



# Effects of hollow-tine diameter and topdressing incorporation implements on sand topdressing integration

Small-diameter hollow tines can reduce surface disruption, and forced-air topdressing incorporation implements can improve efficiency after core cultivation of putting greens.



Thatch and organic matter accumulation on sand-based putting greens have been shown to compromise a number of the soil physical properties that make this rooting medium advantageous. Thatch accumulation has been linked to reductions in hydraulic conductivity (4) and water infiltration (9). Researchers (3) have determined that as Providence creeping bentgrass (*Agrostis stolonifera*) matures, organic matter accumulation will decrease air-filled porosity, thereby decreasing infiltration rates and gaseous exchange with the atmosphere and increasing the potential for saturated playing surfaces. In fact, organic matter concentrations of as little as 4% in a USGA sand-based root zone have been shown to decrease water percolation rates and air movement into the soil (8,10).

## Cultural practices

Vertical mowing (verticutting) and core cultivation coupled with sand topdressing are often used to mitigate the problems associated with organic matter accumulation. USGA agronomists have stated that successful mature putting greens require a core cultivation regime that affects 15%-20% of the surface area annually, and that it is reasonable to aerate up to 30% of the surface area of a well-maintained green (5). Researchers have also shown that the most effective treatment for minimizing organic matter accumulation is core cultivation four times annually with hollow tines, and vertical mowing twice annually combined with sand topdressing (the most aggressive cultivation treatment used in this research) (7). However, in that study, even the most aggressive cultivation

treatment, which affected 23.6% of the surface area, did not prevent thatch accumulation.

Although aggressive cultivation is necessary to mitigate organic matter accumulation, it has also been shown to substantially increase turfgrass recovery time (6). For example, Penn G-2 creeping bentgrass cultivated with 0.5-inch hollow tines recovered twice as fast as areas that were aggressively verticut using the GS04 verticutter (6). Other research (2) has shown that sand topdressing alone was as effective at reducing thatch accumulation on Pennncross creeping bentgrass as core cultivation combined with vertical mowing and sand topdressing.

## Drawbacks to core cultivation

Although the benefits of core cultivation, vertical mowing and sand topdressing on organic matter accumulation are well documented, golfers frequently complain about the surface disruption produced by these practices. In response to the slow recovery produced by vertical mowing and large-diameter hollow tines (<0.5 inch [ $>1.27$  centimeters]), manufacturers have developed small-diameter hollow tines to decrease surface disruption and turfgrass recovery time. However, superintendents may find it more difficult to incorporate topdressing sand into the smaller-diameter holes. If sand topdressing is not incorporated into the recently core-cultivated putting surface, the voids produced by this cultivation practice will be compromised by foot or vehicle traffic, negating the benefits of core aeration. To prevent this, practitioners have developed ways of using forced air to push sand into cultivation holes.

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Hollow-tine core cultivation using a Toro ProCore 648 (left) and 0.375-inch diameter cores before core removal (right) at the Michigan State University Hancock Turfgrass Research Center, East Lansing, on Sept. 19, 2006. Photos by A. Kowalewski

### Research objectives

The objectives of this research were to evaluate the effects of the diameter of hollow-tine core cultivation and implements for incorporating topdressing sand into a recently core-cultivated Declaration creeping bentgrass stand maintained at greens height. The initial hypotheses of this research were: as tine diameter decreases, the percentage of sand topdressing incorporated into the core-aeration holes decreases; and newly available commercial implements for incorporating topdressing using forced air (high-velocity blowers or fans) will improve the efficiency of sand topdressing incorporation (that is, reduce the number of passes necessary to incorporate the topdressing after cultivation). Reducing the number of implement passes necessary to integrate sand topdressing reduces the number of hours of labor devoted to this practice and also prevents vehicle traffic from collapsing core-cultivation holes between passes.

### Materials and methods

The research was conducted on two well-established creeping bentgrass greens at the Michigan State University Hancock Turfgrass Research Center in East Lansing, Mich., in 2006. The experimental design was a 2 x 2 x 4 randomized factorial, complete strip-block design, with four replications totaling 64 treatments; individual treatment size was 4 feet x 6 feet (1.2 meters x 1.8 meters). Factors included location (subplot), hollow-tine diameter (whole-plot factor) and topdressing incorporation implement (strip plot).

Research locations included Declaration creeping bentgrass established in 2005 on a sand root zone built to USGA recommendations (plot 1) (12), and Declaration creeping bentgrass established on native soil (Owosso-Marlette sandy loam) (plot 2) (11).



#### Core cultivation

Core cultivation was done using a Toro ProCore 648 with small-diameter (0.375-inch [9.5-millimeter]) and large-diameter (0.625-inch [15.875-millimeter]) hollow tines set on a 1.33-inch x 1.6-inch (3.38-centimeter x 4-centimeter) spacing, and 2-inch (5-centimeter) depth. The small-diameter tines affected 2.3% of the surface area, and the large-diameter tines affected 5.2%.

Sand topdressing was applied by hand the day after the aeration cores were removed. The volume of soil affected by core cultivation was used to calculate the volume of topdressing necessary to fill the voids produced by cultivation.

#### Topdressing incorporation

Topdressed treatments received two passes with one of the following topdressing incorporation implements: Air Drag, Cyclone KB4 Debris Blower, BT Sandevil and a greens broom, the traditional sand integration implement used in this project. After two passes with these topdressing incorporation tools, the remaining sand was collected by hand using a dustpan and broom and used to calculate the percentage of sand incorporated into the core cultivation holes.

Core-cultivation holes produced by 0.375-inch (left) and 0.625-inch (right) diameter hollow tines at the Hancock Turfgrass Research Center on Sept. 19, 2006.



The four sand topdressing incorporation implements used in this research project: Air Drag (top, left), Cyclone KB4 Debris Blower (top, right), BT Sandevil (bottom, left) and greens broom (bottom, right). Photos by J. Dunne

### % sand topdressing

Location	% (0-100) of sand topdressing incorporated into cultivation holes <sup>†</sup>
Plot 1: USGA sand-based green <sup>§</sup>	80a
Plot 2: Native soil green <sup>¶</sup>	78b
Hollow-tine diameter <sup>**</sup>	
Large diameter (0.625 inch)	79a
Small diameter (0.375 inch)	79a
Topdressing incorporation implement <sup>**</sup>	
Air Drag	90a
Cyclone KB4 Debris Blower	87a
BT Sandevil	73b
Broom	67c

<sup>†</sup>Within columns, means followed by the same letter are not significantly different from each other.

<sup>§</sup>Greens were mature Declaration creeping bentgrass (*Agrostis stolonifera*).

<sup>¶</sup>Number of replications for all treatments = 4.

<sup>\*\*</sup>Native soil: Owosso-Marlette sandy loam (USDA NRCS, 2012).

<sup>\*\*</sup>Core cultivation treatments were applied to plot 1 on July 27, 2006, and plot 2 on Sept. 19, 2006; sand topdressing incorporation implement treatments and data were collected the following day: July 28 and Sept. 20, 2006, respectively.

<sup>\*\*</sup>Treatments received two passes with the various sand topdressing incorporation implements; sand not incorporated into the soil was collected and used to calculate the percent of sand topdressing incorporated.

**Table 1.** Percentage (0%-100%) of sand topdressing incorporated into two different plots treated with large- or small-diameter hollow tines and four different incorporation implements at the Michigan State University Hancock Turfgrass Research Center, East Lansing, Mich., on July 28 and Sept. 20, 2006.

## Results

### Soil type

A greater percentage of sand topdressing was assimilated into the USGA sand-based putting surface than into the native soil green (Table 1). These differences are likely the result of atmospheric conditions at the time of topdressing application. Topdressing was applied to the USGA sand-based putting surface on July 28 when atmospheric temperatures reached a maximum of 86.9 F (30.5 C), and topdressing was applied to the native soil putting surface on Sept. 20 when temperatures reached a maximum of 60.2 F (15.7 C). The relatively high atmospheric temperature observed in July quickly dried the moist topdressing sand and improved incorporation (13).

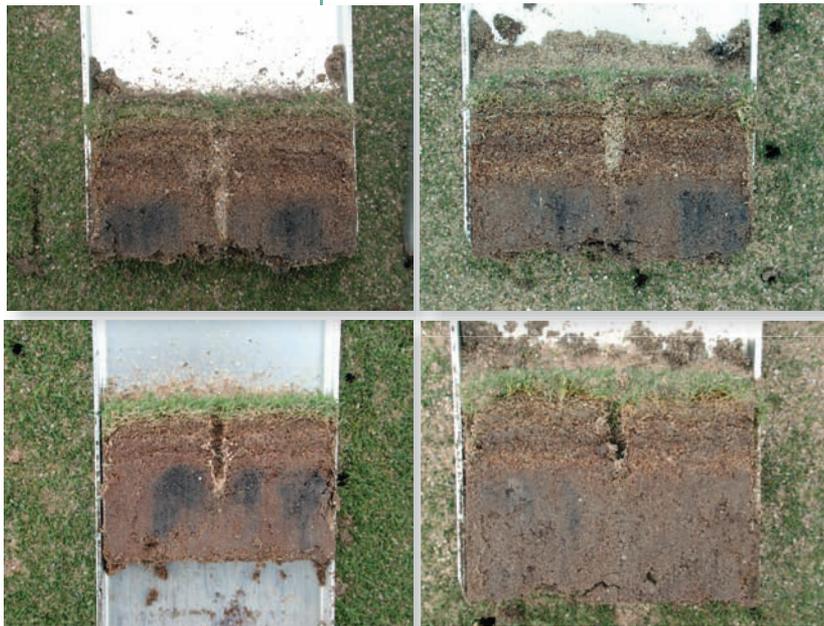
### Hollow-tine diameter

Hollow-tine diameter size did not affect the efficiency of sand topdressing incorporation (Table 1). These findings suggest that superintendents interested in reducing surface disruption can decrease hollow-tine diameter from 0.625 inch to 0.375 inch without compromising sand incorporation.

### Topdressing incorporation

Finally, differences were also observed among the various topdressing incorporation implements (Table 1). The Air Drag (90%) and Cyclone Debris Blower (87%) integrated the largest percentage of sand topdressing in two passes. The Sandevil incorporated significantly less topdressing material (73%), whereas the greens broom integrated the least amount of topdressing in two passes (67%).

These results suggest that superintendents using the Air Drag or Cyclone Debris Blower rather than the Sandevil or the greens broom will see improved topdressing integration efficiency, which is particularly valuable when using small-diameter tines that produce holes that may be difficult to fill with topdressing. These results do not suggest that the Sandevil or greens broom cannot adequately incorporate topdressing into recently core-aerified greens, only that these integration methods will require more implement passes or hours of labor to adequately incorporate the applied sand topdressing. It is also important to note that the greater the number of vehicle passes required to incorporate the topdressing, the greater the potential for collapse of core-cultivation holes as a result of traffic. The authors would also like to note that implements using forced air, the Air Drag, Cyclone Debris Blower and Sandevil, may have been improved since the work was conducted in 2006.



Sand topdressing incorporated into 0.375-inch-diameter holes after two passes with the Air Drag (top, left), Cyclone KB4 Debris Blower (top, right), BT Sandevil (bottom, left) and greens broom (bottom, right) at the Hancock Turfgrass Research Center on Sept. 19, 2006. Photos by A. Kowalewski



## The research says

- Numerous research studies have recommended verticutting, core cultivation and sand topdressing to reduce accumulation of thatch and organic matter in putting greens.
- Avoid topdressing during cool, wet weather, which will make sand incorporation difficult.
- To decrease surface disruption, use small-diameter hollow tines for core cultivation.
- To improve topdressing incorporation efficiency, use tools that employ forced air to incorporate the sand into the core holes.

## Suggestions for superintendents

Golf course superintendents trying to improve the efficiency of topdressing integration should avoid applying topdressing sand during periods of cool, wet weather because these conditions will prevent topdressing material from drying and make it difficult to incorporate. Switching to small-diameter (0.375-inch) hollow tines will decrease surface disruption from core cultivation and will not compromise sand topdressing incorporation when using the sand incorporation methods we employed. Finally, superintendents should consider using topdressing integration tools that use forced air to improve the efficiency of topdressing incorporation.

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