Playing a pivotal role

The concept of applying products to the turf to encourage both soil bacteria and fungal populations has gained momentum in the turfgrass industry over the past number of years. Numerous products have been and continue to be developed to help turf professionals deal with day-to-day management challenges arising from their constant quest for perfect playing surfaces. One such group of products are biostimulants and microbial inoculants. However the actual benefits of these products are still not yet fully understood.

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WHY USE MICROBIAL INOCULANTS AND BIOSTIMULANTS?

The environmental consequences of turfgrass management, in particular golf course maintenance, have captured much media attention. Unfortunately, most of it negative. Golf course greens are an extreme example of a stressed setting. On a green, the grass blade is severely reduced by regular mowing. Added to this is the removal of grass clippings, which eliminates the ability to recycle the valuable minerals they contain. Thus an understanding of the requirements of turfgrasses is among the most important factors in their successful culture.

We all know that correct nutrition is essential for the plant to carry out physiological processes and for maintaining high quality, disease-free turf. However to maintain high quality playing surfaces, particularly on golf greens, moderate to large amounts of fertilisers and chemicals are often required. The need for high nutrient quantities is often compounded by the use of inert sand-based rootzones especially on golf greens which in contrast to sand/soil greens have limited amounts of soil organic matter and require higher quantities of nutrient fertilisers. It is well known that, although sands provide favourable physical properties, they are prone to leaching of water-soluble nutrients.

Because ponds, lakes and rivers border golf course greens, fairways and tees, there is potential for fertiliser and chemical leaching and run-off, which would be a serious source of water pollution. One of the greatest potential threats is from eutrophication, which can cause excessive production of the suspended planktonic algae. Thus developing low risk fertiliser and fungicide programmes may reduce potential pollution.

THE SOIL ENVIRONMENT

Natural environments are extremely diverse and the majority contain a wide range of micro-organisms. An important soil function is the harbouring of a diverse community of organisms that includes bacteria, fungi, mites, springtails, protozoa, millipedes and many others. The most important of these being beneficial bacteria and fungi which are critical to plant health. The microbial community is essential to the decomposition of organic residues and the recycling of critical nutrients such as nitrogen and phosphorus. Due to these activities, soil organisms help in supporting the growth of plants and absorbing, neutralizing and transforming compounds that might otherwise become pollutants in the environment.

Undisturbed soil rootzones normally have healthy populations of these micro-organisms. However in recent years it has been claimed sand-based rootzones, in particular newly-constructed ones, are relatively sterile in comparison to sand/soil rootzones. Thus, any possible benefits that micro-organisms may confer during the early establishment of turfgrass in a newly-constructed putting green are severly reduced.

POTENTIAL BENEFITS OF BIOSTIMULANTS

The term biostimulant usually refers to those products that are aimed at stimulating the biological content of the soil by providing food for microbes and in doing so increasing microbial populations. Sea kelp, humic acids, plant hormones, organic products, molasses, yeast extracts and vitamins are common components of biostimulants.

Kelp is probably the most widely known biostimulant in turfgrass management and contains contains numerous trace elements, alginic acid and plant hormones. One should remember that all kelp is not equally suitable for use as biostimulant material, with cold-water kelp containing higher levels of plant hormones than heat-processed kelp and is thus an excellent biostimulant component.

Humic acids,which are naturally occurring organic materials derived from biological sources, are also commonly found in biostimulant products. In recent times, biostimulants are often made up of a mixture of various different products, with seaweed extract/humic acid being one of the most popular.

Other possible benefits of biostimulants are based on their ability to influence plant hormonal activity. Hormones in plants are chemical messengers regulating plant development such as root and shoot growth, as well as responses to the environment. Therefore they influence overall plant growth and health.

Auxins, cytokinins and gibberellins are the principle growth-promoting hormones found in plants. When growing under normal conditions, plants have adequate endogeneous levels of hormones for normal growth. However if the plant becomes stressed then the plants natural production of these hormones can be negatively affected.

Some biostimulants have added levels of inorganic and organic fertiliser to provide some direct plant growth. It is important to remember though that biostimulants, even those containing some added fertilisers, do not supply all the essential nutrients a plant requires. Some of the potential benefits from using biostimulants are given below:

- Possible reduced fertiliser requirements
- Increased microbial activity
- Enhanced plant hormone levels
- Improved drought and heat resistance
- Increased root and shoot growth
- Amplified tolerance to disease infection
- Promotion of antioxidant activity

Tim Butler investigates Microbial Inoculants and Biostimulants.

Plants typically grow well without biostimulants in favourable environmental conditions. However, one must remember that biostimulants help to condition the plant by enhancing the plant's defensive system. So when the plant becomes stressed, biostimulant-conditioned plants perform. In my opinion, it is vital that if one is to use a biostimulant programme, then it is essential to begin using it in the spring, before the summer heat and stress sets in. Biostimulants will not perform as well once the plant is stressed.

POTENTIAL BENEFITS OF MICROBIAL INOCULANTS

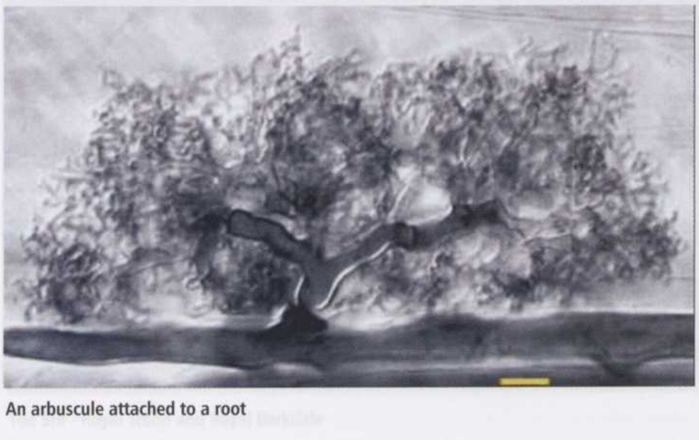
Microbial inoculants, which are often known as bio fertilisers, work differently to biostimulants in that they actually contain spores of beneficial fungi, bacteria or both. These spores are formulated into powder or water-dispersible products that can be applied to soil.

Bacteria occur in the greatest numbers in soils and are possibly the most diverse in their physiology. Bacteria within the genera Azotobacter, Azospirillum, Enterobacter and Klebsiella are efficient, free-living, nitrogen-fixing organisms, taking nitrogen and converting it to a form that plants can use. Bactéria from the genera Pseudomonas and Azospirillum are well known for their growth-promotive effects. These bacteria are commonly included in microbial inoculant blends.

The nitrogen in inorganic fertiliser sources is in a form already available to the plant. No microbes are required. However, for organic sources, we often forget that microbes are required to convert the nitrogen into a form that can be used by the plant such as ammonia. Synthetic organic nitrogen fertilizers include ureaformaldehydes, sulfur-coated urea, resin-coated urea and isobutylidenediurea.

In some cases, large populations of bacteria may give rise to what are known as suppressive soils. These are basically soils that have conditions ideally suited to disease development and have the disease pathogen present yet no disease occurs. This may be due to the activity of the bacteria, which inhibit turfgrass pathogens by competing for resources and producing antibiotic compounds.

Fungi are also a very important component of microbial inoculants. These fungi can be present as spores, hyphae (see Picture 1) or colonized roots. Mycorrhizal fungi are among the most popular fungi used in inoculants. Mycorrhiza refers to an association between the plant and fungi, where the fungi colonize the plant's root system during times of active plant growth. Several types of mycorrhiza fungi form mycorrhiza with grass plants, with arbuscular mycorrhizae also known as endomycorrhiza being the most common.


An arbuscule attached to a root


Soil hyphae establish contact with roots and penetrate the root's surface

Mycorrhizal fungi function by hyphae of the mycorrhizae penetrating between and inside the outer cells of the plant roots. Once inside the root, the fungus forms special coiled hyphae called arbuscules that provide increased nutrients to the grass in exchange for food for the fungus. This hyphal network within the soil is a vital component of the soil ecosystem. The mycorrhizal fungal system will in time form a dense network around the grass root system and provide the grass plants with plenty of food and water. This dense network ensures that the grass plant will be able to access a lot more nutrients than if it were depending solely on its own root system.

- Potential benefits of microbial inoculants include:
- Enhanced plant nutrient availability
- Lower fertiliser requirements
- Superior pathogen resistance
- Better stress resistance
- Improved soil porosity and thus increased water and air movement
- Augmented plant root length and number
- Reduction in thatch build-up

However, it is important to remember that mycorrhizal colonization can be greatly influenced by soil phosphorus levels and herbicide use. It has been shown that high phosphorus levels can severely reduce fungal colonisation, while large volumes of herbicides can desiccate fungal populations.

Looking to the future, I feel that biostimulants and in particular microbial inoculants will play a pivotal role in turfgrass nutrition and maintenance. I believe that these products will never or could ever replace the use of fertilisers and fungicides. However, they may allow us to be less dependent on traditional turfgrass practices by an integrated approach and ultimately contribute to a reduction in fertility and chemical inputs.

Tim Butler is carrying out research in the area of turfgrass nutrition for a doctorate degree at both University College Dublin, Ireland, and Michigan State University, USA.

Pictures courtesy of Professor Nair, Michigan State University, USA