Dollars and "Sense" to Improve Soil Properties

Make rootzone amendment cost comparisons before the final purchase order is signed.

BY MATT NELSON

For the past 40 or 50 years, golf course putting greens have been constructed with predominately sand rootzones. Sand resists compaction, provides rapid drainage, and maintains good aeration porosity. Limiting factors of sand as a growth medium include low nutrient and water retention. To overcome these limitations, sands are commonly amended with organic material. Laboratory testing of the sand and various amendment choices identifies the proper ratio of each component for optimal performance and reduces the potential risk for problems. Over the past few decades, inorganic soil amendments have piqued the interest of turfgrass managers and scientists. Performance criteria and cost are important factors when choosing the proper soil amendment.

The most commonly marketed inorganic soil amendments are porous ceramics, diatomaceous earth, and zeolites. These materials have high water-holding capacity due to internal pore space, and some have a high cation exchange capacity (CEC) for nutrient retention. These are attractive attributes, but a research review is prudent to determine if these qualities actually result in improved turfgrass performance as compared to organic amendments. The next step is to determine if the benefits are cost-effective.

PERFORMANCE CRITERIA: WATER-HOLDING CAPACITY

Inorganic soil amendments are characterized by having a large volume of internal pore space that confers a high water-holding capacity. Evidence suggests that much of this water is held too tightly and thus remains unavailable for plant use,[1,4,24] although McCoy showed that water held by calcined clay and diatomaceous earth might be more available than previously thought.[12] This could be important during periods of extreme moisture stress, but would be less apparent under normal maintenance conditions. Studies by Bigelow et al. indicate that sand particle size and architecture play a more important role in water availability than the internal pore space of soil amendments.[1] Bowman showed that peat retained more water than any inorganic amendment tested and, comparatively, released water more gradually at all tensions.[1,4]

Anecdotal evidence from the field suggests that inorganic amendments are useful to alleviate localized dry spot when incorporated into the upper soil profile via core aeration and topdressing. This has yet to be substantiated with replicated, independent research at multiple sites. A topdressing study conducted at Iowa State University showed that none of the inorganic amendments tested had a significant effect on the amount of dry patch compared to the sand/peat control,[13] while researchers at Missouri found that topdressing with porous ceramic clay reduced dry spot incidence and facilitated turf recovery.[14] An Auburn University study demonstrated a negative effect on rooting when a calcined clay product was added to a creeping bentgrass rootzone via aeration and topdressing.[8]

NUTRIENT RETENTION

Another important aspect of amendments to sand is nutrient retention. Sands have low cation exchange capacity (CEC), and amendments are used to hold more nutrients in the rootzone. This is especially important during turfgrass establishment when nutrient leaching potential is greatest. Several studies have shown that none of the inorganic amendments available today are any more effective at reducing nitrate leaching than peat moss.[1,4,19,21] Zeolites have very high CEC and have been shown to improve potassium retention in the rootzone,[10,16,22] yet research also has shown that peat was more effective at improving nitrogen and potassium recovery in the plant compared to zeolite.[19] Sodium retention may present a problem in sites where salinity and sodicity are issues.[20] With respect to preventing leaching losses and retaining nutrients for plant growth, it appears that organic matter amendments remain superior or equal to inorganic products.

TURFGRASS ESTABLISHMENT

As mentioned previously, sands are most prone to nutrient loss from leaching during turfgrass establishment. As the turfgrass stand matures, plant productivity results in an increase of soil organic matter and a corresponding increase in both nutrient retention and water-holding capacity. Unamended sands typically present challenges for turfgrass establishment, requiring more water and fertilizer than amended sand. Several studies have indicated that peat moss as an amendment is superior to inorganic materials with respect to establishment rate.[2,3,4,26] Conflicting reports exist regarding the influence of zeolites on the rate of turfgrass establishment.[17,21] Zeolite and sphagnum peat

Building putting greens is a costly endeavor, involving specified materials and several construction steps. Soil amendment selection can significantly affect the bottom line.

were found to have similar microbial community structure, thus refuting the claim that zeolite will promote early microbial activity in a sand rootzone compared to traditional organic matter amendments.[6]

LONG-TERM QUALITY

The long-term effects of using an inorganic amendment in putting green construction remain largely unknown, and additional studies are needed. The mechanical and chemical stability of inorganic soil amendments is a concern, as breakdown of these materials could conceivably result in reduced porosity and performance. More long-term study is needed to evaluate the effects of amendment breakdown and physical performance of the rootzones and turf. However, a five-year rootzone study at Rutgers University indicates that turfgrass quality differences between amendment treatments are becoming less apparent with time.[16] A likely explanation is that as the turf matures, the developing thatch/mat layer becomes the limiting factor with respect to water infiltration, gas exchange in the rootzone, and correlating turfgrass vigor.[16,21] Proponents of inorganic amendments argue that the benefits of an inorganic amendment will last over time as compared to peat, which decomposes rapidly. There is no research evidence that demonstrates rapid degradation of peat in the rootzone, but rather evidence that suggests peat will last much longer than other organic matter sources.[24] Organic matter also accumulates in the rootzone as the turf matures. Look around the maintenance facility and take note of how many tools are designed for organic matter removal! Water-holding capacity and nutrient retention are rarely problems for established greens; thus, soil amendments appear to be less important after the first few years of establishment. Gibbs et al. did not demonstrate that zeolites encouraged deeper rooting over the long term.[7]

DOLLARS AND SENSE

The soil amendment debate essentially can be reduced to cost-effectiveness. Recent university research shows quite clearly that none of the inorganic soil amendments evaluated provide any significant agronomic benefit as compared to peat.[1,2,4,16,21,26] There seems to be an inherent desire for *bigger, better, faster, or more sophisticated* products in almost every facet of our industry. While inorganic amendments may appear attractive based upon certain attributes and production methods, research has yet to validate any major performance advantage over traditionally used organic amendments. And when it comes time to put pencil to paper for a construction project, the type of amendment selected can significantly influence the bottom line.

The following example of a golf course construction project is based upon average costs for sand, inorganic amendments, peat, and blending. Obviously, trucking costs significantly alter these figures, depending on where the inorganic amendment must be shipped. The cost of peat varies less (range of approximately $80 to $110 per 4 cu. yd. bale of sphagnum peat) than most inorganic soil amendments throughout the country; thus, transportation costs are not as significant. This example project requires 6,000 cu. yd. of rootzone mixture, which assumes approximately 140,000 sq. ft. of putting greens with a 12 in. deep rootzone, plus a waste factor of 10-20%.

Assuming a 90:10 rootzone construction blend of sand:peat by volume, 600 cu. yd. of peat is needed since peat does not displace any significant amount of sand when mixed (you still need 6,000 cu. yd. of sand). We assume the cost of sphagnum peat is $105 for a 4 cu. yd. bale. If 150 bales are required for this project, the total cost of peat is $15,750. Sand weighs approximately 1.35 tons per cu. yd; thus, 8,100 tons of sand are needed. Dividing $15,750 by 8,100 tons of sand equals a cost of $1.95 of sphagnum peat per ton of mix. Using reed sedge peat could increase the cost of peat to as high as $4.50 per ton of mix. Laboratory testing is a critical component of the construction process to identify the most suitable organic matter amendment for the sand used in construction.

An average blending cost of materials ranges from $2.50 to $3.50 per ton. The cost is the same, regardless of the amendment type. Blending costs approximately $24,300 in this example, using an average blending cost of $3 per ton.

A long-term rootzone study at Rutgers University is addressing the role of various organic and inorganic soil amendments in turfgrass quality and performance.

Sales tax is another important consideration, and for this example we will assume a sales tax of 5%. If the delivered cost of the sand is $25 per ton at 8,100 tons, peat is $105 per bale at 150 bales, and blending cost is $3 per ton for 8,100 tons, the tax would be $10,125, $788, and $1,215, respectively ($12,128 total tax). Thus, the *total cost* of materials for this putting green construction project utilizing a 90:10 blend of sand to sphagnum peat moss is $254,678 ($212,625 for sand + $16,538 for peat + $25,515 for blending).

If, instead of peat moss, an inorganic soil amendment is selected for this project, the calculation to determine the cost of the materials is as follows. We assume again that this putting green construction project will encompass 140,000 sq. ft. of putting surface with a 12 in. deep rootzone. The cost of sand and blending remains the same.

A recent phone survey of the major inorganic soil amendment suppliers revealed an average cost of approximately $200 per cu. yd. (the range was $180 to $225 per cu. yd.). This is an average cost of commonly marketed porous ceramic, diatomaceous earth, and zeolite products before delivery. This number is subject to variation due to trucking costs, and the delivered cost could be higher than reported in this example. For the sake of this example, we will use a 90:10 ratio of sand to inorganic amendment by volume.

Unlike peat moss, inorganic soil amendments displace sand on a 1:1 ratio. Thus, only 5,400 cu. yd. of sand and 600 cu. yd. of inorganic amendment are necessary to achieve 6,000 cu. yd. of rootzone mix. If 5,400 cu. yd. of sand is equal to 7,290 tons, then the cost of sand at $25 per ton is $182,250. The cost for the inorganic soil amendment at $200 per cu. yd. for 600 cu. yd. is $120,000.

The weight per cu. yd. of the inorganic soil amendments ranges from 675 to 1,350 lbs. For the sake of this example, we will use an average weight of 1,000 lbs. per cu. yd. to estimate blending cost. Therefore, 600 cu. yd. of inorganic soil amendment weighs 300 tons. The blender will therefore blend 7,290 tons of sand with 300 tons of inorganic amendment for a cost of $22,770 (7,590 tons × $3).

Assuming the same 5% sales tax, the tax on the sand at $25 per ton for 7,290 tons, inorganic amendment at $200 per cu. yd. for 600 cu. yd., and blending cost of $22,770 is $9,113, $6,000, and $1,139, respectively ($16,252 total tax). Thus, the *total cost* for the materials in this putting green construction project utilizing a 90:10 blend sand to inorganic amendment is $341,272 ($191,363 for sand + $126,000 for inorganic amendment + $23, 909 for blending). Remember, this total could increase significantly, depending on location and trucking costs.

CONCLUSION

In this fictitious 18-hole putting green construction example, the cost of materials increased by $86,594 when an average inorganic soil amendment was used at a 90:10 sand-to-amendment ratio by volume as compared to using sphagnum peat moss at the same ratio. Based upon independent research conducted at several leading universities across the nation, it would be difficult to justify the added expense agronomically. Organic matter consistently is documented as the best amendment for sand-based rootzones for performance criteria and cost.

Currently, the USGA guidelines for putting green construction do not recommend the use of inorganic soil amendments.[23] The upcoming revisions (2003) to the guidelines will likely state that with proper laboratory testing it is safe to use certain inorganic soil amendments and still comply with specifications; however, each course should look at cost effectiveness as an important criterion. In any case, put pencil to paper at the outset of any planned construction project and compare dollars and *sense*.

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