The Agronomics of Sand in Construction and Topdressing

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THE GREEN SECTION adopted a green construction method some 35 years ago that involved the principle of perched water tables. Since then we have seen a major evolution in the choice of components for the root zone mixture. Shortcuts in construction, however, have been tried and failed. The most important change has been the recognition that despite the agronomic benefits of some early mixtures, the playing surfaces were hard and required several years to mature. The automatic drainage system provided by the perched water table procedure remains the same.

As their basic concept, Green Section greens were to provide an alternative to the historic construction method of blending equal parts of sand, topsoil, and organic matter, with or without drainage, and set it atop any kind of base material. First, good topsoil had become hard to find. Second, the manures that keyed the composting operation weren't available in most regions. Finally, time became a limiting factor, because the demand for new courses forced builders to speed construction, eliminating any possibility of composting.

Simple mechanical mixtures, such as the 1-1-1, created easily compacted greens that could not withstand heavy play. When the greens became hard, they were softened by irrigation. That led to further compaction, so that any remaining voids in the soil became filled with water. This lack of soil oxygen severely restricted root growth, weakening and thinning the turfgrasses and almost inviting invasion by *Poa annua* and other weeds. *Poa annua* encroached because its root system could support its growth in shallow soils.

Because of the poor performance of bentgrasses in these soils, summer mowing heights were raised from a standard 1/4 inch to 5/16 inch, or even higher. Championships were then played at 3/16 inch. That often required a major maintenance effort by the golf course superintendents. Motorized aeration tools were invented to relieve compaction and allow better oxygen exchange. New agricultural chemicals were applied to greens just to keep the grass alive, much less flawless.

To keep greens affordable by all, laboratory standards were developed by which the agronomic requisites of root growth could be met by proper blends of

Figure 1: A potential black layer? Excellent root growth in this new green shows strong early turf development. Note the layer of original top growth that was buried by topdressing. This will require spiking or aeration to break up the layer of organic matter before it has the chance to inhibit water movement and become a black layer.

almost any sand, soil, or organic matter source. There was only one hitch. The greens were hard. They produced a satisfactory turf cover, but the golfer often had to play pitch-and-run shots, until a cushion of 1/2 inch or more of organic material built up on the surface.

Through the ensuing years, many concrete sands and most mortar sands have been eliminated from green construction, because the particles of fine gravel in them have usually produced surfaces unreceptive to even well-hit golf shots. Broad ranges of particle sizes are not desirable either, since they can fit together so tightly they leave no room for movement, and greens built with these materials can also become hard. In either case, it is distressing to have to grow a deep layer of thatch on a new green surface before it becomes receptive to a well-hit golf shot.

THE FINE-GRAINED sands at the other end of the scale also produce hard greens. The small pore spaces between the fine particles are easily clogged by silt, clay, or organic matter so that water percolation is slow, and the soil oxygen supply is restricted. Capillarity in fine sand profiles helps retain large quantities of water against the pull of gravity, and pores filled with water preclude air space.

During these years of evolution, the Green Section staff and consulting soil scientists developed a short, concise paper, "Sand for Golf Courses," printed in GOLF JOURNAL, May 1974. In it, the recommendation was made that sands used in green construction and in topdressing should have round particles ranging in diameter from 0.25mm to 1.00mm. Round medium to coarse sands, therefore, provide the narrow window needed for some water retention, adequate space for air, resistance to compaction, and the resiliency needed for golf play. The uniform sand grains seem to move about to become an excellent shock absorber, much like B-Bs in a bean bag. This gives the long-awaited receptivity to the surfaces of greens built with sand as the major component of the growing medium. Sand in this context is not just *any* sand (see Table 1).

In years gone by, we were looking in the wrong places. Industrial, not construction sand is a ready-made source. Casting sand, frac sand, and those known by other names are available in most areas. Some are even decalcified to achieve near neutral pH.

Using soil in green mixtures has become rare in recent years because of the relatively high amount of silt in some soils that in time interferes with the water and air movement into and through the root zone. The lack of soil in the growing medium, however, has a negative effect on its nutrient retention and buffering capacity. Having lost the forgiveness of soil, fertilization and chemical application must be carefully planned and executed. Nutrition management is, of necessity, not unlike hydroponic gardening. Even phosphorus is leachable in soilless greens.

Peat has become the substitute for soil and manure almost everywhere. Other regionally available products are in use as well, such as composted rice hulls and forest by-products. Their obvious use is for water retention, but they also provide some nutrient retention.

In some areas of the country, sand sources are highly calcareous, with a pH in the neighborhood of 8. This substantially reduces the availability of secondary or minor nutrients for uptake by grass roots. We know very little about the gross effect of a deficiency of these minerals on turfgrasses. Except for iron and perhaps magnesium, few, if any, have been visually identified in the field. The only substantive work on visible nutrient deficiency symptoms was done under laboratory conditions by Dr. J. R. Love, Roger Larsen, *et al* at the University of Wisconsin, in the early 1960s. Soil test results on available quantities of these nutrients are subject to question without accurate tissue analyses.

In practice, then, it appears that providing for the total nutrient needs of putting green turf remains a great guessing game. Nutrient retention is low in mixtures with low cation exchange capacity and high permeability. New sand greens require much higher nutritional levels until a cushion of turf has developed to withstand traffic and close mowing. Under alkaline conditions, it

Figure 2: The dark layer in sand topdressing is organic matter generated from plant growth and failure to begin topdressing.

Table 1.

Sand Particle Size Classification Table*

ASTM (Designation E-11) Sieve No.	Tyler Equivalent Mesh	Millimeter	Descriptive Size	
10	9	2.00	↑	
18	16	1.00	Coarse	
35	32	0.500	↓	The ideal particle size range for a USGA green is between 0.75mm and 0.25mm
60	60	0.250	Medium	
100	100	0.150	↑ Fine	
140	140	0.106	↓	

*Meaningful measurements for use in determining sand quality for construction and topdressing. Note that these sieve numbers vary from those published in GOLF JOURNAL, May 1974. The other data remain the same. A desirable sand, then, will pass through number 18 sieve (or 16 mesh) and be retained on a number 60 sieve (or 60 mesh), giving particles ranging *from* 0.25mm up *to* 1.00mm diameter.

Figure 4: The more aeration holes containing topdressing, the better will be the root penetration into the profile of previous soil mixtures.

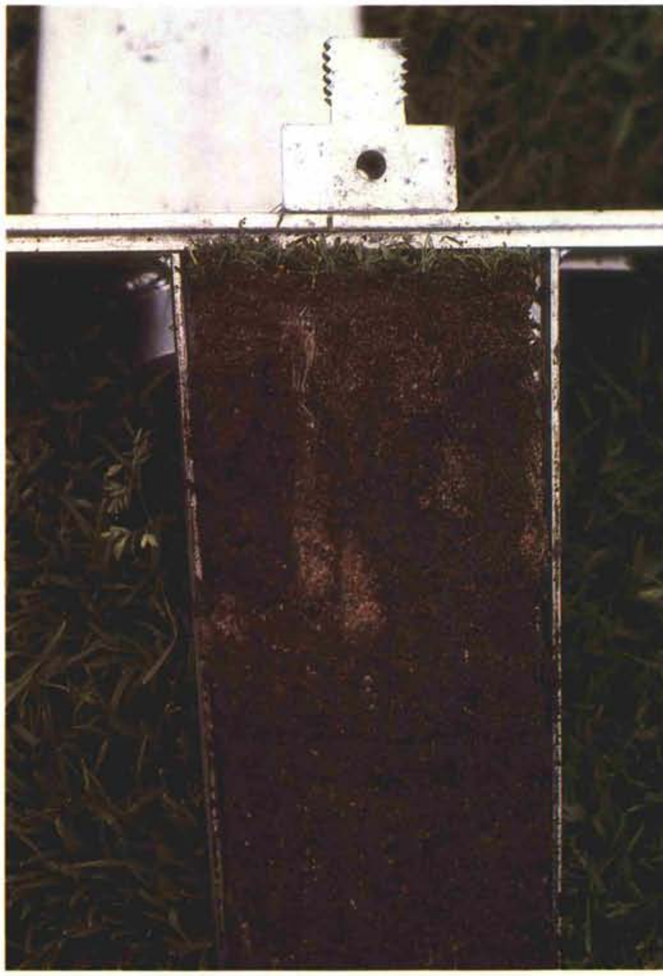

Figure 3: These are four topdressing materials used in 1987, showing a variety of opinions and products: Upper left, well-graded industrial sand, about 76 percent in medium ranges and the rest above 0.15mm. Upper right, same sand with 20 percent peat added. Lower left, same sand with 40 percent soil added. Lower right, a masonry sand. Imagine the quantity of the larger particles that will be removed in dragging and cleanup procedures.

may be necessary to rely principally on leaf feeding some nutrients unless trials *on turf* indicate that chelates or natural organics do, in fact, make them available to grass roots. Data extrapolated from horticultural plants growing on artificial rooting media may be misleading.

Sand on golf courses has had its most far-reaching effect in topdressing. Since the treatise on the subject by Madison *et al* in 1974, sand topdressing has been looked on as the potential remedy for most known putting surface ailments. It has, in fact, permitted the closely mown, high-speed, compaction-resistant, and shot-holding greens golfers expect today. There are exceptions to this, of course, but not many.

First, light and frequent topdressing provides a true putting surface. The topdressing material is the primary ball support, and the protruding grass blades create a live surface for ball control. Every application, in effect, raises the height of cut and permits more leaf growth while covering the stem stubble and dampening its tendency to cause the ball to roll erratically. Thus, putting trueness can be developed at most normal mowing heights independent of surface speed.

Straight 100 percent sand is widely used because it is easily applied and leaves no trash on the surface. It allows a dressing to be applied anytime during the day, with minimal displeasure to the golfer. If the sand is properly sized, brushes or upside-down carpeting can quickly and easily rub it into the turf surface. Sand is easily broadcast by spinner or oscillating spreaders for greater speed, so that frequent applications are feasible.

Frequency is a relative term, but in order to prevent stratification, keep the applications equivalent to the rate of grass growth. Layers of any kind restrict the downward growth of roots and percolation of water. Many years ago sand and/or soil layers were identified as major problems in greens. Even grass growth between infrequent topdressings can become troublesome when it is buried by subsequent applications. This is one cause of black layer problems that became famous in 1986 (Figure 1). Black layers have finally become visible in sands, even though they were described by O. J. Noer in poorly drained, dark-colored soil greens in 1934.

Since stratification affects both root growth and water percolation, it should be avoided in the root zone. Therefore, if topdressing is applied to match the rate of grass growth, layers are not likely to be formed. Madison felt that once a month was enough under the fertilizer regimes at the time, but by allowing five weeks between applications, an organic layer formed. To overcome interruptions in the program from weather and golf events, he suggested planning for three-week intervals, with the fourth as insurance.

HIS SUGGESTED rate of three cubic feet per 1,000 square feet has not been challenged, but it may be a bit heavy. It has been modified by those superintendents who use lighter applications at two-week intervals. Some rate-frequency modification may be necessary in cases where the turf growth is slowed by minimum nitrogen application. In this situation, turf damage is possible if the grass does not grow through the topdressing, particularly during hot weather. The goal is to match topdressing with growth, and to produce a layerless blend of topdressing and living turf.

Organic layers are most likely to develop in the early spring or late fall (Figure 2). The grass grows well during these times, but topdressing is often withheld until the first aeration in the spring. Then it is discontinued after the last treatment in the fall. It seems reasonable, then, that applications of topdressing should be made whenever there is a need for regular mowing.

There are several schools of thought on the use of additives to sands used for topdressing. Peat and/or sandy loam soil additives are prevalent in the Midwest (Figure 3). Some people just don't like the looks of straight sand. Others feel that sand alone tends to add to the wilt potential of the greens. As long as the additives provide the conditions necessary for good growth and optimum playing conditions, there is no cause for doubting their usefulness. It seems, however, that the grass itself can produce an adequate amount of organic matter by simply growing.

A popular mixture throughout the Great Lakes Region is a blend of 80 percent sand and 20 percent peat. In general, the quality of this peat is not well documented, and it often contains substantial amounts of silt, clay, and very fine sands that tend to clog the non-capillary pores in medium and fine sands. Further, the quantity of peat remaining after the dressing has been dragged and mowed is usually less than what had been applied. Larger particles do not fit into dense turf and are dragged, mowed, or washed off during the clean-up operations. The true percentage is never known and may, in fact, vary from one source to another, or from application to application, and could depend on whether the mixture was dry or moist.

There is, perhaps, a positive side to organic additives if they are active chemically or microbiologically. They may help to retain added nutrients or to make available some nutrients in the rooting medium. They may help sustain the activity of microorganisms needed to decompose raw organic matter (thatch). And they *may* help to neutralize, break down, absorb, or otherwise buffer the activity of the many complex pesticides applied to greens.

The generally low microbiological activity in sand profiles may well be a reason why localized dry spots frequently appear where sand is the principal component of the growing medium. If saprophytic fungi cause the condition and are feeding on the undecomposed plant tissue, then the normal population of soil microorganisms is evidently out of balance. The waxy coating on sand particles does not self-generate suddenly, and if it is not found in soil greens, soil microbiologists must answer a number of questions of more importance than what causes black layers. Sand and new pesticides are not solely responsible, however, because LDS was known and photographed on soil greens over 40 years ago.

FINALLY, there is some consternation from time to time about water movement through a sand profile built up by topdressing over the dense soil of old greens. The argument is that surface drainage took care of excess water from rainfall or irrigation on the dense soil mixtures. The sand layer over this old soil would hold the excess to give rise to anaerobic conditions, root loss, and devastation of the turf. If this hypothesis held any water, there would be more dead greens than live ones today.

Whenever core, cupcutter, or profile samples taken from greens are examined, the majority of the grass roots penetrating the lower soil are in the aeration holes, whether sand or a mixture is used for topdressing. It is apparent, then, that a change of topdressing materials should be accompanied by a rather intensive coring program (Figure 4). The holes, filled with the new dressing material, will provide some of the new roots with a uniform rooting medium even if it is only half an inch in diameter and a couple of inches deep. Roots grow into empty holes as well, but that seems only to concentrate organic matter, and if it is not adequately decomposed, it will lead to accelerated thatch development.

Any change in the texture of topdressing materials forms a layer that severely restricts the downward growth of roots and interferes with water and air penetration. For this reason a gradual change of texture between old and new materials is desirable. The simplest method to achieve a gradual transition is to begin with intensive early fall aeration when the cores can be shredded and blended with a relatively heavy topdressing with the new material. Repeating this procedure late the following spring should develop a transition zone between the different dressings and should minimize the impact of an abrupt change. Thereafter, light frequent topdressing can proceed on schedule, and plugs should be removed after future coring.

Greater problems are created when a change is made from coarse to a finer material, for example when sand is covered by a mixture containing peat and/or soil. This creates a perched water table just like a well-built green, where water does not move into the coarser material until the pull of gravity exceeds the capillary attraction in the small pores of the new layer. Since this layer is thin, the surface may remain wet for an extended time. When sand is laid over soil, however, water is absorbed, but at a slower pace.

Where infrequent sand topdressing has created alternating layers of sand and organic matter, future maintenance operations should be keyed to eliminating these layers. The old practice of spiking the greens could be revived. These machines put many small holes in the surface that will breach any shallow layers and give new root growth a better opportunity to penetrate. If spiking precedes topdressing, there is a better than even chance that some of it will be dragged into the small holes to maintain their integrity. Any shallow compaction by the spike tips will be minimized by the sand. Spikers are fast, easy to operate, easily fit into a sanding program, and do not disturb putting surfaces to any extent.

Greens that have been retained in the sand/soil/peat mode are certainly as up to date as any. They have performed up to the requirements of the golfers playing on them, or else the maintenance operations would have been changed by someone long ago. Credit must be given to the superintendents who have accomplished this in spite of the changes in the criteria for putting speed within the last 10 years, not to mention peer and publication pressure.

The evolution of sand quality and its use in construction is paying dividends today. Properly graded sand and high-quality organic matter, blended according to specific laboratory-derived recommendations, are producing very playable greens from the outset. These greens are receptive to well-played shots, and they respond positively to good maintenance operations. They are not an automatic success, but they produce the best playing quality attainable under present conditions. And light, frequent topdressing with the same mixture or with sand alone keeps them that way.