benefits of applied biostimulants.

Research shows that proper mineral nutrition coupled with the use of bio-organic materials is a sound agronomic approach to growing high quality turfgrass. When used at recommended application rates, these materials interact very well together.

In our efforts to manipulate turf to provide the highest playability possible, we often lose track of the plant's natural responses to environmental conditions. Fluctuating air temperatures, soil temperatures, humidity, daylight hours and soil moisture levels all trigger natural turfgrass metabolic changes to tolerate these environmental conditions. Biostimulants signal the plant to produce compounds that permit the plant to slow down or speed up its responses to environmental stresses. If turf is already suffering from outside stresses, auxins, gibberellins and cytokinins can stimulate dramatic, positive recovery responses.

Humic Acids

"There is ... conclusive evidence that quite small amounts of certain organic substances (highly dispersed humic acids, some aromatic compounds, and organic acids — products of the deamination of amino acids) have a definite, positive effect on the growth and development of the plant. [Furthermore] numerous organic compounds ... activate physiological and biochemical processes in the plant, leading in turn to an increased plant uptake of nutrients from the soil and from applied fertilizers. It is precisely the multifunctional properties of organic substances which explain the observation that mineral fertilizers are most effective on soil dressed with organic matter" (Kononova, 1988).

The value of small quantities of highly active biological substances is now supported by a great deal of research. The mechanism that humic substances use to affect plants is similar to that of biostimulants. The modes of action of humic materials on plant growth are divided into direct, which require uptake by the plant, and indirect effects (Syltie, 1985).

Direct effects:

1. Improve transport of nutrients across cell membranes.
2. Enhance protein synthesis.
3. Have plant hormone-like activity.
4. Improve photosynthesis.
5. Enhance enzyme activity.

Indirect effects:

1. Improve solubilization of the micronutrients iron, zinc and manganese and of the macronutrients phosphorus, potassium and calcium.
2. Reduce active levels of toxic ele-

ments.

3. Enhance soil microbial populations.

Soils like those of California — where soluble organic matter does not exceed 20 to 30 mg L^{-1} — stand to reap large benefits from *soluble* humic materials. Be aware that dry, insoluble commercial humates applied to normally productive soils at rates recommended by their promoters do not appear to contain sufficient quantities of the necessary ingredients to produce the claimed beneficial effects (Chen and Aviad, 1990). The key is solubility for rapid plant uptake.

Source of Humic Acid

Commercial production of humic acid starts by adding a dilute (2 percent) alkali, usually sodium hydroxide, to a humus-bearing material. The material used by most of the better bio-organic nutrient manufacturers is leonardite. Leonardite is a lignitic-organic material related to coal and contains large amounts of organic components. This process separates the humus from the alkali-insoluble plant residues.

Acid is then added to the leonardite humus extraction in a vat, and the solution is allowed to react for a time before the leachate that is produced is drained off. Within this leachate, there are three fractions. Fully 50 percent of the leachate contains an insoluble precipitate of lignin, which is the part of plants that is difficult to decompose.

The other 50 percent is the soluble portion of the leachate: 40 percent of it is called *humic acid* (which is how it gets its name because the cation exchange sites are filled predominantly with hydrogen ions), and the other 10 percent is *fulvic acid* (which contains much of the biostimulant-like materials). Humic acid and fulvic acid have no great effect on soil pH because the acids are insoluble in water. When the predominant cation on the exchange sites is other than hydrogen, usually an alkali metal cation, the material is called *humate* (Senn, 1973).

Fulvic acid is a bit more biologically reactive than humic acid, but both are extremely powerful biostimulants. Both humic acid and fulvic acid are made naturally by plants within a soil rhizosphere. However, the amount made is affected by many environmental influences. When humic and fulvic acids are introduced into soils deficient in them, the response of plants can be dramatic.

Combining Diagnostics with Agronomics

Turf managers have available many more technologically advanced agronomic products than 25 years ago, but these advances have led to confusion and reluctance on the part of some to use them. Many turf managers have said, "I think I'll just stick with the good old N-P-K fertilizer that I know will make my turfgrass green."

This can be a short-sighted attitude. With the use of high-grade synthetic commercial turf fertilizers and the implementation of certain cultural practices over the past decades, several problems have surfaced:

- Shortages of some soil micronutrients can limit turf growth and contribute to turfgrass diseases. These shortages are due to continued removal of a broad spectrum of nutrients from the soil while replacing only N, P, K, Ca and S.
- Fertilizer costs, especially for N, are increasing faster than budgets, resulting in decreased inputs and decreasing soil fertility.
- Cultural practices associated with modern turf management have contributed to soil compaction from maintenance equipment, overhead irrigation, poor quality irrigation water and rising soil salt levels from synthetic nutrient sources.

Advanced diagnostic equipment such as near infrared reflectance spectroscopy for tissue testing now enables turf managers to know quickly and easily the nutritional components within plant tissues. Monitoring plant nutrition, soil nutrient load, and water quality can quickly tell you of deficiencies and how beneficial biostimulants and humic acid materials will be. Combining the science of diagnostics with the science of agronomy, you can provide a more biologically balanced environment that is favorable to your turfgrass. ❑

Bill Nolde is the staff agronomist for California Turf and a former golf course superintendent.