BY CATHIE CUSH

A new approach

Fertilizer meta-catalysts can maximize nutrient management

Rising natural gas prices, an increased focus on biofuel crops and growing offshore demand have driven fertilizer costs to record highs. In many markets, fertilizer costs have almost doubled since 2007. Additionally, the growing environmental movement is raising concerns about nitrate and phosphate leaching and runoff.

The industry has tried many approaches to address these concerns, with only partial satisfaction. Some organic products may be costly or offer lackluster performance. However, some research indicates a new category of fertilizer catalysts offers relief for turf managers.

THE NEED FOR NUTRIENTS

Like all living things, plants require various types of nutrients. Nonmineral nutrients – carbon, oxygen and hydrogen – are readily available from water, sunlight, soil and the atmosphere. Plants also require more than a dozen primary mineral nutrients – macronutrients and micronutrients, most of which are obtained from the soil and decaying plant matter.

The three most important macronutrients are nitrogen, phosphorus and potassium, which provide raw materials that the plant needs at a molecular level to grow and thrive. Plants use these nutrients in large amounts to grow and resist disease. Nitrogen is necessary for all metabolic processes, including protein and energy synthesis. It's a component of chlorophyll and associated with rapid plant growth and vigor. Phosphorus plays a key role in photosynthesis and is necessary to support plant maturation, rapid growth and stress resistance. Potassium is necessary for protein synthesis, photosynthesis and disease resistance.

Soil analysis results on extremely salt-contaminated soil by Texas A&M University:

	Calcium	Magnesium	Potassium	Sodium	Total Salinity	Soluble Salts
Meta-catalyst	154 ppm	83 ppm	44 ppm	178 ppm	815 ppm	2.06 mmhos/cm
Alternate Treatment	493 ppm	284 ppm	94 ppm	494 ppm	2138 ppm	5.37 mmhos/cm

Figure 1: The technology in the meta-catalyst has been shown to reduce total salinity and soluble salts, freeing up nutrients for plant use.

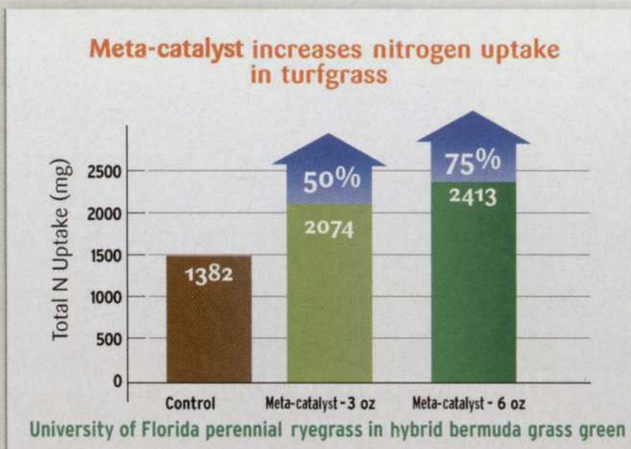

Figure 2: The technology in the meta-catalyst increases nutrient uptake.

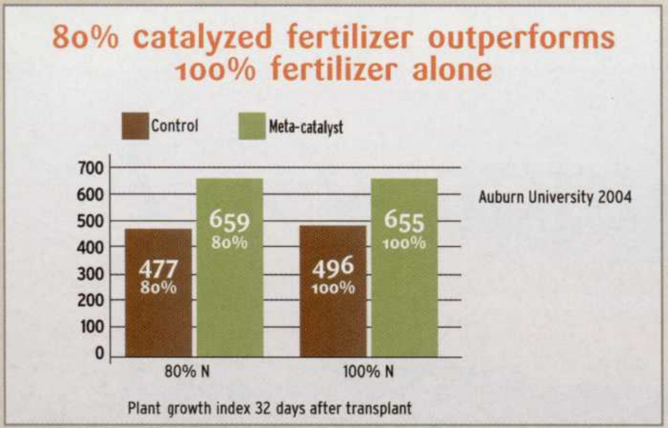

Figure 3: Transplanted nonturf plants that were treated with 80-percent fertilizer containing the meta-catalyst fertilizer showed significantly better growth than nonturf plants treated with 100-percent fertilizer alone.

THE ROLE OF MICROBES

The oldest form of life on earth, microorganisms (or microbes), are tiny single-cell organisms such as micro arthropods, nematodes, protozoa, fungi, algae and bacteria. All plants and animals depend on microbes to digest food.

Microbes are everywhere, with especially high concentrations in the soil. A single teaspoon of healthy soil may contain 25,000 algae, more than 120,000 fungi and more than 1 billion bacteria. Using genetic analysis, researchers estimate a biologically rich soil sample may contain as many as 10,000 distinct species of bacteria. Of these many species, only about 1 percent or fewer can be cultured (isolated and grown synthetically). Even less are known to have specific soil functions.

Microorganisms play active roles in many aspects of the soil environment in which they live. Their activity has measurable impact on organic matter and nutrient availability, nutrient cycling and uptake (by the plants), and soil structure and function. Living in the soil, this community of microbes will metabolize various organic and inorganic materials. All microbes don't process the same nutrients. Different species metabolize different food sources. Some species may do a less effective job in the absence of a microbial community structure that aids efficient metabolic functioning. The microbes absorb nutrients, process them and release unique biochemicals – a rich variety of enzymes, proteins, carbohydrates, organic acids and many others. The soil solution holds these exuded biochemicals, which play critical roles in the complex array of plant/microbial interactions.

Current research points to biochemical communication as a mechanism for many of the observed interactions in growing plants. For example, bacteria will multiply in the presence of nutrients, but they also seem to be receptive to biochemical signals indicating the food reserves are limited or that conditions are not otherwise optimal, which may slow down or stabilize population growth.

Other signaling agents – for example, the release of root exudates that nourish the indigenous microbial community – may be required to elicit certain functions from a plant. Adding microbes to fertilizer blends (along with concentrated solutions of their biochemical byproducts), appears to help increase the plant's efficient use of essential nutrients.

However, recent research points to the likelihood that the product's metabolic capacity, rather than organism counts, may be the critical variable in enhancing fertilizer efficiency. In other words, products with a broad metabolic profile may metabolize a wider range of food sources, making them more available to the plant. Improved nutrient uptake by the plant will, in turn, build greater biomass (roots and shoots) and allow the plant to reach its full genetic potential better.

A NEW CATEGORY: META-CATALYSTS

The concept of adding microbes or other enhancements to fertilizer is not new. However, much of the focus has been placed on growing and harvesting individual strains that have been cultured in high concentrations in the laboratory.

A fertilizer meta-catalyst, on the other hand, starts with a base stock of naturally occurring microbes that's highly diverse – both microbiologically, as shown in plate counts, and in metabolic capacity – that is, the ability to metabolize a broad range of food sources. Rather than just containing a few isolated species, this meta-catalyst base stock might include scores or hundreds of different strains of organisms living in an interactive community that reflects the soil's extraordinarily rich microbial environment.

To commercialize a meta-catalyst, the diverse base stock is fermented in community, and the microbes are harvested along with a fermentation medium, which contains the rich deposits of naturally exuded biochemicals. The better products are taken through a stabilization process to make them easier to use and to extend their shelf life. They're tested to assure they're free of known plant and animal pathogens, and then profiled for production batch management and traceability to ensure consistency. In many cases, the base solution may be blended with other beneficial materials such as humic acid, nutrients or other biostimulants to bundle together benefits for the plant and soil.

The end result is a fertilizer meta-catalyst that contains viable, beneficial bacteria, a complex of fermentation byproducts (biochemicals) and other materials that increase the efficient processing, conversion and uptake of soil-applied nutrients. The meta-catalyst may be added to

Figure 4: Potential cost savings.

FERTILIZERS	Cost per ton	Application rate-lb/1000 sq ft	Amount Nitrogen	Cost per 1000 sq ft	Savings per sq ft
30-0-10 50% Slow N	$920	3.5	1.05	$1.61	
30-0-10 50% Slow N with Meta-catalyst	$980	2.75	0.825	$1.35	16.3%
46-0-0	$1,000	2.5	1.15	$1.25	
46-0-0 with Meta-catalyst	$1,060	2	0.92	$1.06	15.2%
15-25-10 33% SCU	$1,085	4	0.6	$2.17	
15-25-10 33% SCU with Meta-catalyst	$1,150	3	0.45	$1.73	20.51%

granular and liquid fertilizer products to enhance performance.

PROVEN RESULTS

Research about fertilizer meta-catalysts shows promising results. More than 400 field, university and third-party studies have been conducted on such blends, and the products have been proven effective in improving nutrient uptake into plants. The potential implications are enormous – opening the door to reduced fertilizer application rates, improved fertilizer performance and the possibility of reduced leaching and runoff of soil nutrients.

Some studies suggest this microbial technology can increase nutrient uptake in grass and other plants by 25 percent or more.

Some of the studies suggest this microbial technology can increase nutrient uptake in grass and other plants by 25 percent or more. A University of Florida study about perennial ryegrass and hybrid bermudagrasses showed a soil application of the meta-catalyst increased nitrogen uptake over the control by between 50 percent and 75 percent at application rates of 3 ounces and 6 ounces per thousand square feet, respectively. (See figure 1.)

Meta-catalyzed fertilizer appears to have a significant impact on the plant itself – as measured at roots and shoots. Auburn University conducted a controlled study in bentgrass. Plots were treated with a conventional 19-5-9 fertilizer or a meta-catalyzed 19-5-9 fertilizer, each applied at a rate of four pounds per 1,000 square feet. Bentgrass in the treated plots had 91-percent higher fresh root weight, 105-percent higher fresh shoot weight and 37-percent higher average diameter.

In a similar Auburn study of root growth in tall fescue, samples treated with the microbial technology showed increased biomass, especially root mass, in less than four weeks. Deeper roots provide more surface area for nutrient uptake and can draw on soil deposits of nutrients that haven't been depleted yet. A healthier root structure also can help plants survive stress better, even in dry soils. Enhanced nutrient uptake is important particularly for new plant establishment.

IMPLICATIONS

When plants use nutrients more efficiently, it's possible to use less fertilizer – or to use fertilizer with a lower ratio – to get the same results. When nutrient uptake is increased by 25 percent or more, one can reduce fertilizer application rates by as much as 25 percent without sacrificing performance. For example, a turfgrass that's normally fertilized at a rate of 4 pounds per 1,000 square feet could be treated at just more than 3 pounds per 1,000 square feet with a meta-catalyzed blend. Similarly, if a ton of fertilizer treats 11.5 acres at the 4-pound rate, a ton of meta-catalyzed fertilizer treats 14.4 acres because it's applied at a lower rate. In either case, the use of the enriched blend could reduce costs by 15 to 20 percent or more.

As an alternative to applying the lower rate, it's possible to use a meta-catalyzed fertilizer with a reduced nutrient content. For example, instead of applying conventional 30-0-10 fertilizer at 4 pounds per 1,000 square feet, an Auburn study says it's possible to apply a meta-catalyzed 22-0-8 fertilizer at the same rate to achieve the same results.

In 2004, an Auburn team fertilized transplanted broccoli plants. Plants were broken into four groups. Two groups were treated with conventional fertilizer with 80 percent and 100 percent nitrogen, respectively. Two other groups were treated with meta-catalyzed 80-percent or 100-percent fertilizer. After 32 days, plants in the meta-catalyzed fertilizer groups were more than 30 percent larger than the other plants, and the 80-percent meta-catalyzed fertilizer significantly outperformed the untreated 100-percent fertilizer. (See figure 3.)

There are some advantages to focusing or improving the efficiency of fertilizer use, as the examples above illustrate. That said, the use of meta-catalyzed blends or any other enriched fertilizers isn't a panacea for undisciplined turfgrass or horticultural management. Sound agronomic practices – including the measurement and management of soil nutrient levels – remain essential to any turf professional's long-term success.

The use of meta-catalyzed fertilizer can provide several environmental benefits. First, such products can reduce the amounts of fertilizer that must be added to meet plant nutrient requirements. Second, increases in plant and root mass will enable plants to absorb more nutrients from the soil. As a result of reduced application rates and improved uptake, there is less residual material to leach or run off into the water table. A study conducted by Illinois-based Arise Research & Discovery found the use of such meta-catalysts reduced nitrate concentrations at 12-inch depths by 48 percent, and 57 percent at a depth of 30 inches.

SUMMARY

A difficult economy forces many to tighten budgets, and for turf managers, the rising cost of fertilizer is a challenge. Until now, solutions have forced users to trade off – on cost, performance or environmental impact. Microbial-based fertilizer meta-catalysts represent a new product category that may enable users to hold or reduce costs without sacrificing performance or environmental health. **GCI**

Cathie Cush is a freelance writer based in Newtown, Pa.

AGRONOMIST'S VIEW

Food for thought

BY JEFF HIGGINS

Soil microbes serve many functions when growing turfgrass. One of those functions is to make fertilizers and nutrients available in forms turfgrass plants can uptake. For example, nitrogen can be taken up by plants only in the inorganic forms of ammonium and nitrate. Therefore, all nitrogen fertilizers have to be converted or applied in one of those two inorganic forms for the plant to use them. The process of mineralization converts organic nitrogen- and urea-reacted fertilizers to ammonium. Nitrification converts ammonium to nitrate. All of these require aerobic soil microbes for the reactions to occur.

There is such a thing as good and bad microbes. Aerobic microbes are required for many of the reactions mentioned above; however, when anaerobic conditions exist, anaerobic microbes survive and cause unfavorable reactions, such as the formation of black layer.

Microbes needed to grow healthy turfgrass already exist in the soil, or else grass wouldn't grow. If and when microbes are added, the diverse population of soil microbes are at a balanced state already. When new microbes are added, if they're of the same genus and species, there's a great chance they'll survive. If they're foreign, there's a great chance they won't.

However, it's important to review some basics about soil microbes. The beneficial soil microbes are primarily aerobic, which means they require oxygen. I've yet to have any of the soil microbe product manufacturers answer this question for me. If these microbes require oxygen, then what happens to them when they're vacuum sealed in a jug or package? What is their shelf life? Is this shelf life for alive or dead microbes? What would happen to you if you were submersed in an environment with limited supply to no oxygen? Let's assume these are superman microbes and can survive without oxygen and are alive when applied to the soil. The soil and soil microbes are a competitive environment, and the ones present are there because of competitive exclusion and survival. What's going to happen to the newly introduced microbes? More than likely, they'll get outcompeted or eaten alive by the ones that have been there for many years and become well established under the environmental conditions for a given geography.

What happens with the bugs-in-a-jug type of products is they're simply food for the existing soil microbial population. More than likely, they're dead when applied, and they behave as a simple organic fertilizer. Any type of organic material, whether it's chicken litter, Milwaukee's finest sewage sludge (Milorganite), or a bunch of dead microbes, they'll behave as organic fertilizer (material) existing soil microbes will feed on (mineralize), and you'll see a turf response.

For example, catalyst microbes that are being added are more than likely dead when they reach the turfgrass. If they're not, they only serve as a food source for the existing soil microbial population, which makes the soil microbial community more active, and thus, the microenvironment activity is escalated. One may see a positive result from this increased activity. One can get the same catalyst type of activity by applying molasses or sugar water, which many of the old school superintendents did and some still do. Any food source applied to the environment will stimulate microbial activity, whether it's molasses, sugar water or meta-catalyst microbes. GCI

Jeff Higgins, Ph.D., is director of agronomy for ValleyCrest Golf Course Maintenance.