Trees--

(Continued from Page 19)

one must remember that trees also compete with trees. It is entirely appropriate to mass trees in some areas, perhaps to create definition or separation. However, stand-alone specimen trees also are desirable and can have dramatic visual impact. It is not recommended to make every tree a specimen tree, but highlighting and exposing some of the better ones is certainly worthwhile. Golfers will be allowed to appreciate a magnificent tree they might otherwise completely overlook.

Many courses have hidden specimen trees that are worthy of exposing and highlighting. Stop for a moment and try to recall your favorite golf course trees. More than likely, you are recalling trees that are 75 or 100 years old or more and are exposed and uncluttered with other plant material.

Tree spacing also should be carefully checked. Trees planted too closely will be sickly, stunted, and deformed, and they will never be able to achieve their full potential. Even if there are no specimen trees involved, culling out the less desirable trees may be worthwhile. The turf and the remaining trees will benefit from the reduction in competition, which also may extend the life span of the trees. This type of tree work can enhance the appearance of the course since it amounts to "getting rid of the clutter." Reducing competition among trees and choosing potential specimen trees for the future is a wonderful gift for future generations.

High-Tech Sunlight Assessment

For critical areas where safety and/or particularly valuable specimen trees are involved, it might be worth utilizing a high-tech sunlight assessment technique. It takes all of the guesswork out of tree removal and can predict how much light will be gained by doing specific tree work before the work is actually done.

Concentrate on Quality Rather than Quantity

That golfers love to plant trees is a simple fact of life. Planting a tree is to leave a lasting mark on the landscape of our courses. Memorial trees are especially popular, particularly because of the emotion associated with the loss of a loved one. Unfortunately, memorial tree programs can result in emotional and indiscriminate tree planting. When the number of monuments or plaques that often accompany memorial plantings accumulates, it can create an undesirable cemetery-like feel.

It must be noted that a comprehensive tree program must also include planting trees, but all potential plantings should be reviewed in the same manner as suggested for reviewing existing trees. Few programs can ruin a golf course more quickly than overzealous tree planting. There clearly are many valid reasons for planting trees, but a good rule of thumb is to **"Never plant a tree without a specific purpose in mind."** Remember, planting trees can be expensive, but the costs for years of care, leaf removal, and eventual removal are much higher. Overplanting is an expensive mistake that future generations have to bear. Most courses would do well to concentrate on quality rather than quantity when it comes to planting trees.

Conclusion

By now, some readers may be chomping at the bit to get out their chainsaws. So, should you go out blindly and begin cutting trees down? No, but you should undertake a systematic and unemotional review of your trees. Once the review has been completed, develop options for scheduling the needed work. Utilizing large-scale land-clearing equipment, some courses have removed several hundred trees in just a couple of weeks. Other courses take a more conservative approach and spread the work out over several fall and winter seasons. Since tree removal work can be upsetting to golfers, it usually is best to schedule it for the off-season.

In all likelihood, much of the work needed will be straightforward. However, there may also be some very difficult decisions to make along the way. Removal of the "no-brainers" is a good place to start. These are the trees that have no redeeming features, and getting them out of the way first usually makes the tough decisions easier. These might be trees of the wrong species or ones located where they are interfering with turfgrass health or playability.

Next, look for any specimen trees that might exist on the property. If they are in good health, have a reasonable life expectancy, and make sense architecturally, carefully cull out the competing trees to expose the better ones. Trees take a long time to grow, and there is nothing wrong with having to come back and revisit some of the more complicated situations.

Ultimately, the goal of a thorough tree review is to promote healthier turfgrass and better playability. Properly carried out, this comprehensive program also will create a better stand of trees.

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Sand-Based Rootzone Modification with Inorganic Soil Amendments and Sphagnum Peat Moss

Current player volume and maintenance practices call for research into changes in putting green construction materials.

By CALE A. BIGELOW, DAN BOWMAN AND KEITH CASSEL

"The pace of golf activity and traffic on golf courses is presently at a peak which has never been equaled. Many of our construction methods that were satisfactory before, will no longer produce greens which will withstand the wear now imposed upon them."

THESE WERE THE WORDS that prefaced the 1960 Green Section specifications for a method of putting green construction. Although we have had a widely accepted system for constructing putting greens for nearly 40 years, it seems that the same words also hold true today.

Four years ago, in an effort to further understand and improve putting greens, the USGA supported a series of scientific research projects at universities across the United States. One of the projects, entitled New Materials and Technologies for Putting Green Construction, was conducted at North Carolina State University. In this study we evaluated a variety of materials that could be used to amend sands used in putting green construction.

Basic Principles of Sand-Based Rootzones

Since 1960, the most widely accepted method of putting green construction has specified a high sand content rootzone. Sand is well suited for high-traffic areas like putting greens because it resists compaction, drains quickly and maintains good aeration properties. Also, it is relatively inexpensive and generally is available most anywhere. Although sand is a good substrate for putting green rootzones, it does have limitations, most importantly poor water retention and nutrient retention.

To correct these deficiencies, sand has most often been amended with peat moss *(Beard, 1982)*. Although peat moss may be the frequently used soil amendment for putting greens, other materials may also be suitable. As with any organic material, peat moss decomposes over time. This gradual decomposition may adversely affect the rootzone physical properties and this, in turn, may contribute to poor performance of turfgrasses grown on these declining rootzones. Turfgrass researchers have evaluated many inorganic soil amendments for sand rootzone construction with mixed success *(Waddington et al., 1974; Schmidt, 1980; Ferguson et al., 1986; Nus and Brauen, 1991; Kussow, 1996; Carlson et al., 1998; McCoy and Stehouwer, 1998)*.

Renewed interest in inorganic soil amendments has resulted in many products being marketed for turfgrass areas. A few of the more commonly used inorganic soil amendments are the porous ceramics, diatomaceous earth, and zeolites. Some of the characteristics of these products that potentially make them desirable for improving the properties of sands are a large internal porosity that results in water retention, a uniform particle size distribution that allows them to be easily incorporated, and high cation exchange capacity that retains nutrients. Therefore, research exploring the suitability of newly marketed inorganic soil amendments that are not subject to biological degradation, but still provide water and nutrient retention, would be worthwhile.

Considerations Before Selecting an Amendment

Before deciding on which amendment to use for improving the properties of a particular sand, you should consider a few questions. What effect will the amendment have on the overall particle size distribution of the rootzone mixture? Too many coarse or fine particles is undesirable. What impact will the amendment have on the chemical properties of the sand? Some amendments may dramatically change the soil pH or contribute unwanted nutrients. How stable is the amendment? Will it physically or biologically degrade and potentially clog up the drainage pores of the rootzone mixture? Lastly, it is important to consider availability and cost. An amendment could have the best physical and chemical properties in the world, but if it needs to be shipped across the country the benefits may not warrant the cost. Since all amendments do not have identical characteristics, an overview of some of the major properties of the more commonly marketed amendments follows.

Types of Amendments

There are essentially two major classes of amendments: 1) organic materials, which are derived from decomposed plant materials, and 2) inorganic materials, which are mineral based.

Organic materials are typically inexpensive and, depending on the origin, may be somewhat short-lived in the rootzone. The benefits of adding organic matter to most any soil

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are numerous. It does an excellent job of enhancing soil structure by improving aggregation and can be an excellent substrate for microbial growth. Increasing aggregation also enhances soil aeration, which may ultimately improve turfgrass health.

In addition to the structural benefits, most organic matter can hold several times its weight in water. When taken advantage of in coarse-textured soils, this property can greatly improve moisture retention. A certain amount of organic matter improves the resiliency or the ability of soils to withstand traffic.

In addition to improving soil physical properties, organic matter may have moderate nutrient-holding capacities, depending on soil pH. If an organic material is used for soil modification, it is important to use well-decomposed materials because they are more stable and less likely to negatively impact the physical properties that you have worked so hard to achieve.

Inorganic materials are derived from large, naturally occurring mineral deposits, and these products are generally mined from the ground. These products range from low to high in cost, depending on the particular material and its availability. Several inorganic materials have been marketed over the years for soil modification. Some of the more commonly used products include: calcined clays, porous ceramics, expanded shale, diatomacous earth, and the zeolites.

Calcined clays, also marketed as porous ceramics, are products that have been heat treated at a very high temperature (1000-1800°F). This heating increases the structural integrity of the particles while retaining their chemical properties. Once calcined, most products are often screened to a uniform particle size that makes them well sized for use in putting green rootzones. Since these products are clays by nature, they also have a very high inherent moisture-holding capacity. This high moisture retention is the result of many small internal pores. Earlier research has suggested that particles comprised of many small pores may hold moisture so tightly that it may not be available to plants *(Davis et al., 1970)*. Another benefit of these clay-based minerals is that, because they are clays, they have some nutrient-holding capacity, particularly for cations like the ammonium (NH_4^+) ion.

Diatomaceous earth is a material that has been mined from deposits of diatom shells. Diatoms are one-celled

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ocean organisms whose cell walls consist of interlocking parts and valves containing silica. The skeletons of these diatoms have a high degree of internal pore structure, and thus, like the clays, retain significant quantities of water. These products have been marketed with and without clay binders. The clay addition certainly affects the water-holding capacity of the product. Like the clay-based amendments, the availability of water to plants and the long-term stability of these materials is not fully understood.

Zeolites are a relatively new class of amendments being widely used for turfgrass rootzones. The main attraction of zeolites is that they are tremendous absorbers. They have long been used in removing environmental pollutants and in many industrial processes. Some zeolites have even been fed directly to livestock to improve gastrointestinal performance. The use of these minerals in turf has become popular because they have a strong affinity for cations. In fact, the cation exchange capacity (CEC) of some zeolites has been measured at 200 cmolc/kg or more *(Ming and Mumpton, 1989)*. For comparison, the CEC of quartz sand is < 1 cmolc/kg. Zeolites do have internal porosity and hold significant amounts of moisture, but generally do not retain as much as the clay-based products.

The primary interest in using these materials is for improved nutrient retention. Several university studies have documented dramatic reductions in fertilizer needs in zeolite-amended sands (Nus and Brauen, 1991; Huang and Petrovic, 1994). Currently, some of the zeolite products are being sold "pre-charged" with fertilizers. Applications of these zeolites may be like applying fertilizer and improving CEC all at once. Theoretically, the plant is able to use the fertilizer contained in the zeolite, and it can be "re-charged" by subsequent fertilizer applications.

One precaution when selecting a zeolite is that some of the zeolites may have rather high residual sodium contents, which is harmful to turfgrasses in large quantities. Therefore, before purchasing a zeolite, it is advisable to determine how much, if any, sodium may be present. As with the other amendments, the long-term particle stability under turfgrass cultivation and freeze-thaw cycles is still undefined.

Materials and Methods

Experiments were conducted to examine the suitability of several commercially available inorganic amendments for use in sand-based rootzones. Specifically, amendments

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were tested to determine their effect on the physical properties of three contrasting sand size classes and their ability to limit nitrogen leaching. A locally available quartz sand was mechanically screened into three uniform size classes (fine: 0.1-0.25 mm, medium: 0.25-0.50 mm, and coarse: 0.5-1.0 mm). Five amendments (two porous ceramics: Profile and Greenschoice; a diatomaceous earth containing a clay binder: Isolite; a clinoptilolite zeolite: Ecolite; and sphagnum peat moss) were studied. Amendments were tested at two rates (10% or 20% by volume).

The following physical properties of the amendments, sands, and the respective rootzone mixtures were measured: particle size distribution and density, water retention, bulk density, and saturated hydraulic conductivity (percolation rate). Nitrogen leaching was determined using amendments mixed with a predominately medium-sized sand. Rootzone mixtures (12" deep) were installed in acrylic cylinders placed above a 4" layer of gravel, saturated and drained for 24 hours. A liquid solution of ammonium nitrate, equivalent to 1 lb. of N per 1,000 sq. ft., was applied to the surface of the rootzone mixtures and leached with distilled deionized water. The effluent was collected and
analyzed for the presence of ammonium and nitrate.

In addition to the laboratory analysis, a field study was conducted to determine the effect of some of the amendments on creeping bentgrass establishment when mixed at 10% by volume in a medium-sized sand. The sand/ amendment mixtures were installed into field plots constructed according to USGA guidelines (USGA, 1993). The experimental greens were then seeded to creeping bentgrass in October of 1997 at the Turfgrass Field Laboratory in Raleigh, N.C. Creeping bentgrass establishment was rated visually by percentage ground cover until full coverage was achieved. Due to space limitations, only a portion of the data collected in the entire study will be presented in this article.

Results and Discussion

Physical Properties

Porosity and Water Retention: Sand size significantly affected porosity and water retention. Fine sand had the greatest total porosity of the three size classes but was not significantly differend from medium sand, which was similar to coarse sand. Although fine sand was similar to medium sand for total porosity, the pore size distributions and inherent water retention were very different. Fine sand con

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