BIOSTIMULANTS - YES OR NO?

By Wayne R. Kussow, *Emeritus Professor of Soil Science, University of Wisconsin-Madison*

INTRODUCTION

Biostimulant - what a glorious name. In the broadest sense, it's anything that promotes the growth, development or general health of a living organism, be it plant or animal. This is much too broad a definition for us to work with here. We're only concerned with turfgrass and "non-traditional" substances and materials. This excludes the traditionally applied products such as fertilizers, pesticides, water, and even plant growth regulators. Traditional products have a long history of use and their value has been proven through many years of research.

This more restricted definition of biostimulants implies a couple of things. The first is that they are not "stand alone" products. They are "add-ons" to the traditional irrigation, fertilization, growth regulation and pest control practices adhered to in turfgrass management. This is why biostimulants are generally touted as products that overcome stresses in turfgrass from which conventional products or cultural practices do not provide relief. This is an interesting claim in light of the fact that turfgrass researchers have yet to develop a simple and convenient method for measuring stress in turfgrass. When I once pointed this out in a telephone conversation, the call was abruptly ended with the statement, "Young man, all turfgrass is under stress".

The classification of biostimulants as "non-traditional" products also implies limited scientific evidence of their efficacy, particularly under field conditions. Behind virtually every biostimulant is some research supporting the claim one or more of the constituents in the product can influence plant growth. The problem is the conditions under which much of this research was conducted. A good case in point is humic acids. Add them to plants growing in nutrient solutions or pure quartz sand totally devoid of humic acid chances pretty good that and you will see some type of response. But grow the plants in

soil and there is no response to additions of humic acids. Why? All soils inherently contain humic acids. They result from microbial decomposition of organic matter.

No one has been able to identify a humic acid "deficient" soil. In fact, there is no standard method for measuring the humic acid content of soil. Lack of humic acid deficiency in even sand-based putting greens is evidenced by research such as that recently conducted by Utah State University researchers. They applied four humic acid products and one fulvic acid product to putting greens on four golf courses. The purpose was to test claims that the products reduce turfgrass water requirements and the need for fertilizer P. The data gathered refuted both claims.

RESEARCH

Through the years I've field tested many different biostimulants, the majority of which contained humic acid along with numerous other materials such as fulvic acid, plant extracts, amino acids, proteins, seaweed extracts and small quantities of secondary and micronutrients. Sometimes their composition is a closely guarded secret. A former colleague once asked about the active ingredients in a biostimulant he was being asked to test. The response was, "Only God knows and he's not talking".

I examined biostumulant influences on bentgrass establishment, putting green quality, thatch development and even the claim that application of humic acid containing fertilizers improves soil health that translates into healthier turfgrass. The results of my research are summarized in tables 1, 2, 3, and 4. You can wade through the description of each trial if you wish or just go to the bottom entry labeled "Net responses". I arrived at them by first totaling the numbers of positive *and* negative responses in each trial and calculating them as a percentage of all measurements taken. I then subtracted negative from positive percent responses to get the net responses expressed as percent of all measurements in the trial.

Logic says that the chances of seeing positive responses to humic acid applications are highest when putting green humic acid contents are at their lowest levels. This is during bentgrass establishment on newly constructed putting greens. In the trials I conducted the putting green organic matter levels were around 0.2 % and concentrations of soluble humic acid were in the range of 40 to 50 *micrograms* per kilogram of soil. As shown in table 1, the net responses of bentgrass during establishment to biweekly applications of humic acids or 67 kg/ha of humate were either 0 or a miniscule 0.1 percent positive response rate. This was not surprising. At the recommended application rates of 0.09 to 0.23 lb humic acid/M there were no significant changes in soil humic acid concentrations.

Over 5 seasons of bi-weekly applications of numerous biostimulants to sand and pushup putting greens the net

Table 1. Biostimulant influences on bentgrass establishment.

Experiment variables/outcomes	SR 1020 from seed	A-2/G-6 washed sod
Biostimulants tested	3 humic acids seaweed extract	6 humic acids 1 humate
Measurements	Stand density root weights	Stand density and quality chloropyll index roots and tillers soil humic acid
Experiment duration	63 days	134 days
Number of measurements	42	234
Number of positive responses	0	3
Number of negative responses	0	0
Percent positive responses	0	0.1
Percent negative responses	0	0
Net responses - percent	0	0.1

Table 2. Biostimulant influences on putting green quality.

Experiment variables/outcomes	Type of putting green		
	Sand	Pushup	Sand
Biostimulants tested	7 alone and in combnation. Humic acids, carbohydrates, amino acids, proteins, micronutrients.		5 with different compositions - humic acids, sugars, bacteria, plant extracts
Measurements	Turfgrass color, quality, chlorophyll index, clipping weight and nutrient contents roots and tillers disease severity		Turfgrass color, quality, clipping weight and nutrient content, 4 soil enzymes, soil bacteria diversity
Experiment duration	5 seasons		2 seasons
Number of measurements	540 to 2214/season		808
Number of positive responses	0 to 9/yr	0 to 18/yr	143
Number of negative responses	4 to 25/yr	1 to 9/yr	0
Percent positive responses	5.1	0.8	18
Percent negative responses	5.3	1.1	0
Net responses - percent	-0.2	-0.3	18

Table 3. Biostimulant influences on thatch in turfgrass.

Experiment variables/outcomes	Putting green	Bent fairway	Lawn
Biostimulants tested	4 humic acids + bacteria	3 humic acids, 3 rates	3 humic acids + bacteria, sugars
Measurements	Turfgrass color, thatch, infiltration rates	Turfgrass color, quality. Thatch thickness	Turfgrass color, thatch thickness, infiltration rates
Experiment duration	163 days	188 days	163 days
Number of measurements	576	624	420
Number of positive responses	0	0	0
Number of negative responses	0	0	0
Percent positive responses	0	0	0
Percent negative responses	0	0	0
Net responses - percent	0	0	0

* For contrasts between the synthetic and organic fertilizers.

responses were insignificant -0.2 and -0.3 percents, respectively (Table 2). In the third trial conducted on an established putting green there was an 18 % net positive response rate. This has to be clarified. These positive responses were temporary increases in soil enzyme levels seen within a week of application of soluble carbohydrates, plant extracts or amino acids. None of these temporary elevations in soil enzyme levels had any detectable influence on putting green quality or clipping production and nutrient content.

The results of three investigations of biostimulant effects on thatch control in a putting green, a bentgrass fairway and a lawn speak for themselves (Table 3). There were no significant responses, positive or negative, among

1,620 measurements in these trials. I attribute this to the fact most biostimulants for thatch control have been formulated on the premise that thatch accumulates when turfgrass production of plant tissues exceeds the capacity of microorganisms to decompose the material. This naturally leads to the assumption that adding food for the decomposers or more microorganisms will lead to more rapidly breakdown of the thatch. My research and that of many others offers proof that this is not a valid assumption. It is well established that lignin, which is difficult for microorganisms to decompose, accumulates in thatch. This fact prompted my telephone call to a chemist at the U.S. Forest Products Lab in Madison who was researching microbial breakdown of wood lignin. He'd found that fungi are the primary decomposers of lignin, but that they do so only when starved for nitrogen. Perhaps one of you can find a way to starve fungi in thatch for nitrogen *and* grow acceptable quality turfgrass.

The proponents of cation balancing in soil, hard core natural organic people and some manufacturers of biostimulants follow the mantra, "Feed the soil, not the plant. Healthy soils produce healthy plants". I spent three years investigating the relationship between soil and turfgrass health. In designing the study I quickly learned that soil scientists do not agree on the best way to measure soil health. It results from interacting soil physical, chemical and microbiolgical properties. Turfgrass health is likewise an elusive thing to measure. The soil and turfgrass properties I chose to measure are listed in table 4. Eleven fertilizers comprised of various types and amounts of organic materials, some amended with things like microorganisms, molasses and humate or humic acids were applied. Their influences on the measures of soil and turfgrass health were compared to those resulting from application of a 100% synthetic fertilizer.

What did I find? Over the three years there were significant fertilizer effects on fairway quality ratings. These changes in fairway quality did not appear to have been influenced by changes in soil physical or chemical properties. Rather, fairway quality was highly dependent on clipping production and this in turn on clipping N content. There was no evidence that clipping N content was influenced by changes in soil organic matter levels or microbial activity. In other words, soil organic matter decomposition did not appear to contribute a significant amount of nitrogen to the bentgrass, leaving fertilizer as the dominant source of N. Application of the synthetic fertilizer consistently resulted in higher clipping N contents, clipping yields and fairway quality ratings than did the organic or organic-based fertilizers. Therefore, when

Table 4. Biostimulant influences on soil and turfgrass health.

Experiment variables/outcomes	Bentgrass fairway
Biostimulants tested	5 natural organic fertilizers 6 organic-based fertiliers with added bacteria, yucca extracts, molasses, micro-nutrients
Measurements	Turfgrass color, quality, clipping weights and nutrient content, root mass, thatch thickness, disease ratings. 7 soil chemical, physical and biological properties
Experiment duration	3 seasons
Number of measurements	8,400
Number of positive responses	488*
Number of negative responses	1968*
Percent positive responses	5.8
Percent negative responses	23.4
Net responses - percent	-17.6

* For contrasts between the synthetic and organic fertilizers.

the contrasts were made between responses to the synthetic and the totally organic or organic-based fertilizers the overall net response to the latter group of fertilizers was a -17.6 % (Table 4).

OPINIONS

In closing, I want to express my view on claims that biostimulants overcome anti-oxidant, hormone or nutritional imbalances or deficiencies resulting when turfgrass is subjected to stress. I can't think of an instance where stress does not result in a reduction in turfgrass shoot growth rates. Reductions in shoot growth rates are accompanied by reductions in turfgrass nutrient demand and, quite likely, in anti-oxidant and hormone production that is in accord with actual plant requirements. This being the case, there is no validity to claims that stresses create the need for applications of biostimulants containing various organic compounds and small amounts of nutrients.

There may come a day when researchers develop turfgrass stress indices based on factors such as air temperature, water deficits, and soil oxygen levels and can associate these with specific physiological deficits that can be overcome through applications of biostimulants. Until that day arrives, I see no justification for spending something like $50 per gallon for a biostimulant when the chances of seeing a positive response are those observed in my research.

I expect that this article may trigger some telephone calls or emails from superintendents telling me that they applied one or more biostimulants and got excellent results. If you do, be prepared to tell me what the weather was prior to and after application and that you know the complete analysis of the product you applied. Sudden drops in air temperatures and timely rainfalls can work miracles when turfgrass is under stress. The laws regarding labels for biostimulants are very lax. I've documented cases where the labels legitimately did not disclose that the products were spiked with a small amount of water soluble nitrogen. Of course these biostimulants gave quick, short term greening responses.