Managing Organic Matter in Putting Greens

Effectively managing organic matter will help create the firm and smooth putting greens that golfers have come to expect.

BY ADAM MOELLER AND TODD LOWE

Soft playing conditions, deep ball marks, inconsistent green speed, and bumpy putting surfaces frustrate golfers and golf course superintendents. If golfers and superintendents both want firm and smooth putting greens, why do some facilities struggle to achieve these conditions? Putting greens might be temporarily soft or inconsistent for many reasons, such as recent rainfall, but when there are chronic issues the underlying problem is often excessive organic matter just beneath the putting surface.

Core aeration, verticutting, and topdressing are the primary agronomic practices used to manage organic matter, but they are disliked by most golfers. The choice for superintendents is a difficult one: Upset golfers by failing to produce the desired playing conditions, or upset them by occasionally implementing disruptive programs that are necessary to produce the desired conditions. Since course conditioning is one of the most important factors affecting golfer satisfaction (M. Adler, 2013), effective organic matter management should trump occasional disruptions for maintenance. This article will assist golf course superintendents and the golf community by describing the most effective programs for managing organic matter in putting greens.

Putting greens with excessive organic matter are prone to soft conditions, ball marks, inconsistent green speed, and a host of agronomic problems.

ORGANIC MATTER IN PUTTING GREENS

Surface organic matter, or thatch, is a layer of dead and living shoots, grass stems, and roots that accumulates just below the putting surface. A small amount of organic matter is necessary for putting greens to receive incoming golf shots and tolerate golfer foot traffic and routine maintenance programs. Conversely, excessive organic matter can be detrimental to putting greens in many ways. Extensive research has demonstrated that soil physical properties of sand-based putting greens are impaired by elevated levels of organic matter in the upper 3 inches of the rootzone (Murphy et al., 1993; Neylan, 1994; Carrow, 2003). As organic matter increases in sand-based rootzones, soil macropores decrease. The reduction of macropores results in a host of problems, including lower oxygen diffusion rates, decreased water infiltration, and higher capillary porosity and moisture retention (O'Brien and Hartwiger, 2003). All of these problems increase the likelihood of soft playing conditions, inconsistent green speed, lack of smoothness, footprinting and golf shoe scuffing, disease, wet wilt, shallow rooting, black layer, and high-temperature stress.

There are many agronomic programs that influence the playability and health of putting greens, but organic matter management is arguably the most important. Golf course superintendents work hard to produce the best conditions possible; however, if putting greens have too much organic matter, playing conditions will rarely meet or exceed golfer expectations.

Superintendents have long known that managing organic matter and maintaining sand as the primary rootzone medium are important aspects of maintaining healthy putting greens and good playing conditions (O'Brien and Hartwiger, 2003). Sand is an ideal rootzone medium for putting greens because it resists compaction, allows uniform and rapid water infiltration, and strikes a balance between aeration and capillary — i.e., water-holding — porosity. These properties give superintendents better control of firmness and green speed, even when Mother Nature provides unwelcome rain. However, when organic matter levels become excessive, the desirable properties of sand are diminished and turf health and playing conditions begin to decline (O'Brien and Hartwiger, 2003). In severe cases, excessive organic matter can lead to rapid decline and even complete turf failure during periods of high temperature and humidity (Carrow, 2003; and Landreth et al., 2007). Concerns about excessive organic matter have led many superintendents to ask the question, How much organic matter is too much?

HOW MUCH ORGANIC MATTER IS TOO MUCH?

Many turfgrass researchers and agronomists have suggested critical thresholds for organic matter content in the upper rootzone. The most common range targeted by superintendents is no more than 3-4 percent by weight, a threshold established by research from numerous studies (O'Brien and Hartwiger, 2003). Organic matter levels greater than 4 percent are generally cause for concern. However, variability exists with organic matter testing procedures, mainly with sample depth, e.g., shallower depths often show higher organic matter content. The *USGA Green Section Record* article "Strategies for Organic Matter Control" outlines the variables that impact organic matter data and explains why using a scientific approach to manage organic matter can sometimes be frustrating. Collecting the most meaningful data about organic matter content can be achieved by:

- Having an accredited lab perform the analysis
- Sampling to a consistent depth of 2-3 inches
- Using the loss-on-ignition method

Laboratory data regarding organic matter content should be used as a benchmarking tool, not the sole factor guiding management programs. After all, some putting greens might perform well at one level of organic matter content while others experience problems. For instance, a creeping bentgrass putting green with 4 percent organic matter might perform well in Wisconsin but would likely struggle in regions with warmer summer weather. Lab results, recent putting green performance, and field observations should all be used to determine optimal levels of organic matter in putting greens.

MANAGING ORGANIC MATTER

Organic matter accumulation is linked to several factors, including the aggressive growth habit of some turfgrass species and cultivars, excessive nitrogen fertilization, poor air circulation, high soil moisture, and acidic soils, i.e., pH less than 6 (Carrow, 2003). Problems with excessive organic matter can become more severe when several of these conditions occur simultaneously.

Topdressing is crucial for managing organic matter and improving the smoothness and firmness of putting greens.

Core aeration remains the standard practice for removing organic matter and infusing a significant volume of sand into the upper rootzone. Equipment advancements have allowed for tighter tine spacing, removing more surface area in one core aeration event.

In general, organic matter accumulates when programs that dilute organic matter are not keeping pace with organic matter production. The remainder of this article will outline the most common cultural practices for managing organic matter.

SAND TOPDRESSING

Light and frequent sand topdressing is the most important program for managing organic matter and producing smooth, firm putting greens. Topdressing dilutes organic matter as it accumulates, ensuring that macropores are not plugged by roots and decaying plant biomass. Each light application of topdressing sand also masks the imperfections created by ball marks and traffic.

Developing a successful topdressing program is part of the art and science of managing golf surfaces. Topdressing must be applied at a rate and frequency that match shoot growth in order to adequately dilute organic matter accumulation. The amount of topdressing required depends on the grass species and growth rate, which are affected by soil conditions, fertility, plant growth regulation inputs, traffic, and geographic location. There is not a "one-size-fits-all" topdressing program.

However, many superintendents have found that applying topdressing sand at a rate of 0.5-1.5 cubic feet per 1,000 square feet every 7-14 days effectively dilutes organic matter throughout the growing season. Others will utilize a slightly longer interval if the putting greens are growing slowly.

If too much sand remains on the surface after a topdressing application, it can disrupt ball roll and dull mower reels and bedknives. Low mowing heights and ultradense turf canopies can make it difficult to incorporate sand into the surface. Advancements in topdressing and brushing equipment and the use of walk-behind fertilizer spreaders have made it easier to incorporate sand into the turf canopy, reducing problems associated with sand remaining on the putting surface.

Some superintendents have switched to weekly topdressing at ultralight rates, e.g., less than 0.5 cubic feet of sand per 1,000 square feet, to eliminate sand incorporation challenges. Ultralight application rates are low enough that sand is barely visible after it is worked into the turf canopy. Unfortunately, in many cases organic matter begins to accumulate at the surface after a year or two of ultralight topdressing. Although ultralight top-

dressing applications may smooth the surface, is the topdressing rate high enough to dilute organic matter? More research is needed to determine the interaction between topdressing application rate and frequency and organic matter dilution. However, the total amount of sand applied throughout the growing season — not the topdressing frequency — has the biggest impact on organic matter dilution (Vavrek, 2007).

Sand moisture and particle size distribution play a big role in how easily topdressing is incorporated into the turf canopy. Although dry sand is more expensive, it is worth the extra cost because it easily penetrates the turf canopy. Limiting the amount of topdressing particles larger than 1 millimeter will also facilitate sand incorporation. However, the coefficient of uniformity and the amount of particles smaller than 0.25 millimeter must be carefully monitored to ensure that the topdressing material is compatible with the underlying soils. Topdressing sands with a low coefficient of uniformity, i.e., less than 2.0, or a large percentage of particles smaller than 0.25 millimeter could cause soft conditions or undesirable moisture retention at the surface. Superintendents should closely monitor turf growth, playing conditions, and soil physical properties to determine the best topdressing rate, frequency, and sands for their putting greens.

Solid-tine aeration cannot correct problems such as layering, compaction, and excessive organic matter.

CORE AERATION

Core aeration is a very effective method of removing organic matter. It also makes incorporating topdressing sand into the upper rootzone easier. The core aeration process physically removes organic matter. Backfilling the resulting aeration holes with sand dilutes the remaining organic layer. Core aeration also reduces soil compaction and improves water infiltration. Golfers may dislike the disruption that accompanies core aeration, but the agronomic benefits are extremely important.

The *USGA Green Section Record* articles "Core Aeration by the Numbers" and "Aeration and Topdressing for the 21st Century" formed the basis for many organic matter management programs over the past decade. To keep organic matter content below 3-4 percent in the upper rootzone, these articles recommend core aeration treatments that impact 15-20 percent of the putting surface each year and topdressing programs that incorporate at least 40-50 cubic feet of sand per 1,000 square feet annually. These recommendations are still relevant, but some facilities may need more or less core aeration and topdressing based on their grass species, rootzones, fertility, traffic, and climate.

For example, golf courses in southern states with ultradwarf bermudagrass or creeping bentgrass putting greens often try to impact 20 percent or more of their putting surfaces with core aeration and verticutting each year. Northern courses with creeping bentgrass or *Poa annua* putting greens commonly target 15-20 percent. Tine size and spacing are easily adjusted, thanks to equipment advancements, providing superintendents more flexibility to achieve the desired amount

of surface area impacted from core aeration. Many golfers prefer superintendents to core aerate with tines smaller than 0.375 inch because putting surfaces can quickly recover. Unfortunately, small-diameter tines will remove less organic matter than larger tines. However, using small tines at a close spacing, e.g., 1.0- to 1.5-inch centers, can impact the same or more surface area than larger tines at a wider spacing. It is important to note that a tighter spacing does increase the potential for turf heaving, even with the best equipment.

Select a tine size that allows for easy backfilling of the aeration holes. Putting conditions will be bumpier and the benefits of organic matter dilution will not be maximized if aeration holes are not completely backfilled with sand. Even though a small hole may recover quickly, backfilling aeration holes with a diameter smaller than 0.5 inches is considerably more difficult than filling larger aeration holes. Hand brushes or counter-rotating brushes often provide the best results when backfilling aeration holes.

Improvements in aeration equipment have also increased the popularity of niche practices such as double core aeration. Double aeration is gaining popularity at courses with ultradwarf bermudagrass putting greens because it removes a tremendous amount of organic matter and reduces the number of disturbances to the golf calendar. However, superintendents should be aware that this program may be too aggressive for creeping bentgrass or shallow-rooted *Poa annua* putting greens.

Core aeration should always be performed during periods of active growth. The *USGA Green Section Record* articles "Core Cultivation: Timing is Everything" and "Easing the Pain of Core Aeration" cover this topic in great detail. Spring, late summer, and early fall are the preferred seasons for core aerating cool-season putting greens, whereas summer is the ideal time to aerate warm-season putting greens.

VERTICUTTING

Verticutting is a cultural practice that removes organic matter from the upper rootzone and helps with surface grooming. Light verticutting uses thin vertical blades to affect the leaves and stems of the upper turf canopy. Aggressive verticutting removes organic matter beneath the turf canopy, affecting leaves, stems, crowns, and roots.

Combining core aeration and verticutting is a great way to impact more surface area without extending recovery time.

Aggressive verticutting can be performed with light verticutting blades set at deeper depths or by using wider blades, carbide-tip blades, or a more aggressive machine. Verticutting may be employed along with core aeration to remove more organic matter in a single cultivation event. For example, using 1-millimeter-wide blades at 1-inch centers can impact an additional 4 percent of a putting surface. Combining verticutting with core aeration is a good option when large amounts of organic matter need to be removed.

Deep verticutting can sometimes replace a core aeration event, especially if sand is injected into the surface layer during the process. Aggressive verticutting can actually remove more surface organic matter than core aeration (Landreth et al., 2007), but, in most cases, the organic matter removal is limited to the upper 1 inch of the rootzone. Replacing core aeration with deep verticutting may not be the best practice if there are rootzone issues deeper in the profile. Research has also shown that aggressive verticutting can take 1-3 weeks longer to heal than core aeration (Landreth et al., 2007). Aggressive verticutting must be carefully performed when putting greens are healthy and actively growing to avoid a lengthy recovery time.

SOLID-TINE AERATION

Over the past decade there has been a growing interest in using only solid-tine aeration programs, i.e., no core aeration, combined with light topdressing on a regular basis. Research from the University of Nebraska found that aerating twice annually with solid tines controlled organic matter as effectively as core aerating twice annually when topdressing was regularly applied (Schmidt et al., 2014). The research suggests that topdressing plays a more important role in managing organic matter than the style of aeration. Although the research from Nebraska

has only two years of data and was conducted under a high-nitrogen regime, it has influenced some facilities to abandon core aeration in exchange for solid-tine aeration programs.

Solid-tine aeration is appealing because it is less costly, less disruptive, and still allows superintendents to modify the rootzone with sand. However, it is difficult to say if solid-tine-only programs can truly replace traditional core aeration. More research is needed before the long-term effects of solid-tine-only aeration on organic matter dynamics and other soil physical properties can be fully understood. In fact, several other studies found that topdressing alone did not adequately control organic matter accumulation, whereas core aeration, verticutting, and topdressing did control organic matter (Landreth et al., 2007; McCarty et al., 2007; and Ervin and Nichols, 2008). Where solid-tine-only aeration programs have been successful, the putting greens had a uniform sand profile, minimal organic matter, and no visible layering at the outset. These are necessary pre-conditions for a solid-tine-only program to be successful over a long period of time.

Solid-tine-only aeration programs will not correct problems with excessive organic matter, layering, poor infiltration, and compaction. Solid-tine aeration must be done in conjunction with regular topdressing to effectively control organic matter. Without regular topdressing, organic matter will accumulate and become detrimental to playing conditions and turf health. Superintendents also consistently report that less sand is incorporated into the rootzone when backfilling solid-tine aeration channels compared to core aeration channels of equal tine size, spacing, and depth. This is significant because many putting greens require sand modification to provide high-quality playing conditions and healthy turf, especially putting greens built with poorly draining native soils. A successful solid-tine-only aeration program also requires judicious fertility and irrigation inputs to control turfgrass growth rate. If putting green turf is rapidly growing and topdressing frequency does not match the growth rate, organic matter will accumulate and problems can be expected.

The Graden® Contour Sand-Injection machine simultaneously verticuts and backfills the channels with sand. This machine effectively removes and dilutes organic matter near the surface, but the recovery time could be lengthy.

Despite some success stories, a solid-tine-only aeration program could prove problematic at many facilities. Superintendents following such a program should conduct annual soil tests to identify negative trends before they become problematic. USGA Green Section agronomists more commonly see putting greens that require conventional core aeration than putting greens that could support a solid-tine-only aeration program. If problems begin to arise from organic matter buildup, water retention, layering, or compaction, a solid-tine-only aeration program must be abandoned and immediately replaced with a conventional core-aeration program. Any delay could necessitate aggressive core aeration or verticutting for several years to correct the problem, increasing the disruption and cost of following conventional core-aeration program in the first place.

SAND–INJECTION AERATION

Sand-injection aeration, e.g., DryJect®, is becoming a popular supplemental practice for managing organic matter. This process injects small columns of sand into the rootzone without removing cores from the putting green. Golfers prefer sand-injection over core aeration because it is much less disruptive, but, because this process does not remove any material, it should not be used to replace core aeration or verticutting. Technological advancements have improved the efficacy and injection depth of sand-injection equipment. However, deeper is not always better. The injection depth should be adjusted so the majority of sand is injected where it is needed most, often in the upper rootzone.

CONCLUSION

The growing variety of effective tools for managing organic matter has allowed traditional core aeration and topdressing programs to become more dynamic in recent years. However, traditional programs still provide the most consistent results for managing organic matter and improving putting green playing conditions. Incorporating newer techniques where appropriate is encouraged, but it is important to remember that what works at the

DryJect® machines infuse a significant amount of sand into the rootzone without much disruption to the putting surface. However, this process does not remove organic matter and should not be used to replace core aeration.

neighboring facility may not work for you. Regardless of the programs used, effectively managing organic matter with sound core aeration and sand topdressing practices will help create the firm, fast, and smooth putting greens that golfers have come to expect.

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ADAM MOELLER *is director of Green Section Education and Outreach.* TODD LOWE *is an agronomist in the Southeast Region.*