Managing Fertility in High-Sand-Content Greens

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ONE OF THE MOST significant changes in golf course management during the past 30 years has been the switch from the use of topsoil for putting green construction to the use of materials consisting predominately of sand.

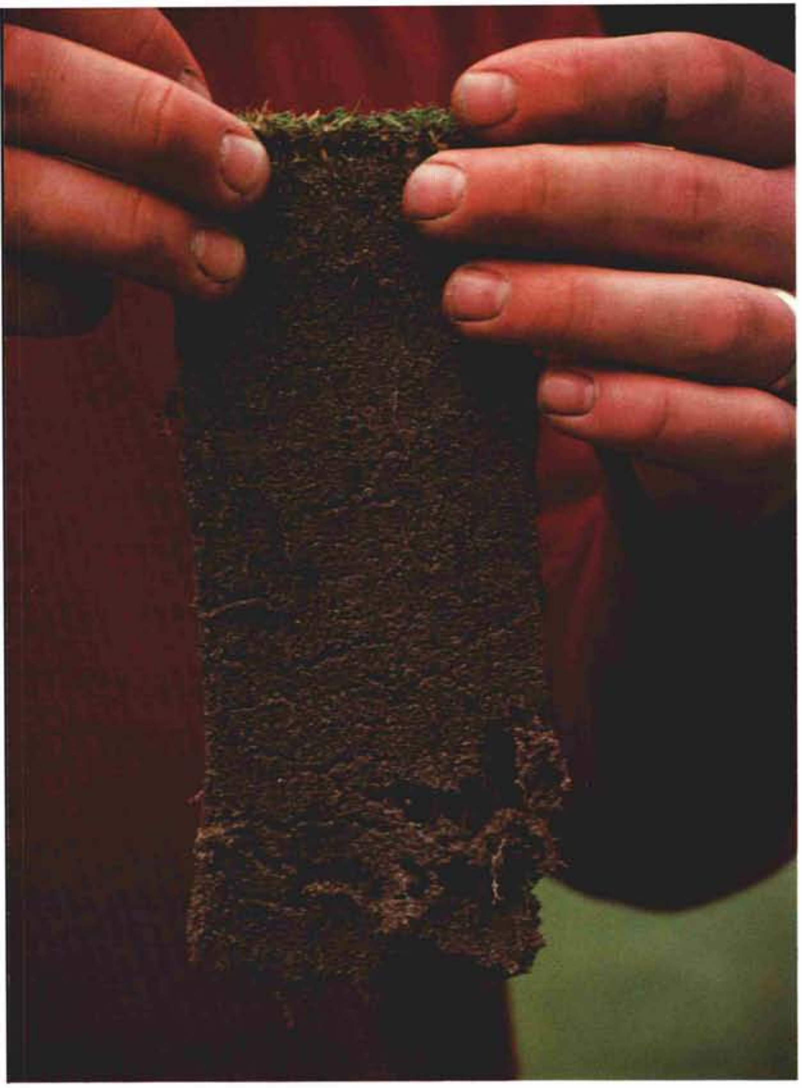
This year marks the 30th anniversary of the publication of the USGA Green Section *Specifications for a Method of Putting Green Construction.* At the time of their introduction, these specifications were considered a radical departure from green construction methods that had endured for decades. The specs advocated lighter, sandier soils with lower bulk densities, higher infiltration rates, greater soil aeration and lower moisture retention than the traditionally blended soil-based greens of that day.

Prior to these specifications, greens were typically constructed with mixtures of sand, topsoil, and peat at 1-1-1 or 2-1-1 ratios. Very little consideration was given to the type of sand, soil, or organic matter used. Further, greens were often intentionally underlaid with a thick layer of clay to hold water. At that time, irrigation systems were in their infancy, with hose and sprinklers being the norm. Compaction from heavy play was of little concern because courses simply did not receive the amount of traffic they do today.

These old 1-1-1 mixes were based on general guidelines handed down over the years that utilized blends of manures, composts, sharp sands, etc., all part of the art of putting green construction of that era. Sometimes they worked; sometimes they did not.

The USGA Green Section specifications were an attempt to put numbers on the physical characteristics of a good

Striping due to phosphorus deficiency!



(Left) Sandy mixture meeting USGA specifications.
(Below) Old-style topsoil-based green. Different soils require different fertility programs.

quality putting green topmix. A properly sized sand, with the appropriate distribution of small and large pores, is the key to a putting green topmix that handles traffic and drains excess amounts of water, yet in combination with a small amount of soil and organic matter retains enough moisture to grow good turf under the widest range of environmental conditions.

Today, many greens built by architects and builders consist only of washed sand and organic matter. Should these sand/organic mixes be prepared with soil to provide some silt and clay? The anwer is yes; putting green mixes should contain some silt and clay to improve nutrient availability, increase water-holding capacity, and help minimize the potential for severe damage from diseases like take-all patch.

Sometimes the silt and clay are added by way of a separate soil source. Sometimes they come from the use of a dirty sand or from the organic matter source. A maximum of 5% silt and 3% clay is considered the standard for USGA spec greens.

High-sand-content greens have become the standard throughout most of the world because of their ability to drain well and resist compaction. However, many golf course superintendents have difficulty growing good turf on these greens for several years after establishment. Usually, the problem is a lack of understanding of the fertility requirements of high-sand mixes.

Maintaining Adequate Fertility Levels

How much fertilizer is enough for new sand-based greens? This is not an easy question to answer. Compared to topsoil greens, much greater amounts of fertilizer are needed to develop and maintain good growth on high-sand-content greens for the first couple of years. Much depends on how quickly the profile drains. A green which has a percolation rate of 12 inches per hour has the potential to leach more nutrients than a green that drains at 1 inch per hour. This is common sense.

Another important factor is the Cation Exchange Capacity (CEC) of the mix. This number is often overlooked when studying a chemical soil test and when determining how much or what kind of fertilizer to use on a green. The CEC is the measure of that soil's ability to hold nutrients. A soil with a CEC of 10 has twice the nutrient retention ability of a soil with a CEC of 5. Obviously, a soil with a low CEC will often require more fertilizer, more applications of fertilizers applied at lighter rates, and greater use of slow-release fertilizer than a soil with a higher CEC value.

A fertility program that works well for one golf course may not work the same for another course that has a different soil with a different Cation

Exchange Capacity. That's why it is so hard to be specific with soil fertility requirements when establishing new greens.

As a basis for comparison, straight sands with very little silt and clay often have CECs of 2-3 or less. This is very low. Sands blended with a high-quality fibrous organic matter with traces of silt and clay often have CECs of 5-6. This is a common range for CECs in new construction. In contrast, native topsoils have CECs in the range of 12-18, if not higher. Thus, recognizing that soils vary in their abilities to hold nutrients provides the basis for a better understanding of chemical soil test results and formulating a fertility program for high-sand-content greens.

Nitrogen

Nitrogen use rates on new sand greens should be high, beginning with the seedbed. To speed the establishment of new greens, USGA specifications suggest 2 lbs. of nitrogen per 1,000 sq. ft. be added to the seedbed before planting — 1 lb. of nitrogen as a quick-release fertilizer containing phosphorus and potassium as well as nitrogen, along with 1 lb. of nitrogen as a slow-release organic product.

After planting and during the initial growing-in phase, applications of 1 lb. of actual nitrogen per 1,000 sq. ft. per week for at least six weeks is a common and usually reasonable recommendation. As the grass matures, rates and frequencies should be reduced. Nonetheless, the first year totals for nitrogen in new greens could well seem ridiculously high compared to maintenance fertility levels for mature greens.

After the green has matured, maintenance fertility levels in sandy soils are typically about ½ lb. of actual nitrogen per 1,000 sq. ft. per growing month. This can vary due to several factors like CECs, infiltration rates, the amount of irrigation/rainfall, traffic, etc. To some, this may still seem like too much nitrogen, especially when ultra-light fertility programs in vogue a few years ago are recalled. While it is true that older topsoil-based greens can still be fertilized at low rates, this is not the case for new sandy soils. More nitrogen is needed, especially during the initial phase of new putting green establishment. In fact, the lack of adequate fertility is one of the most common problems in the maintenance of new sand-based greens.

All too often the grass establishes as it should and then, after the initial growth slows, the grass becomes thin, shallow rooted, and stalky. These are signs that the green has run out of fertility.

Phosphorus

For years, we have been told that phosphorus is not needed on putting greens. Soil tests often show excessive levels of phosphorus, and besides, we were warned that high levels of

Poor mixing of a sand/peat green only complicates fertility management.

phosphorus stimulate *Poa annua*. This may be true with golf greens constructed of topsoil, but the story changes when dealing with soils composed predominately of inert sand. The fact is, grass needs phosphorus. Topsoils can be rich in phosphorus, but sands are not. Further, while phosphorus is not mobile in heavier-textured topsoils with their naturally higher CECs and slower drainage rates, phosphorus can move in sands with their much lower CECs and rapid drainage.

Do not forget phosphorus. As a general guideline, 2-3 lbs. of actual phosphorus per 1,000 sq. ft. per year as a maintenance fertility level is reasonable. Also, high phosphorus "starter" fertilizers are recommended during establishment. These fertilizers should be raked into the seedbed. Thereafter, periodic soil tests should let you know for certain the extent to which phosphorus needs to be applied to sand-based greens.

By the way, the link between phosphorus and *Poa annua* stimulation is exaggerated and is secondary to the need to grow a strong, healthy stand of turfgrass. The best weed control, including *Poa annua*, is to develop a dense stand of grass. Proper fertility should provide the density which helps contain the *Poa annua*. Sandy soils need adequate phosphorus fertilization.

Potassium

Recent research, in conjunction with field observations, is showing just how important it is to maintain adequate levels of potassium in sandy soils. Potassium is nearly as prone to leaching and luxury consumption as nitrogen. In sandy soils with low CEC values and high percolation rates, potassium needs to be applied at nearly the same rates as nitrogen. Since most sandy soils are naturally low in potassium, a ratio of 1.5 lbs. of potassium to every 1 lb. of nitrogen applied during the growing season is not unreasonable. Field experience and periodic soil tests (at least once per year) should help determine adequate potassium levels and application rates.

One final point. Because grass exhibits luxury consumption of both nitrogen and potassium, periodic applications at light rates are preferable to infrequent applications at heavier rates.

Soil Reaction — pH

Maintaining soil pH in a reasonable range is recognized as being important by all turfgrass managers and scientists, regardless of the type of soil. This can be a special challenge in sandy soils, with their inherently low CECs and low soil buffering capacity, especially when the greens are young. Big swings in soil pH and nutrient levels are common in new greens. Fortunately, these peaks and valleys tend to soften as a green ages. For example, the addition of a small amount of elemental sulphur can radically change the pH of a new sand soil. Strive for a middle-of-the-road approach to pH management. Maintaining pH in a range between 6.0 to 7.5 is reasonable and is no great cause for concern, especially during the first few years following a green's construction.

Also, when soil tests are done, include the test for buffer pH. Standard pH tests tell you the pH of the soil solution, whereas the buffer pH is more representative of the true pH of that soil. A rainfall can affect the pH of the soil solution, but it will not change the buffer pH.

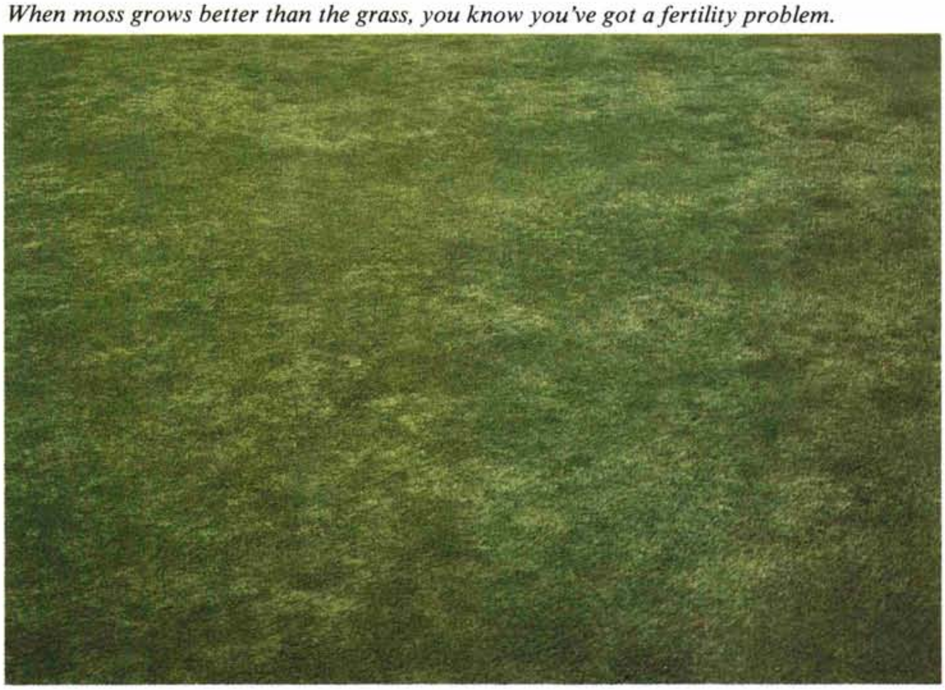
Low pH levels should be slowly raised by light applications of lime, never exceeding 25 lbs. per 1,000 sq. ft. per application. Lighter rates applied more often is preferred to burying the greens in lime.

Similarly, pH values above 8.0 should be managed carefully and slowly with sulphur or, better yet, fertilizers which naturally create acid as they break down. The Calcium Carbonate Equivalent on every bag of fertilizer is one way of measuring how much acidity is created by that particular fertilizer product. If the bag states 640 lbs. Calcium Carbonate Equivalent, then it takes that amount of lime to neutralize the amount of acid that is formed by the fertilizer. On high-pH greens, you can use this value to good advantage in lowering pH without running the risk of burning the turf, which sometimes can occur with granular applications of elemental sulphur.

In my opinion, the use of elemental sulphur to lower soil pH levels can be overdone, especially if the sand used in the original construction of the green is calcareous. Lowering the pH level in this type of soil can be an exercise in futility. Yes, you can change the pH of the soil solution, but it is nearly impossible to overcome a high buffer pH soil such as those constructed with calcareous sands. The best advice to superintendents who must deal with calcareous sand greens is to learn to live with it. Keep a close watch on nutrient levels in these greens, especially iron, and make adjustments accordingly.

This is an important point to consider when choosing a sand for new construction or topdressing. Hard rock or

When moss grows better than the grass, you know you've got a fertility problem.



silica-based sands, which are nearly neutral, are preferred over high-pH calcareous sands. Sometimes there is no choice. However, if there is a choice, the long-term management of nutrients and soil pH is far easier in neutral or slightly acid soils than in high-pH soils.

Micronutrients

Much has been said about the value of micronutrient applications on high-sand-content soils. Actually, the only micronutrient deficiency in sand-based greens that we have identified in the field is for iron. This problem is worse in high-pH sand greens, where iron availability is poor. Beyond this, evidence suggests that heavy use of micronutrients probably is not needed. Prudence would suggest, however, that in sandy soils with low CECs, micronutrient applications be made periodically to satisfy micronutrient requirements. Again, the exception is iron, which should be applied lightly and on a frequent schedule.

In Summary

In the past decade or so there has been a trend in our industry toward low levels of fertility on golf greens. On older topsoil-based greens, about 2-3 lbs. actual nitrogen per 1,000 sq. ft. per year has been successful in many instances. It should be appreciated that these low fertility levels are best utilized for topsoil-based greens and not sand greens. Extremely low fertilizer rates are not appropriate for the growing-in phase of new golf greens or for their follow-up maintenance. This is why so many turf managers are hesitant to apply enough fertility to new greens; they simply are not accustomed to applying that much fertilizer!

Look at your new greens. Do they have good roots, good density, reasonable color, and a developing thatch layer for good resiliency? If so, then you probably are on the right track.

By contrast, is the grass shallow-rooted, thin, coarse bladed, prone to spike marks, and speckled with invading *Poa annua*? Does the grass lack density, color, and an appreciable thatch layer? If this is the case, then your fertility program may be too low.

Consider all of these points. If you do have any questions, call your local USGA Green Section agronomists for advice. Once you become accustomed to the higher rates of fertility required by them, sand greens become far easier to manage than the old greens they replaced.

Environmental Fate of Common Turf Pesticides — Factors Leading to Leaching

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PESTICIDE users make a precarious decision every time they apply a chemical: Will residues of the chemical contaminate the groundwater or not? To complicate the situation, there is little information available to make such a decision and to guarantee its accuracy. Manufacturers are reluctant to elaborate on this. Scientists use predictive models to make educated guesses about potential residue movement. Though models are based on defined environmental factors rarely found in the same combination in the field, they remain the best available tool to assess the potential of a chemical for contamination of groundwater.

Most models are based on results of studies done in relatively small geographic areas. Consequently, they are most useful in areas for which they were developed. In other areas, different factors and combinations affect the accuracy of the results. Most important, the interpretation of results requires experience.

Despite considerable amounts of available information, the simple question, "Will compound X, when I use it, contaminate groundwater?" is difficult to answer. To illustrate the point, a sophisticated model was chosen to suggest which of the compounds that had been used in the past on several golf courses on Cape Cod might have contaminated groundwater. The computer selected dicamba and suggested that chlordane would remain in the topsoil. Ironically, chlordane was found in water samples (GC/MS analysis), and dicamba was not. This is an extreme example and is not intended to discredit the use of models.

However, the user needs an answer, and there are situations where quick answers are needed to assess the potential for groundwater contamination. In these cases, good knowledge of local soil and weather conditions (environmental factors) in combination with some basic information about the chemicals involved (compound-related factors) provides the basis for a quick and reasonably good assessment of a field situation.