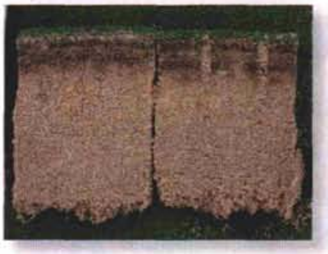
Cultivating to manage organic matter in sand-based greens

Aggressive verticutting removed more organic matter from greens, but core-aerated greens recovered more quickly.



Putting greens constructed according to USGA recommendations contain a medium-to-coarse sand root zone, which provides rapid water infiltration, drainage and oxygen diffusion, while maintaining acceptable water retention (7). A golf facility makes a considerable investment to construct greens according to USGA recommendations, so it is important that the greens are maintained to perform as designed with regard to water retention and drainage.

Newly constructed creeping bentgrass (*Agrostis stolonifera* L.) greens often perform very well during the first few years following establishment, but decline in subsequent years, especially during periods of high temperature and humidity. This decline is likely caused by changes in the root zone's physical properties over time, especially near the surface where organic matter accumulates. Organic matter concentrations greater than 4% to 5% in a USGA root zone will decrease water percolation through, and air movement into, the root zone (5,6), resulting in conditions that are wetter than desirable. Such conditions can ultimately lead to summer decline when temperatures are high and creeping bentgrass respiration rates (and root-zone oxygen requirements) are greater than oxygen diffusion rates into the root zone (1).

USGA

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Verticutting

Newer cultivation techniques may be effective in reducing organic matter and maintaining desirable root-zone physical properties. Verticutting equipment has been demonstrated to aggressively cut channels through surface organic layers in greens, removing more organic matter than traditional core-aeration treatments. However, some superintendents have expressed concern about the difficulty of backfilling cultivation channels and the slower recovery times associated with aggressive verticutting.

Core-aeration

A recent trend in core-aeration in greens is using more closely spaced tines, either by retrofitting older aeration units with adapters or by using new aeration units with closer tine spacing. It is important to note that reducing the tine spacing by half quadruples the affected area when core-aerating greens. Decreasing tine spacing should

This greens aerator has been retrofitted with tine adapters allowing for a tine spacing of 1.25 × 1.5 inches.
Photos by J. Landreth

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not affect turf recovery because individual hole sizes do not change. This may allow for a more aggressive approach to controlling organic matter without the limitations associated with aggressive verticutting.

A moderately aged USGA green typically has desirable physical properties throughout the profile, except near the surface where organic matter has accumulated. Therefore, it is probably not beneficial to remove desirable root-zone sand from below the surface organic matter layer during aeration. Under such conditions, an aeration tine needs only to be long enough to completely penetrate and remove cores from the organic matter layer. Longer tines would result in excess sand debris being pulled to the surface, increasing both the labor required to remove the debris and the amount of sand needed to backfill aeration channels.

The objective of this research was to determine the effects of various aggressive verticutting and core-aeration treatments on removal of surface organic matter from a sand-based green. We investigated various blade widths for verticutting and tine diameters, spacings and depths for core-aeration.

Experimental cultivation methods

A two-year experiment was initiated in spring 2003 at the University of Arkansas Research and Extension Center in Fayetteville, on a 1-year-old Penn G-2 creeping bentgrass green built according to USGA recommendations (3,7). The research green was mowed six days per week at a height of 0.125 inch. Nitrogen and potassium were each applied at 3.5 pounds/1,000 square feet/year, and phosphorous was applied at 0.5 pound/1,000 square feet/year. Deep irrigation was applied as needed to encourage root growth and prevent drought stress. In addition, light sand topdressing was applied every two weeks throughout each growing season.

The Graden GS04 verticutter is capable of cutting channels through the surface organic layer of putting green root zones.

Once the debris was collected, sand topdressing was applied and brushed into the turf until the cultivation channels were filled. **Photo by D. Karcher**

Cultivation treatments were applied using either a Graden verticutter (GS04 Verti-Cutter/Scarifier) or a Toro greens aerator (Toro Greens 09120) in the spring and fall of each study year. Verticutting treatments were made to a 1-inch (2.5-centimeter) depth to ensure complete penetration through the thatch/mat layers and included blade widths of 1, 2 or 3 millimeters. Core-aeration treatments included various combinations of tine spacing (1.25 × 1.5 inches or 2 × 2.5 inches [3.2 ×3.8 centimeters or 5 × 6.4 centimeters]), tine diameter (0.25 or 0.5 inch [6.4 or 1.3 centimeters]), and tine penetration depth (1.5 or 2 inches [3.8 or 5 centimeters]). Cultivation treatments were made to individual plots measuring 5 × 20 feet (1.5 × 6 meters), and each treatment was applied to four replicate plots.

The day before cultivation treatments were applied, in each plot, the percentage of organic matter was measured in the top 1 inch of surface soil, and from 1 inch deep to the depth of cultivation. Immediately following cultivation treatments, scoop shovels were used to collect the debris (sand and organic material) from each plot. Once the debris was collected, sand topdressing was applied and brushed into the turf until the cultivation channels were filled. The amount of debris removed and topdressing sand incorporated into cultivation channels was recorded for each plot. The organic matter in the cultivation debris originating from the surface inch was calculated based on the distribution of organic matter from the surface inch to the depth of cultivation (evaluated the day before treatment applications). In addition, each plot was rated for recovery and overall turf quality twice weekly following cultivation treatments.

Surface organic matter

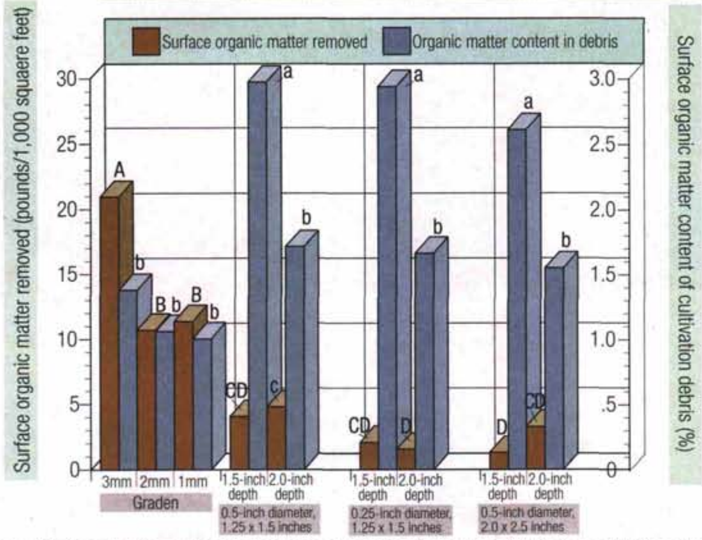


Figure 1. Surface organic matter removed and percentage of organic matter in the cultivation debris as affected by cultivation treatment. Data were collected May 21, 2003, in Fayetteville, Ark. Within evaluations, treatments with bars sharing a letter are not significantly different (capital letters are used for surface organic matter removed, and lowercase letters for surface content of cultivation debris).

Turf recovery

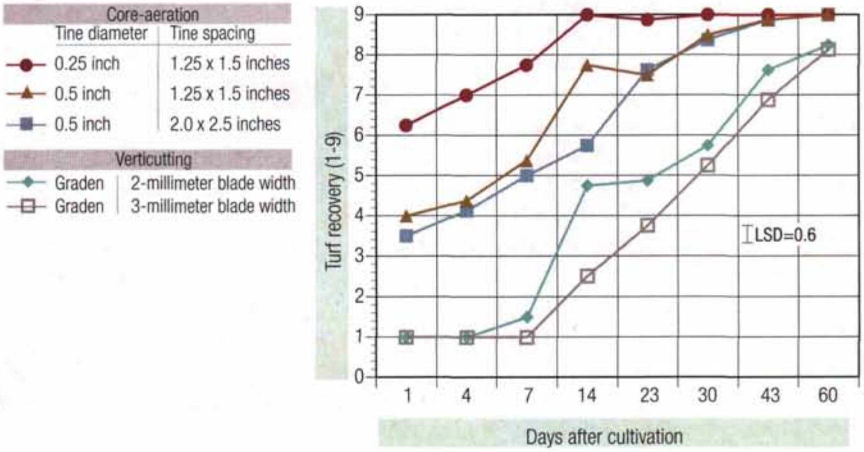
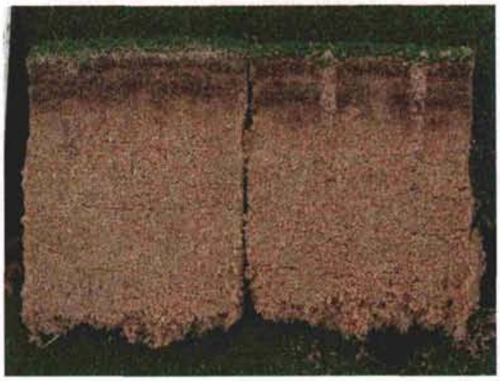


Figure 2. Turfgrass recovery from cultivation as affected by cultivation treatment. Turf recovery is rated on a scale of 1 to 9, where 1 is no recovery and 9 is fully recovered. Data collected September through November 2003 in Fayetteville, Ark. Error bar represents least-significance-difference value between treatments within a single evaluation date.



Although verticutting treatments (**left**) removed more surface organic matter, core-aerated plots (**right**) recovered significantly faster. **Photo by J. Landreth**

Organic matter removal

All of the verticutting treatments removed more surface organic matter than any of the core-aeration treatments (Figure 1). In fact, the 3-millimeter verticutting treatment removed more than four times the amount of organic matter removed by each core-aeration treatment. There was not much difference in organic matter removal between the 1- and 2-millimeter verticutting treatments; however, they only removed about half the organic matter removed by the 3-millimeter treatment. Superintendents with sand-based root zones with very high organic matter content should consider aggressive verticutting to remove excessive organic matter near the root-zone surface. Among the core-aeration treatments, the larger-diameter, closely spaced, deeper-penetrating treatment removed the most organic matter from near the root-zone surface.

Although it was not as effective as verticutting in removing large amounts of organic matter from the root zone, core-aeration — especially with shorter tines — was more efficient in completely penetrating the organic matter layer without bringing excess sand to the surface. Verticutting treatments and the deeper-penetrating hollow tines had significantly less organic matter in the cultivation debris compared to the hollow tines, which do not penetrate as deeply (Figure 1). Cultivation debris that was not surface organic matter was predominately root-zone sand with desirable physical properties.

Turfgrass recovery and quality

Turfgrass recovery evaluations following cultivation are summarized in Figure 2. To improve the clarity of Figure 2, the 2-millimeter verticutting treatment and core-aeration treatments with 1.5-inch-deep tines were not included. However, recovery with the 2-millimeter verticutting treatment was similar to recovery from the other verticutting treatments, and recovery from treatments with the 1.5-inch tine depth was similar to recovery from treatments with the 2.0-inch tine depth.

Verticutting vs. core-aeration

Cultivation channels healed over more quickly for core-aeration treatments than for verticutting treatments. The time required for the verticutting treatments to heal following cultivation was nearly 60 days, approximately twice that necessary for core-aerified turf. This difference was likely the result of the problems in backfilling cultivation channels with sand. Once the cultivation debris was removed from those plots, many of the verticutting channels had partially closed, making it difficult to fill the channels with sand and smooth the surface.

Aerification holes created by coring treatments were less prone to collapse and were more completely filled with topdressing sand, creating a smoother surface, which hastened recovery. In fact, in all plots that were core-aerified, the amount of topdressing sand that was incorporated back into the turf canopy was greater than 100% of the volume of the debris that was removed during cultivation. In contrast, only 70% of the volume of cultivation debris could be incorporated back into the canopy as topdressing sand for turf that was verticut.

After this research was completed, Graden released a new verticutting unit that verticuts and backfills channels with sand in a single operation (1). Turf recovery from aggressive verticutting would likely be enhanced with sand injection, although no published research has documented this.

Tine diameter

Among core-aeration treatments, tine diameter had the greatest effect on recovery time. Turf cored with 0.25-inch-diameter tines recovered in 14 days, about half the time of turf treated with 0.5-inch tines. Neither tine depth nor tine spacing affected turf recovery in this study. Consequently, a superintendent can use closer tine spacing to affect a larger percentage of the putting surface without affecting recovery time. This is a better alternative to increasing tine diameter, which would also increase the affected area, but would delay recovery time. In addition, a shallow tine is preferable to a deeper tine (so long as the tine completely penetrates the surface organic layer) because shallow tines bring less debris to the surface, and the amount of organic matter removed and recovery time are the same as with deeper tines.

Turf quality

Cultivation treatments did not affect turf quality in this trial except during periods of recovery from treatment. This study was conducted in a full-sun location with considerable air movement, resulting in minimal disease pressure and summer stress symptoms. Cultivation treatments would have been more likely to enhance turf quality in an environment with limited sun exposure and air movement. Although visual quality was not affected by cultivation treatment in this study, untreated plots were considerably softer by the end of the study and probably had less desirable ball roll characteristics. In a follow-up study on the same plots, uncultivated turf consistently had lower hardness values than all treated turf (2).

Organic matter content

After three sets of cultivation treatments and 14 months after the study was initiated, aggressive verticutting was most effective at minimizing organic matter content in the surface inch of the root zone (Figure 3). In particular, the 3-millimeter verticutting treatment reduced the content of surface organic matter significantly below that of the untreated control and all core-aeration treat-

Surface organic matter vs. treatment

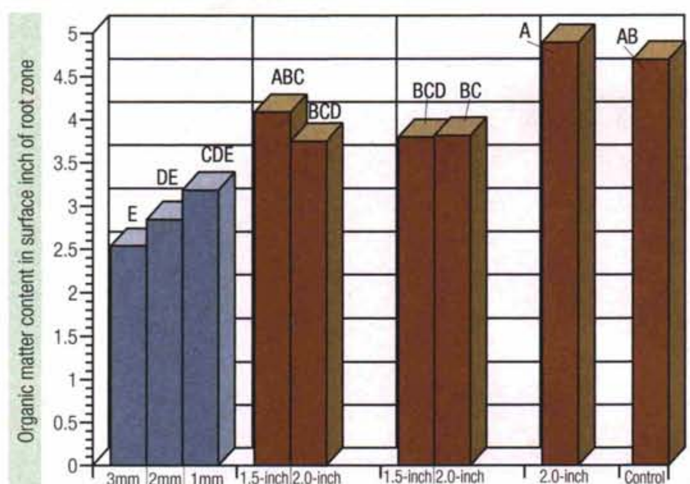


Figure 3. Organic matter content in the surface inch of the root zone as affected by cultivation treatment. Data were collected June 21, 2004, two months after the third set of treatments were applied. Treatments with bars sharing a letter are not significantly different.

ments. These results are not surprising considering the large amounts of organic matter brought to the surface by verticutting treatments.

Although all of the closely spaced core-aeration treatments resulted in lower content of surface organic matter than the control, differences were slight and not statistically significant after three sets of treatments. It is important to note again that this study was conducted under ideal conditions (full sun and air movement) for microbial breakdown of organic matter. A green with limited air movement and limited sun exposure would probably have greater moisture content at the root-zone surface, limiting microbial activity. Under such conditions, core-aeration treatments would be expected to significantly reduce surface organic matter compared to untreated turf.

Conclusions

Verticutting treatments were more aggressive and effective than core-aeration treatments at removing organic matter from the surface inch of the putting green root zone. However, the verticutting treatments removed a disproportionately large amount of debris and recovered more slowly. Therefore, aggressive verticutting may be most useful when a large amount of organic matter must be removed at once and recovery time is not a primary consideration, for example, during renovation of a green. Core-aeration with closely spaced tines may be better suited to more-general maintenance of surface organic matter for greens that must return to a high level of quality shortly after cultivation.

The research says

→ Aggressive verticutting was more effective at removing surface organic matter than core-aerification treatments.

→ Turf recovery from aggressive verticutting was much slower than recovery from core-aerification. Turf recovery was faster in turf treated with smaller-diameter tines.

→ Tine spacing did not affect recovery time. Closely spaced tines can increase the affected surface area (and organic matter removal) without delaying recovery.

→ After three sets of treatments over 14 months, aggressive verticutting resulted in a lower organic matter content near the root-zone surface compared to core-aerification.

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