Humic substances influence creeping bentgrass growth

Subtle effects are sometimes noticeable and perhaps statistically significant.

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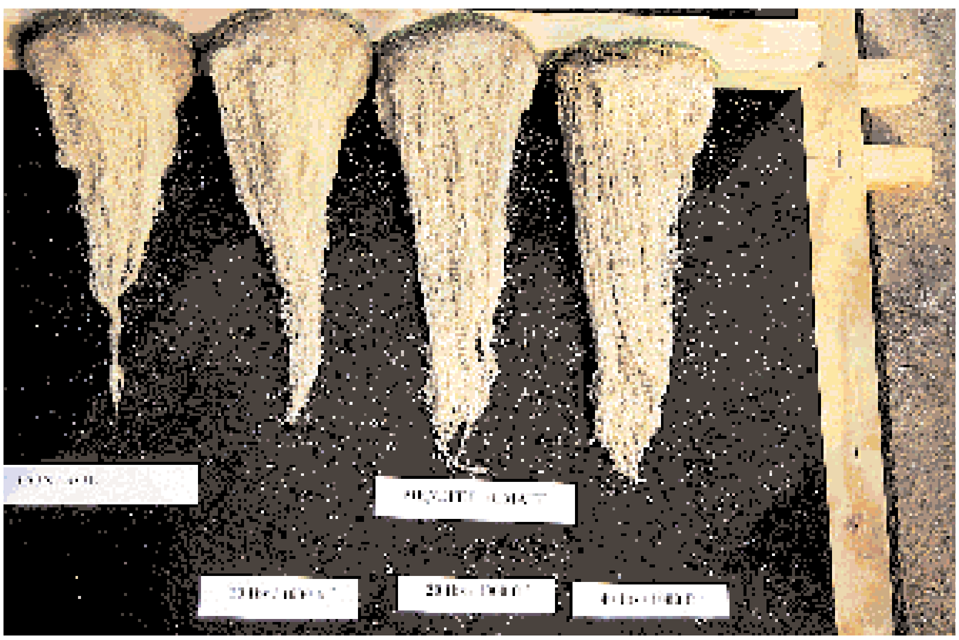
In recent years, many commercial products containing humic substances have been promoted for use on turfgrasses. Although the effects of humic substances on cereal grasses and numerous other plants have been studied for some time, their effects on turfgrass growth have not been well documented.

Humic substances can be generally described as "naturally occurring, highly decomposed organic substances with a very complex structure" (1). They are derived from plant and animal residues and are usually dark in color. Humic substances can be divided into humic acids, fulvic acids and humins, on the basis of their solubility in acidic and basic solutions. Researchers (1) have characterized the fractions:

- Humic acid is the fraction of humic substances that is not soluble in water under acidic conditions (pH less than 2) but is soluble at higher pH values.
- Fulvic acid is the fraction of humic



Photos courtesy of Chunhua Liu

Granular humate mixed into the top 4 inches of a greenhouse sand culture improved bentgrass rooting.

KEY POINTS

- Heavy application of humic acid to bentgrass in hydroponic culture significantly increased photosynthesis, root enzyme activity and root mass, but not chlorophyll content or root length.
- Creeping bentgrass rooting was increased by mixing granular humates into the top 4 inches of the root zone. However, turfgrass shoot growth and visual quality rarely differed from untreated turf.
- Although treatments with humic substances sometimes caused a significant increase or decrease in the concentration of several nutrients, the changes were relatively small, and probably not of biological significance.

substances that is soluble in water under all pH conditions.

- Humin is the fraction of humic substances that is not soluble in water at any pH value.

Humic substances are essentially components of organic matter and can be found almost anywhere: streams, lakes and virtually any soil that contains organic matter, animal or plant residues. Many commonly used soil organic amendments have significant humic and fulvic acid content. Reed-sedge peat is often used in high-sand-content root zones because it has a higher cation exchange capacity and humic acid content than other sources.

Humic substances are not traditional fertilizers. Carbon, hydrogen, oxygen, nitrogen, phosphorus and sulfur account for nearly 100 percent of the composition of humic substances on an ash-free basis (5).

What's in humics?

Element	Humic acid (%)	Fulvic acid (%)
Carbon	54-59	41-51
Hydrogen	3-6	4-7
Oxygen	33-38	40-50
Nitrogen	1-4	1-3
Sulfur	0-2	0-4

Average elemental composition (percentage) of soil humic substances (5).

Humic contents

Amendment	Humic acid (%)	Fulvic acid (%)	Cation exchange capacity (meq/100 g)
Reed-sedge peat	21.1	12.0	118.0
Sphagnum peat	8.3	8.6	74.8
Rice hull compost	5.8	6.9	16.5
Fir bark	3.1	5.8	18.3

Humic and fulvic acid content and cation exchange capacity of four commonly used organic soil amendments.

In recent years, commercial humates and humic acid products have been promoted for use on turfgrasses, especially creeping bentgrass (*Agrostis stolonifera*). Though popular for its quality on putting greens in the northern United States and in the transition zone, bentgrass is often difficult to manage during summer. Heat stress often results in a shallow root system, and less healthy bentgrass becomes more prone to disease and insect damage.

Manufacturers of commercial humic products often claim benefits to turfgrasses, including:

- A better-developed and deeper root system
- Increased establishment rate
- Improved plant vigor and survivability
- Improved salt, heat and other stress tolerances
- Increased nutrient uptake
- Improved soil structure
- Increased effectiveness of fertilizers and pesticides

The purpose of our research was to investigate the effects of humic substances, including both humates and humic acids, on the growth of creeping bentgrass (2,4).

Photosynthesis, chlorophyll and rooting

Crenshaw creeping bentgrass plugs were grown hydroponically in a 25 percent Hoagland's nutrient solution containing humic acids at zero, 100, 200 or 400 parts per million in the greenhouse. A 100-parts-per-million solution contains 1 liquid ounce of humic acid in about 78 gallons of solution. Hoagland's solution contained all of the mineral nutrients needed for plant growth. Growing plants in Hoagland's solution ensures that they have adequate nutrients during the study.

Measurements of photosynthesis, chlorophyll concentration and root dehydrogenase enzyme activity were made weekly for one month. Root enzyme activity reflects the vigor and health of roots; the more active the dehydrogenase enzyme is in the root tissue, the more healthy are the roots. All clippings harvested after humic acid application were combined for nutrient analysis. At the end of the study, root length and dry mass were measured.

Results and discussion

The results showed that the photosynthetic rate of plants growing in 100 or 200 parts per million solutions of humic acid rarely differed from that of the control. However, the treatment at 400 parts per million consistently increased photosynthesis by as much as 20 percent. Chlorophyll content did not vary in response to humic acid application on any sampling dates. Thus, it appears that the increase in photosynthesis following humic acid application was due to some process other than increased chlorophyll production.

Humic acid had no promotive effect on root length after the original roots were excised; however, 400 parts per million significantly increased root dry mass on all sampling dates. Root enzyme activity of plants receiving humic acid at 400 parts per million was significantly higher than that of nontreated plants, with the increases ranging from 35 percent to 108 percent.

Increased root enzyme activity suggests that root respiration was increased substantially by humic substances. There is a close connection in plants between the energy-releasing process of respiration and the energy-consuming process of growth. Thus, increases in root growth might be due to the stimulation of enzyme systems by increased respiration.

A greenhouse hydroponic culture system was used for humic acid evaluation.

Roots, shoots, visual quality

Two commercially mined granular humates, a commercial humic acid, and three reference humic acids (defined by the International Humic Substance Society and extracted from leonardite, peat and soil) were applied to creeping bentgrass growing in sand, hydroponic culture or the field. Commercial granular humates were either incorporated into the top 4 inches of the root zone in sand culture, or surface applied to field plots at 10, 20 and 40 pounds per 1,000 square feet. Humic acid solution (100, 200 or 400 parts per million) was either foliarly applied (in sand culture, in hydroponic culture and in the field) or applied to the surface of the root zone (in sand culture) at 5 gallons per 1,000 square feet.

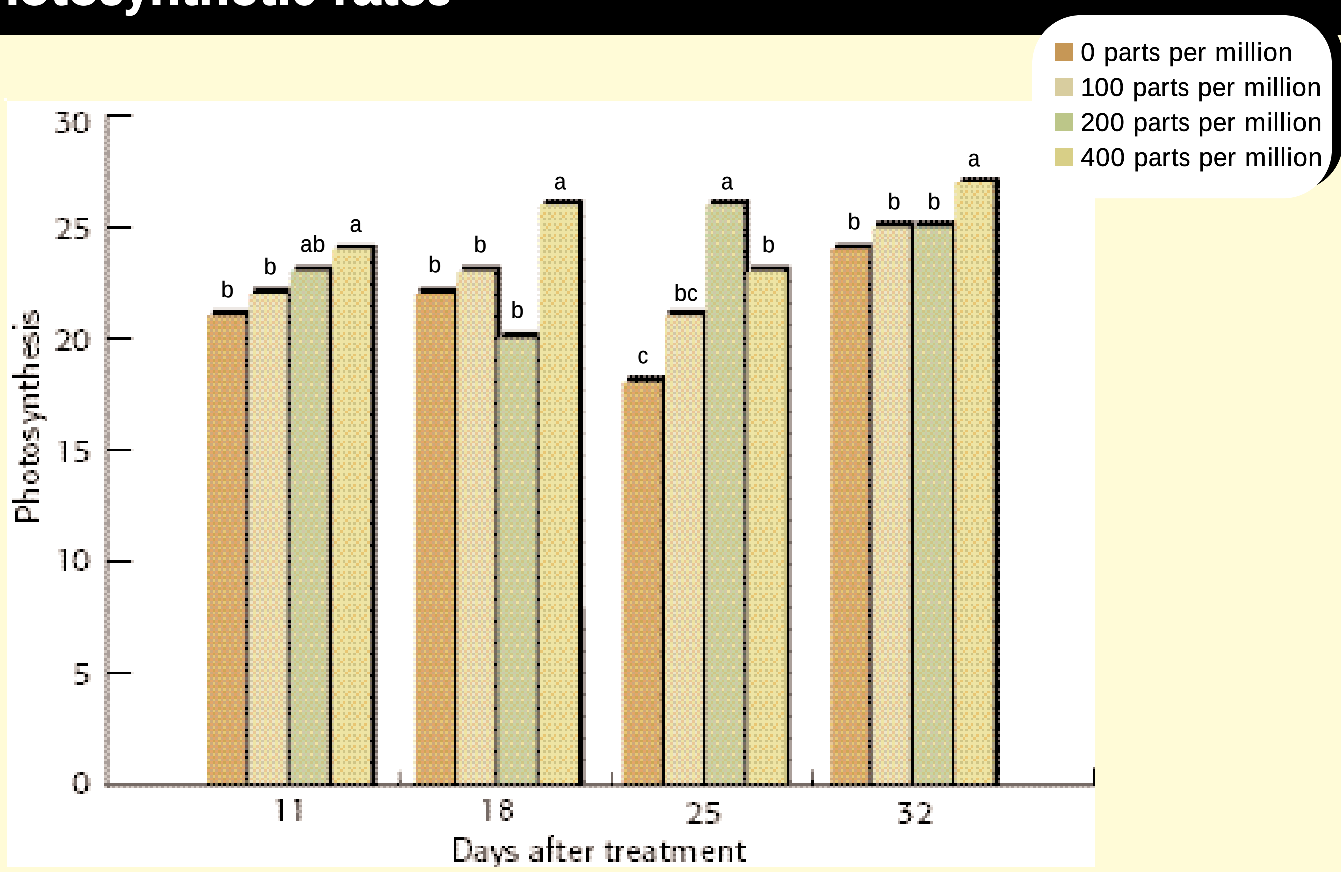
Results and discussion

Creeping bentgrass rooting at all depths was increased by mixing granular humates into the top 4 inches of the root zone. This may have been due to more direct contact of humic substances with developing roots. No single foliar-applied humic acid treatment consistently improved rooting compared with the control in either sand culture or hydroponic culture experiments. Similarly, foliar application of humates on a field-grown Cato-Crenshaw creeping bentgrass blend also produced no improvement in rooting (3).

In general, application of humic substances did not affect clipping dry weight and did not improve visual quality compared with untreated turf, just as previous researchers have reported (6).

Nitrogen and calcium concentration in leaf tissue were relatively unaffected by the application of humic substances, regardless of application rate.

Photosynthetic rates



Photosynthetic rates of hydroponically grown creeping bentgrass increased with humic acid application (in parts per million) in one greenhouse solution-culture experiment. Within each group, bars with the same letter are not significantly different.

Phosphorous uptake in sand culture was increased by incorporated granular humates as well as by several of the foliarly applied humic substances.

Iron uptake was increased in the field but not in sand or hydroponic-culture experiments. The influence of humic acid application on the nutrition of hydroponically grown plants was minimal. The leaf tissue concentration of several other nutrients was significantly (statistically speaking) affected by treatment application; however, the differences were so small that they are probably not important to plant growth.

Summary

Application of humic acid materials at 400 parts per million in hydroponic culture significantly increased root mass compared with untreated turf on almost every sampling date in greenhouse studies. The response to lower rates was not as conclusive. Although the materials improved the amount of roots present, they did not affect root length. When granular humates were incorporated into the root zone to a depth of 4 inches, the rooting effects were stronger than the effect of foliar sprays. Keep in mind that these results were from plants growing in sand or in hydroponic solutions containing little or no native organic matter or humic substances. Rooting responses might be less evident on a putting green containing significant organic matter or naturally occurring humic substances.

Photosynthesis is an important process because it provides the plant with carbohydrates for growth and recovery from stress injury. Applying humic acids at 400 parts per million in hydroponic culture increased photosynthesis compared with untreated turf on most dates when photosynthesis was measured. Root enzyme activity was enhanced by humic acid application, suggesting plant root respiration may be increased substantially by humic substances.

Although, in all the evaluations of nutrient uptake, we consistently measured differences in tissue nutrient content attributable to humic substances, the differences were usually very small. It is doubtful that these differences would result in improved turfgrass quality in the field.

Although rooting, photosynthesis, root dehydrogenase activity and nutrient content were often improved by the application of humic substances, turfgrass shoot growth and visual quality rarely differed from those of untreated turf. Even so, we remain open-minded regarding the potential benefits of making supplemental applications of humic substances. Applying the materials to low-fertility soils or newly seeded greens might be useful in some putting green situations. Given the very low application rates required, one might consider humic substances cost-effective because they might improve rooting during the summer months. ■

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