Microbes in soil and sand-based rootzones

BY **DAVID A. ZUBERER**

Throughout my career as a university researcher and teacher, I have studied microbes in soils from a number of viewpoints. Mostly my interests have been focused on the roles of so-called beneficial microbes in soil-plant systems ranging from agricultural fields to reclaimed surface-mine sites. More recently, perhaps because of an interest in golf, but perhaps more so because of the need for basic information for turfgrass managers (my job brings me in contact with many students aspiring to work in the sports turf arena), our studies have focused on some of the microbiological aspects of sports turfs on native soils as well as those established on sand-based systems.

As I read various publications, from trade magazines to information on the World Wide Web, I find that there is a wealth of misunderstanding and misconceptions among the general public regarding not only the real functions of soil microbes but also of what it takes to maintain or manipulate them. To read some of the material "out there" one would think that agriculture, including turf management, has been waging "all out" chemical warfare on soil microbes and that we have all but annihilated them in our soils. To try to bring some clarity to the subject, I would like to discuss some of the issues surrounding soil microbes in turf with special reference to sand-based root zones, as that seems to be an area of some confusion.

I would like to address the following questions:

1. Are native soils and sand-based rootzones different?
2. What microbes are in sports-field soils?
3. How many are there? How much biomass?
4. What do they do?
5. What do you need to do for them?

I will try to provide some relevant information from the standpoint of what we know about soil microbes and their activities and I will try to indicate areas where the science is still uncertain.

Are native soils and sand-based root zones different? To some, this is obvious; there are differences in the two systems! But let's take a look from a microbiological perspective. Some of the major ways in which soils and sand-based root zones might differ are listed in Table 1. It is likely that native soils will have a greater content of silt and clay than a sand-based root zone as that is one of the principal reasons for developing the sand base; it cuts down on the finer particles and leads to coarser (more sandy) textures with the presumed advantage of better aeration and drainage. It is also likely that native soils have better aggregate-forming potentials than the coarser sands.

Thus, if managed properly, native soils can exhibit good drainage and will likely have a more variable range of pore sizes. Pore size is critical for air and water retention and finer textured soils, if not well aggregated, tend to drain poorly making the soil environment less suitable for microbes and roots. One might envision that the chemical properties of soils would be more complex than those of the sands although many different ingredients, e.g., zeolites or diatomaceous earth, have been added to sand mixes to improve their chemical properties (cation exchange capacity, etc.).

One might also expect that native topsoil would have more organic matter than a sand mix and that it might be more complex in its chemical composition. Sand-based systems are generally constructed with peat or some other organic material (for example rice hulls) making up as much as 20% of the mix. One should realize that sand-based systems can also accumulate new organic carbon fairly quickly in the surface few inches as roots and microbes grow, die off and decompose. Thus, grasses in sand-based systems become sources of microbial substrates relatively quickly in their early development.

Table 1. Some major characteristics that differ between native soils and sand-based root zones

	Native Soil	*Sand-Based*
Texture	Varies but likely to have silt and clay	Sand of specified particle-size range
Structure	Probably aggregated with a mixture of pore sizes. Mechanical properties may deteriorate when wet	Probably lacks aggregation; pore size less variable. Better mechanical properties than soil when wet
Drainage	Variable, mix of pore sizes. Better water retention. Drainage can be poor depending on texture and structure	Rapid drainage, pore space mostly due to packing of the larger sand particles. Water movement retarded due to perched water table
Chemical properties	More complex, greater cation exchange capacity due to clays properties derived mainly	Less complex; lower cation exchange capacity. Chemical from the organic matter content
Organic matter	Probably greater and perhaps older; more humified	Can be quite high in surface few inches. Different composition during early stages

What microbes are in sports-field soils?

Sand-based rootzones contain abundant populations of bacteria and fungi as well the other major microbial groups; actinomycetes (a specialized group of mostly filamentous bacteria and well known for their ability to produce many of our modern, medically useful antibiotics), algae (and cyanobacteria, formerly known as the "blue-green algae") and protozoans. Bacteria and fungi generally dominate the soil microbial population and this is probably true of sand-based root zones as well (see Table 2). It probably is not inaccurate to say that we know less about the microbial ecology of sand-based rootzones than we do about "normal'" soils. But that is changing as more research efforts are focused on these highly managed systems. However, what we do know is that they tend to function like regular soils once vegetation is established and regularly maintained as a healthy turf. Numerous studies document the abundance of microbes in sand-based turfgrass systems and they indicate that microbial numbers equal or exceed those of turf growing on various soils. Thus, one might expect that microbes in sand-based systems would behave like their counterparts in soil-grown turfs.

The major role of the bacteria and fungi is to decompose organic materials in the rootzone mix (or soil), including the cells of their recently dead microbial colleagues. It is precisely this turnover of root tissues and microbial cells that releases organically bound N and P as plant-available, inorganic ("mineral") forms. This so-called mineralization process is the essence of what soil microbial activity is all about. Yes, they do bring about other important processes, some beneficial and some detrimental, but their primary benefit is to decompose organic materials, make more microbial cells and synthesize some soil organic matter (humus) along the way. This is why we can use mulching mowers and return grass clippings and the nutrients in them back to the soil where they belong.

Algae and cyanobacteria occur in very small numbers unless a soil is kept overly moist. They can be a problem on closely mown turf, like putting greens, where they may form slick spots if they are not shaded out by the grass canopy. More often than not, they are only problematic in very wet soils. On the other hand, in arid soils they represent a source of new organic matter albeit a relatively small one.

Protozoa probably deserve more research attention in turf systems. Grass roots generally support abundant bacteria and that is where you'll find the protozoa. Soil protozoa are effective "grazers" of soil bacteria and other microbes. In fact, this may be their most important role. By eating bacteria, they not only keep a check on the size of the population but they speed up the rate at which nutrients locked up (immobilized) in those microbial cells are recycled (mineralized) for uptake by plants and other microbes.

Table 2. Numbers and biomass values for the major groups of microbes found in soil

Microbial Group	*Biomass (Wet wt. in lbs/ac; 6" depth)*	*Number per Gram of Soil*
Bacteria **Actinomycetes**	300-3,000 300-3,000	10 Million - 1 Billion
Fungi	500-5000	10 Million - 100 Million
Algae and Cyanobacteria	10-1500 (Bloom*)	100 - 1 Million (Bloom)
Protozoa	50-200	1000 - 100, 000
Viruses	???	10 Billion - 100 Billion

**A bloom is a visible overgrowth of algae on the soil surface.*
Alexander, 1977, Sylvia et al., 2005

How many are there; how much biomass?

There are countless microbes in soils and literally tons of microbial biomass in normal, healthy turfgrass systems, including sand-based systems. Grasslands have long been known to support large populations of soil microbes. Some figures for numerical abundance and microbial biomass of various microbial groups are listed in Table 2. For perspective, one gram of soil is about the size a kidney bean in the palm of your hand.

But what about numbers of microbes in intensively managed, sand-based, sports fields? Are the populations somehow compromised? Research suggests that the answer to this question is, No! Results from multi-year monitoring of microbial populations in sports fields at Texas A&M University showed that bacteria consistently number in the tens of millions (Log10 7.0 = 10 million; Log10 8.0 = 100 million) per gram of sand (Kyle Field, Soccer Field) or soil (Intramural Field) and fungi number in the tens to hundreds of thousands per gram.

The soccer field was first sampled just 2 weeks after washed Bermudagrass sod had been laid on an 11-inch base of pure sand with no organic amendments (peat). The sand used in construction of the field contained only 100,000 (Log10 5.0) bacteria per gram. Thus, we found that microbial numbers increased rapidly (10- to 100-fold) as the grass "grew in" and new roots of the washed sod were the primary source of microbes and the carbon sources to sustain them. Fluctuations did occur during the seasons and they appeared to be most associated with the moisture status of the fields when we collected samples.

However, we observed that populations remained high throughout the year and that they were similar in the sand-based and soil rootzones. We have found similar populations in common Bermudagrass with and without compost additions (15 or 90 tons per acre), sand-based putting greens under dwarf Bermudagrass varieties and even under common Bermudagrass treated with molasses at 16 times the suggested rate of the vendor.

I hope to dispel the notion that sports turf is "lacking soil microbes" and that microbial preparations (microbial inoculants, small amounts of carbon sources like molasses or sugar, etc.) are needed to restore them.

While the numbers of microbes in soil are no doubt impressive, it is the biomass (weight) of the microbes that truly indicates their abundance. Though not all soil microbes are actively growing at any given point in time, a large biomass indicates great potential for the many biochemical activities of the microbes under appropriate conditions for their growth! A healthy stand of grass can literally contain tons of soil microbes! Thus, we know that soils with large active populations do in fact mediate lots of beneficial processes in the soil.

We are only at the beginning of our understanding of the microbial biodiversity in soils and sand-based systems. Molecular biology research from the past two decades suggests there may be as many as 4000-13,000 species of bacteria in a single gram of soil. Moreover, we have managed to culture only a very small percentage of these in the lab. The challenges of understanding and harnessing this diversity are many but they must be understood in order to determine if we can actually manipulate soil microbial populations to our benefit under "real world" conditions!

What do soil microbes really do?

The fact is that they do all sorts of things in the soil when active, but mostly, they just "hang around" waiting for something to eat. Contrary to what some might think, soils are not seas of organic soup. Rather, they tend to be limiting in supplies of organic carbon to feed microbes and the competition for that carbon is fierce. This is one reason why the rhizosphere, the zone of soil immediately around a plant root, is such a "hot spot" for microbial growth. Roots, as it turns out, give off organic carbon in a variety of forms (sloughed cells, exudates, etc.) that are exploited by the nearby microbes.

WE ARE ONLY BEGINNING TO UNDERSTAND MICROBIAL BIODIVERSITY IN SOILS AND SAND-BASED SYSTEMS

So, one of the things that microbes do in soil is to reprocess these materials into available forms (i.e., mineralization) and into microbial cells and humus (recalcitrant, stable organic matter). They are also involved in many other processes too numerous to describe here in detail. For example, many soil bacteria can fix atmospheric nitrogen (N_2) in order to grow in areas where available soil N is scarce. Note, that I said where N is scarce! They're "smart enough" not to rely on N_2 fixation when soil N is sufficient because the process of biological N_2 fixation is energetically very "expensive" for them.

A common misconception is that one can apply small numbers of nitrogen-fixing bacteria to turfgrass and they will supply nitrogen for the plants. While some N_2 fixation might occur, it is unlikely that one could achieve a healthy stand of turfgrass on such miniscule amounts of nitrogen. Perhaps more likely than N_2 fixation in turfgrasses is the process of denitrification, the microbial conversion of plant-available nitrate to gases such as nitrous oxide (N_2O) and dinitrogen (N_2). This process occurs when soils become saturated and oxygen is depleted within the soil/sand matrix. Then, denitrifying bacteria convert the nitrate to gases that escape from the soil taking with them one of the most expensive turf management inputs, namely, fertilizer nitrogen.

These are just a few of the processes brought about by microbes in soil.

The discussion above about the abundance and functions of soil microbes leads us to the final question: What do you need to do for soil microbes?

This is probably the question that generates the most confusion among turfgrass managers as this is an area where I see a lot of information not based on the science of what we know about soil microbes. It is in answers to this question that we find much misinformation! A common misconception about soil microbes is that using synthetic fertilizers and other management inputs (pesticides, etc.) somehow kills the soil microbial population leading to "dead" or "sterile" soils. The Internet abounds with information (in some cases posted by well-meaning individuals and, in others, by persons selling miracle cures) that is just patently false! Take the following statement gleaned from the Internet for example:

"Chemical fertilizers will eventually destroy even the best soils by killing the beneficial organisms that plants rely on to gather nutrients and moisture. Growers are then forced to pour on larger and larger amounts of expensive petroleum-based fertilizers to maintain yields, but the overdoses create unbalanced "dead soil." (Anon.) A recent search of the World Wide Web for the term "dead soil" returned 96,000 hits.

While it is true that fertilizers may inflict some harm on microbes directly exposed to granules or to anhydrous ammonia, the overall effect of fertilizer applications is to markedly increase microbial numbers and activity in soil through increased plant growth. We have known this for decades! As I mentioned earlier, the majority of soil microbes require organic carbon to grow and produce new cells. In grass systems, the vast majority of organic matter is produced from decomposing roots and leaves. Fertilization increases the amount of organic substrates available to soil microbes by increasing its source, the grass plants themselves. Thus, rather than producing "dead soil," judicious use of fertilizers invigorates soil microbes by allowing plants to produce more resources for them!

Remember though, all management inputs must be used carefully and correctly. Too much of a good thing can produce negative consequences. Excessive fertilizer applications will likely lead to enhanced runoff and leaching and the undesirable environmental consequences that go with those processes.

So, do you need to add "beneficial microbes" to the soil to make it function properly? That's highly unlikely. Many studies of turfgrasses, whether in sports fields, golf courses or home lawns, have shown that soil microbial populations are not compromised by normal management practices. The best thing that you can do to "manage" the soil microbes under your care is to grow a healthy stand of turf and pay close attention to the condition of the soil or rootzone supporting it. Paying attention to the agronomics of grass culture, fertilization, aerification, drainage, etc., will insure that the microbial populations are not being adversely affected. ST

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Preventing summer stress

BY **JEFF HAAG**

Maintaining intensively manicured turfgrass during the summer months, whether it is an athletic field or golf tee or green, becomes a real challenge due to a complexity of problems that have the potential to cause the turf to develop stress. Around 1993 and 1994 several highly respected researchers referred to a decline in bentgrass golf greens as "summer bentgrass decline," to which no single pathogen was ever attributed. It was suggested that a correlation existed between Lanzia, Rhizoctonia, Magnaporthe poa, Anthracnose, and Phythium diseases as being the main culprits to the decline of turf during summer months.

There is no doubt that these diseases can become a serious problem during the summer, and will cause turf to decline. We suggest, however, that there are other underlying causes that cause turf to decline at this time of the year, and that the diseases that can be attributed to the decline of the turf are the end results. We also believe that most causes can be prevented.

Probably the number one cause of turf decline in the summer months is a result of free radical damage in combination with high soil and air temperatures. Just what are free radicals? Typically, stable molecules contain pairs of electrons. When a chemical reaction breaks the bonds that hold paired electrons together, free radicals are produced. Free radicals contain an odd number of electrons, which makes them unstable, short-lived, and highly reactive. As they combine with other atoms that contain unpaired electrons, new radicals are created, and a chain reaction begins.

The next question is, What causes these molecules to become unstable? The most common one would be the one that turfgrass managers do the most, mow. Mowing is a destructive process that wounds grass plants and increases the susceptibility of grass plants to other stresses. Formation of reactive oxygen species is a typical response of plants to wounding. The obvious prevention method would be to constantly check to make sure that blades, reels, and bedknives are as sharp as possible.

Other stresses that lead to the development of free radicals are environmental, such as drought, heat, and ultraviolet light, or chemical, such as herbicides. These stresses cause the reactive oxygen molecules hydrogen peroxide, superoxide, singlet oxygen, and hydroxyl radicals that can damage lipids, proteins, and DNA inside cells.

At supraoptimal temperatures, photosynthesis is extremely sensitive and is the first metabolic process that is damaged. High temperatures possibly cause an imbalance between photosynthesis and respiration processes and carbohydrate depletion, particularly for turf that is mowed daily at a low mowing height, such as golf greens.

Low mowing when temperature is high during summer imposes additional stress on the turf by removing large amounts of leaf area that are used for photosynthesis, while respiration continues. Not only are metabolic processes reduced at high leaf temperatures, but also moisture stress, from increased transpirational losses, results in stomatal closure, which decreases the supply of C02 to the chloroplasts slowing photosynthesis. Under optimum temperature conditions, however, plants maintain a balance between producing and scavenging active oxygen species.

Prevention

What can you do about free radical damage affecting turfgrass? One idea is applying biostimulants because of their antioxidant properties. Various biostimulant products on the market contain a-tocopheral and ascorbic acid. When these two antioxidants become concentrated in the chloroplast they protect the photosynthetic apparatus photosystem II when plants are subjected to environmental stresses by scavenging excess reactive oxygen species.

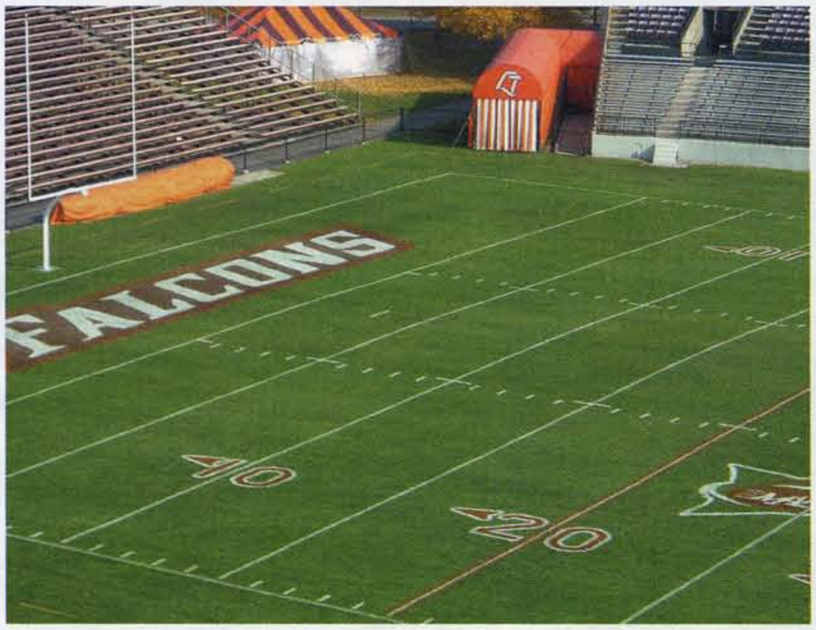
Another benefit of biostimulants is their hormone containing property of cytokinins that is found in seaweed extract from ascophyllum nodosum, a known growth hormone that promotes cell division. Thus, the plant not only receives antioxidants to combat free radicals, but also has a propensity for deeper root growth, as long as some other factors are dealt with which will be discussed later.

Many researchers over the years have demonstrated the positive effects plants receive from the application of biostimulants containing cytokinins. Turfgrass managers must, however, use caution that they are not applying cytokinins when cytokinin content is operating at a normal level since the addition of cytokinin applications at these times have actually been found to be detrimental. It will vary from region to region, but given a normal year, we in northwest Ohio typically apply them from mid-May until the second week of September.

Humic acids are another compound that has shown to contain antioxidant properties, which promote the scavenging of free radicals. The other benefits of humic acids are that they have also increased the availability of micronutrients, phosphate, and potassium, and enhance the chlorophyll content of plants.

Several nutrients seem to also play a key role in preventing turf decline during the summer months, including calcium, which along with cytokinins, plays an essential role in cell division and elongation. Heat tolerance with the use of calcium is known to exist, but is still unclear as to how it is regulated. Some suggest that it may be involved in signal transduction, and gene expression under oxidative and heat stress. Others have found that calcium increases antioxidant enzyme activities and reduces lipid peroxidation of cell membranes. Calcium has also been shown to regulate guard-cell turgor and stomatal aperature. Although no research has shown calcium to prevent pythium, it has been demonstrated to possibly reduce the severity of pythium by inhibiting the activator of pectolytic enzymes, thus, protecting the cell walls.

Silicon is another nutrient that has shown great promise in the past 3 years as a stress-preventer. This is most likely due to three factors. First, when silicon is present in leaf tissue the concentration of sodium in the leaf tissue is decreased by up to 50%. Second, when silicon is present in the plant tissue it prevents physical penetration by some insects and makes plant cells less susceptible to enzymatic degradation by fungal pathogens. Third, structural functions of silicon include compression resistance in cell walls, which increases traffic resistance.



Potassium is another vital nutrient in helping combat summer turf decline, and is probably one of the most underused nutrients in the turf industry. Its greatest attribute is that it helps strengthen cell walls inside the plant, which in turn allows the plant to hold up to traffic better, tolerate extreme heat, and help the plant require less water. Keep in mind, however, that potassium can have a negative effect on Magnesium if used in excessive amounts. As an example, we generally foliarly apply 1/10 of a pound of potassium every 2 weeks during the summer months using Floratine's 4-4-16 Tiger Turf, and then use PhlexMag at a .75 ounce per 1,000 sq. ft. rate every 2 weeks.

Although not considered an antioxidant, amino acids play a key role in the prevention of summer decline. This can be attributed to at least three functions, possibly more, that amino acids impart on the plant: osmotic adjustment, water-stress tolerance of plants, and helping prevent chlorophyll degradation. Chlorophyll breakdown occurs to an oxygenolytic opening of the porphrin cacrocycle of pheophorbide (pheide a) followed by a reduction to yield a fluorescent chlorophyll catabolite. This step is comprised of the interaction of two enzymes, pheide a oxygenase and red chlorophyll catabolite reductase.

Although we haven't seen any published research on it, we have experimented with on our greens the past 2 years with excellent results by applying an amino acid product called ProteSyn from Floratine every 2 weeks; we then add an application of Nutramax's MacroSorb Foliar on a biweekly rate. We either apply the MacroSorb Foliar with a fungicide to allow it to get into the plant easier if we are applying one, or apply it by itself. We feel that it is important to keep amino acid levels up during the summer because photosynthetic rates are generally lower during this time, and amino acids are known to help play a key role in photosynthesis.

Another amino acid product we have found very beneficial on our golf greens and our football field comes from the application of Nature Safe's organic fertilizers. We use Nature Safe for four reasons: its high amino acid content, its extremely low sodium index, its slow release form of nitrogen so that we get no surge growth, and finally, is its well documented ability to increase microbial populations that aid in triggering the plants' own defense mechanism in fighting off fungal pathogens.

Phosphorous is another key nutrient in the summer that becomes critical. Why? Because phosphorous is a required nutrient for plant health, but there are several products available that can be used instead of the fungicide Aliette in the prevention of pythium. We use a product from Helena Chemical called Elemax Super Foliar Phosphite. There are several other foliar phosphorous containing products that will work as well. We not only get pythium prevention protection, but the plant also gets the nutritional benefit, and it is a lot cheaper per 1,000 square feet versus Aliette.

Manganese serves many functions within the plant, but the two most critical for summer decline prevention are the important process it plays in helping develop chlorophyll, and the second being the proper development of respiratory enzymes. As stated earlier, respiratory rates become higher in the summer, which also has a negative effect on carbohydrates.

Need oxygen

Another critical process in helping to avoid summer turf decline is keeping a good supply of oxygen in the soil. This is best done through various types of aeration. Aeration also allows for gaseous exchange, water movement through the soil profile, reduction of compaction and thatch, providing oxygen to promote greater microbial function, as adequate soil-oxygen levels are extremely important for soil micro-organisms, and controlling the amount of organic matter accumulation.

We use various forms of aeration techniques throughout the year on our golf greens. We try to get some form of oxygen down to our roots monthly from April through October. In April and May we use 7-inch bayonet tines due to their surface area and their ability to get down that far. In June, July, and August we use 5-inch needle tines. These cause no more surface disruption than a hydroject aeration.

Once they have been mowed you can't even notice that it has been done. Obviously if it is extremely hot, dry, or both common sense tells us to hold off until conditions are conducive to performing it. In this region of the country there is usually at least a 1-2 day window of opportunity to do this. We also perform one hydroject aeration in July and August.

In the fall we core aerify with hollow tines, remove the cores, and topdress them to fill the channels in, then fertilize them with a granular fertilizer to start building up carbohydrate reserves for the winter. On our athletic fields we core aerify as opportunities present themselves based on field use and weather conditions. This past season we were able to core aerify the football field six times, five times before the start of games, and once during the season. We were also able to deep tine the field during the season once using 10-inch solid tines. If we experience a very hot summer then we use 5-inch slicing knives on the athletic fields to keep oxygen in the root system.

One important process that we do every year before we make any kind of application that is extremely important is soil testing. It is absolutely imperative that you find out what nutrients are available from the soil, and which ones are tied-up in the soil. Whichever nutrients are not available then they need to be addressed as to why they are not so that necessary soil amendments can be applied to improve their availability, which, in most cases, is going to take time, perhaps several years, to improve them. The chosen method for bypassing nutrient unavailability is to apply nutrients foliarly.

These are some of the practices that we have used to help prevent summer decline, strengthen overall root systems, and improve plant health. The past 2 years we have only had to hand syringe our greens once, which has to be a direct correlation to the health of our greens. This past summer (2004) we consistently had 12-14 inch roots on our golf greens in June, July, and August, and 11-12 inch roots on our football field. We were able to cut our fungicide applications by half as compared to previous years on our golf greens, and made only two fungicide applications during the summer on the football field. This year we plan on cutting our fungicide applications by half as we normally would apply on our greens. Root systems can grow during summer months instead of experiencing root dieback, which can be a common problem typically encountered during this time of year. ST

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Organic product veteran speaks out

Interview with Robert Riley, founder of Green Pro Services, Inc.

SPORTSTURF: What got you started working with organic products?

Robert Riley: When I used chemical products and methods some 30 years ago, I realized that the turf was not responding the way I thought it should. The root structure was never very good; thatch was a problem, as were diseases. In fact, I recorded that it took more and more effort and money to maintain the turf. It got to the point that every lawn had to be plug aerated and de-thatched every year.

ST: Is this what made you move into organics?

RR: As I did more and more research, the fundamentals of soil biology, plant nutrition, and the relationship between the two became very clear to me, and explained why I was having problems with diseases and why I couldn't get a good root system. By pulling together and organizing the available research, plus my observations on lawns, I was able to develop the principles for designing organic turf care products and procedures. Since then, it has been an ongoing process of development, testing, refining, re-testing, etc.

ST: Organics have been touted and tried before with less than acceptable results. What makes your products different?

RR: There are some fundamental differences. First, there has to be the recognition that turning to organics is not just "using" organics. Rather, it is gaining the knowledge of how the earth's natural systems work, and then using specific materials, timed to work in concert with these established natural systems. The commonly used materials available today, typically animal byproducts can't reliably or effectively do the job.

ST: Isn't organic "organic"?

RR: No. Organic products are either animal organics or plant organics. Some organics, sewage sludge for instance, can be very high in heavy metals, which are somewhat toxic. Cow manure can contain weed seeds. It makes a difference whether they are completely or only partially decomposed. Most organic products, including composts, are not ready to "go to work" immediately. In a sense, the soil's process of getting some organic materials ready to go to work actually consumes some of the components that are supposed to be available for turfgrass support. Turf managers have not gotten the response that they were seeking so they concluded incorrectly that organics don't work, or are slow to work.

In order to be effective and efficient, the organics applied must be ready to do their job as close to immediately as possible. Moreover, ALL of other materials used (e.g. N.P.K. fertilizers) must be in balance and work together synergistically.

ST: How are your organics different?

RR: The materials are completely decomposed, so no further time is needed for them to provide the benefits to the soil and to the plant. Our plant-based organic products can also have as much as 40 times more organic content than a similar volume of other organics. That alone makes a huge difference in turf performance. Also, some organics have heavy metals and other undesirable components, which can be toxic to the soil and create nutritional imbalances.

ST: What do you mean by "nutritional imbalances"?

RR: For optimal function, nature must be in balance. Upset the balance and performance suffers. Optimize balance and nature will respond favorably. Specifically, this is about nutritional balance within the soil. At least 30+ necessary nutrients are required and they must be available in the correct proportions. The soil grows what it is "programmed" to grow. For instance, there is a nutritional profile that is more likely to grow grass, and a different profile that is more likely to grow weeds. Growing 100% turfgrass is "unnatural" to nature, but by altering various components within the soil, we can optimize that process.

ST: How does aeration work with organics?

RR: Most maintenance programs today approach aeration as a "mechanical" process, using a machine to poke holes in the ground. It is very inefficient, ineffective and expensive. If you were to aerate in two different directions, university calculations report that less than 10% "aeration" of the surface is possible. We also have to realize that in many parts of the United States it is impossible to mechanically aerate during certain times of the year.

Even under the most ideal conditions, which seldom exist, penetration is measured in inches, and the period of "aeration" measured in days or weeks. We want our soil aerated 100% of the growing season, as deep down as possible, because that is the most important part of working in concert with the earth's natural systems.

ST: How do you aerate?

RR: We use biological methods. Our method is more advanced and we've used it successfully for the last 30 years. Our program aerates 100% of the surface area all season-long. And the cost of using our Natural Aeration process is but a fraction of mechanical aeration, plus it saves money in other ways.

For instance, we have athletic fields with roots over 15 inches deep. That means grass plants have a greater root system for storing food energy, providing for a tougher turf to withstand wear-and-tear, thus requiring less seeding. It means that the soil can hold 15 inches of water, a larger reservoir of water, which can save as much as 30% in watering costs. In some areas of the country that represents a huge savings. It also means a larger "warehouse" of nutrients to draw upon for a better nutritionally balanced turf.

Combine all these bonuses with the elimination of dethatching and aerating equipment and labor, and the savings can be very significant. Plus, it produces a better turf that requires fewer pesticides. From every perspective, it is better for the environment.

ST: What do you see as the future of organics in sports turf maintenance?

RR: The 20th century was the age of "A Better Life Through Chemistry" and chemical solutions where created for every imaginable aspect of our lives. Special chemical solutions for turf problems and the latest mechanical equipment were, and still are by many, considered to be modern and progressive. The research and development process has taught us much and the information has value. Yet, I feel strongly, and have proven empirically, that too much emphasis has been placed on the grass plant and not enough attention paid on the growing medium, the soil.

Combine this with the large group of turf people who have ventured into organics only to be disappointed by products and/or procedures that didn't work well enough. They too often mistakenly conclude that organics don't work.

What is really driving organic products today is environmental concerns and public pressure. In the rush to capitalize on this shift, some companies are developing products that are environmentally responsible but are often budget-busting and/or poor performers. They are trying to use the symptom management paradigm of the chemical companies rather than going back to the basics of how the biological processes within and between the soil and the plant take place. Performance is a matter of fundamentals.

I am optimistic about the future of organics. It has so many benefits, both economically and environmentally, and it is consistent with the way nature functions, the way that the natural biological and chemical processes have worked together for thousands of years. **ST**

Contact Robert Riley at 1-800-645-6464.

TURFVIGOR

TurfVigor, a liquid microbial fertilizer, maximizes nutrient uptake while improving turf color and quality. Perfect for sports turf applications, TurfVigor 9-3-6 improves plant health, accelerating recovery from physical damage and maintains root mass under high-stress conditions. Available in 2.5-, 15- and 110-gallon containers, TurfVigor should be applied with water and is perfect for spoon-feeding applications. Combining patented high-impact microbial strains, biostimulants, and macro and micronutrients in one formula, this easy-to-use liquid fertilizer helps turfgrass hold up under temperature, drought, physical injury and other stress-causing environmental conditions.

Novozymes/800-342-6173
For information, circle 073 or see http://www.oners.ims.ca/5062-073