Jump-Starting Microbe Activity in Sand-Peat Root Zone Mixes

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The search for the perfect putting green continues, and if you buy into what the vendors are saying, the USGA's sand-based green is far from perfect. On one side of the aisle is the 'biologicals crowd. Their position is that sand-peat blends start out nearly devoid of microorganisms. This must be bad because everyone knows that "healthy" soils are those that teem with microbes.

From the other side of the aisle we are hearing that the problem is with the sand and peat. Inorganic materials such as calcined clay and diatomaceous earth have superior physical and chemical properties. They offer better soil structure and all that goes with it—more plant available water, higher infiltration rates, better aeration, and improved nutrient retention in the root zone.

The interesting thing is that the two sides are expressing somewhat opposing views on what is "wrong" with USGA putting greens. Replacing some of the peat, the bearer of microorganisms, with an inorganic product may be detrimental to initial microbe populations.

What I am about to do here is stick my neck out and offer my views on the biologicals and inorganics schools of thought regarding USGA greens. On the biologicals side, there seems to be two issues that single out low microbial activity as a problem in newly constructed sand-peat putting greens. One I discussed in the March/April issue of THE GRASS ROOTS. This is the notion that low microbial activity in new sand-peat greens limits nutrient biocycling to the extent that excessive fertilizer N rates are required for grow-in.

The second implicating piece of evidence for low initial microbial activity is the occurrence of Pythium root rot in young sand-peat putting greens. The strains of Pythium involved occur in virtually all soils, but at such low populations that they are innocuous saprophytes rather than pathogens. These low populations are thought to be the result of the antagonistic and competitive actions of other microorganisms present. This leads to the assumption that in young sand-peat greens the lack of antagonism and competition from other microorganisms is what allows Pythium to become pathogenic and invade the roots of stress-weakened bentgrass.

Evidence that USGA putting greens initially suffer from lack of microbial activity is scarce. One field investigation of the microbe population of a 15-month old 80/20 putting green revealed bacteria numbers that rival native soil—a million or more per gram of soil. Fungi and actinomycete numbers were relative low in the root zone mix proper, but high in the thatch layer. Our research indicates that the global microbial activity in an 85/15 sand-peat putting green does start out low, but within 3 months after seeding, is as high or higher than in mixes amended with innoculum and/or organic materials that stimulate microorganism growth.

In our research and that of others, efforts to employ innoculums and various organic materials to fortify the microbe populations of soil have met with limited success. One reason is that inoculums, while teeming with microorganisms, generally do not add greatly to the total microbe population. For example, our addition of an inoculum containing 2.3 million organisms per gram at the rate of 5 lb/cu. yd. of root zone mix had the potential of increasing the total microbe population by a whopping 0.2%. The result was as expected—the uninnocluated green had just as high a level of microbial activity as did the innoculated root zone mix.

This brings us to a second reason why innoculation of sand-peat mixes often yields disappointing results. The native microbe populations are made up of those microorganisms that have managed to survive in a highly antagonistic and competitive environment. Introduced organisms seldom survive for long under these conditions.

Now we move to the other side of the aisle and consider what the inorganic amendment advocates have to offer. What I am hearing are recommendations that root zone mixes be compounded with 70 to 80% sand, 5 to 10% peat, and the balance, or 10 to 15%, with an inorganic amendment. The inorganic amendments are either calcined clays or diatomaceous earth. Common brand names of the calcined clay products are Profile, Greenschoice, and Ecolite. Axis and PSA are two diatomaceous earth products.

Without alluding to what research has been done with root zone mixes containing the inorganic amendments, much can be surmised about their influences simply by examining their properties in relation to sand and peat. Some of the key properties of each are shown in the following table.

Typical ranges in selected properties of root zone mix components.

	Component		
Property	**Sand**	**Peat**	**Inorganics**
Bulk density, g/cc	1/6-1.7	0.05-0.2	0.25-1.0
Porosity, %			
Total	35-40	†	60-80
Capillary	5-10	40-60	30-55
Non-capillary	25-30	†	20-45
Coarse+medium particles	60-80	†	70-90
Cation exchange capacity, me/100 g	<1	75-200	25-35

† Depends on fineness of the peat

As shown, the inorganics have bulk densities less than that of pure sand, although not nearly as low as for peat. Regardless, blending the inorganics with sand will reduce bulk density. This comes about because of an increase in porosity which, in itself, will create a better medium for root growth.

Further gains in porosity are achieved with the inorganics because they have porosities nearly double those of sand. Whether or not the inorganics are more effective than peat in this regard depends on the quantities of each blended with sand. Perhaps more important than total porosity is capillary pore volume. Capillary pores are those of sufficient fineness to hold water against the downward pull of gravity. In this respect, the inorganics appear to be at least on par with peat.

The inorganic amendments have particle size distributions that meet USGA criteria for root zone mix sand. This is reflected in the percentages of coarse+medium sand shown in the table above for three amendments. From this, we can surmise that at the percentages of inorganic amendments being recommended for root zone mixes, their use will not significantly alter the particle size distribution of the mix from that for the sand.

The cation exchange capacity of the inorganic amendments is typically 1/2 or less than that of an equal weight of peat. There are, however, some differences that can be important in certain instances. The cation exchange capacity of peat is dependent on soil pH; the higher the pH, the higher the cation exchange capacity. In the case of the inorganic materials, cation exchange capacity does not change with soil pH. This allows for greater predictability with respect to the contribution of cation exchange capacity to a root zone mix. Another distinguishing feature of the inorganic amendments is that, unlike for peat, the cation exchange sites do not bond more readily to calcium and magnesium than to potassium ions. The net result expected is better fertilizer potassium retention in greens containing an inorganic amendment.

Results from laboratory measurements tend to bear out these expectations of what the inorganic amendments can do to the properties of sand-peat blends. Their use can increase the plant available water content of the mixes and their permeabilities and hydraulic conductivities. Improved K retention is reflected in higher concentrations of the nutrient in turfgrass. Except for the latter effect, there is a caveat in all of this.

Exactly how much an inorganic amendment alters the moisture properties of root zone mixes is sensitive to the type of sand used. For sands that are on the fine side of the USGA specs, the increases in available water are minimal and permeability is enhanced. For sands on the coarse end of the USGA specs, the increases in available water are more substantial, but the effects on permeability and hydraulic conductivity are minimal and may not change at all.

My concluding thought here is that I am not convinced from what I have seen so far that tweaking the microbial activity of sand-peat blends or making minor modifications in their moisture relationships with inorganic amendments will cure what "ails" USGA putting greens. I feel the real issues are deviation from USGA specifications in materials and construction of putting greens, inexperience in their management, and the erroneous notion that USGA greens can tolerate much higher stress levels than can push up greens.