USGA Research *You Can Use*

Organic Matter Dilution Programs for Sand-based Putting Greens in Virginia

By Erik Ervin and Adam Nichols

The project objective is to compare various putting green cultivation strategies to determine which organic matter dilution program maintains mat layer organic matter at less than 4% while providing the fewest days of putting quality disruption each year. The techniques implemented for this study removed from 10 to 27% surface area, and the effects on agronomic performance of a mature putting green in east-central Virginia were carefully examined. The

Cultivation programs have been implemented and studied across the country. For example, the USGA Green Section sponsored research at the University of Georgia in the 1990's, and the results of that work provided Georgia-specific data for cultivation and topdressing recommendations for sand-based greens commonly known as "organic matter dilution" programs. A 2003 article published in the *Green Section Record* magazine (http://turf.lib.msu.edu/2000s/2003/030301.pdf) summarized the details of this approach, recommending annual cultivation practices that remove 15 to 20% surface area and incorporate 40 to 50 ft^3 sand/M, with the ultimate goal being to maintain surface rootzone organic matter at four percent or less. Aggressive organic matter dilution programs are intended to manage aeration porosity and subsequent infiltration rates, thereby allowing superintendents to more easily manage their putting greens and lessen the effects of summer environmental stresses.

Our research was conducted on nine-year-old Penn A4 bentgrass practice putting greens at the Independence Golf Club (Dan Taylor, superintendent), the home course of the Virginia State Golf Association, near Richmond VA. Prior to initiation of the study, analysis of four randomly-selected cup cutter cores revealed a thatch/mat layer (approximately 0-2" deep) with 5.8% organic matter and an infiltration rate of 11"/hr. Various combinations of small tines (0.25" inside diameter (id)), big tines (0.50" id), and vertical mowing (3 mm blade) were imposed in late March and early September to provide a range of seasonal surface removal from 0% to 26.6% (Table 1). Verticutter blade spacing was 1", while depth was 0.75"; tine spacing was 1.33" X 1.5", with a coring depth of 2". Heavy sand topdressing of approximately 12 ft^3 (1200 lbs/M) was applied on both days of cultivation, supplemented by four light topdressings of 0.15 ft^3 every 4-6 weeks between cultivations, for a seasonal total of about 24.6 ft^3. Cultural management of

Manufacturers provide a wide array of cultivation options to manage the turf health. Selecting the best method for the golf course requires testing and evaluation.

TGIF Record Number: 169455

these greens were identical to all others on the golf course, receiving preventive pesticide applications, daily mowing at 0.125", and January through October fertilization of 2.3 lbs N/M.

RESULTS

Cultivation treatment had no effect on soil temperature, soil moisture, or ball roll distance throughout the 2008 season (data not shown). These data were not measured in 2009.

Our data focus will be on measurements of percent organic matter (%OM from loss on ignition tests) in the thatch/mat layer at the end of each season as affected by the various cultivation treatments and on our estimates (from digital image analysis) of days required to achieve 99% recovery following cultivation. At the end of 2008, only those coring treatments that removed 14.8 to 19.6% (treatments 5-6) significantly reduced %OM relative to the untreated control (Table 1). Use of smaller tines-alone (treatment 2), verticutting-alone (treatment 3), or combinations of the two (treatment 4), failed to reduce %OM in 2008.

At the end of 2009, all treatments, except verticutting alone, significantly decreased %OM in the thatch/mat layer relative to the control (Table 1). Coring spring and fall with 0.5" id tines on a tight spacing to remove approximately 9.8% surface area to a depth of 2" (treatment 5) resulted in the least OM (3%) over the two years. These data imply that verticutting to a depth of 0.75" does not remove enough material for adequate organic matter dilution, even though this procedure removes a large amount of surface area (11.8%) with each pass.

To track percent cover or recovery rate following cultivation treatments in 2009, digital images were taken every 7 to 14 days with a light box and analyzed with SigmaScan software. Linear regression was used to predict the number of days required for each treated plot to return to 99% cover or a non-disrupted putting surface (Table 2). Fastest spring recovery of 24 days was measured for treatments 2 (small tine coring) and 3 (verticutting). Large diameter coring (treatments 5-7) or small diameter coring + verticutting on the same day (treatment 4) required 31 to 36 days for spring recovery (Table 2).

Table 1. Treatment Details & Thatch/ Mat Organic Matter % at end of 2008

		Surface Area Removed (%)			Thatch/Mat (%OM)	
	Treatment Details	March 31	Sept 10	Total	Nov 2008	Nov 2009
1	Untreated	0	0	0	5.2 a*	4.3 a
2	0.25" id core, 2 passes; Sp&Fa	5	5	10	4.9 ab	3.4 c
3	Verticut, 3 mm blade; Sp&Fa	11.8	11.8	23.6	5.0 ab	3.9 ab
4	0.25" id + Verticut, 3 mm blade Sp; 0.25" id core, Fa	2.5+11.8	2.5	16.8	5.2 a	3.7 bc
5	0.5" id core Sp; 0.25" id core, 2 passes, Fa	11.8	5	14.8	4.8 b	3.3 cd
6	0.5" id core Sp&Fa	9.8	9.8	19.6	4.8 b	3.0 d
7	0.5" id core Sp; Verticut, 3 mm blade + 0.25" id core, 2 passes, Fa	9.8	5+11.8	26.6	5.1 ab	3.3 cd
				LSD 0.05	0.38	0.42

* Within a column, values followed by the same letter are not significantly different.

Late summer/early fall recovery data were very similar to recovery times for spring treatments. In particular, treatment 3 (verticutting), recovered in only 21 days (Table 2), while large-diameter coring alone (treatment 6) required only two extra days of recovery (38 days vs 36 days), relative to the spring. Fastest early September recovery of seven days was with treatment 4, where only 2.5% surface removal occurred.

Data interpretation for the remaining treatments (2, 5, and 7) is confounded by unforeseen irregularities in how the treatments were applied. For treatments 2 and 5, when the second 0.25" id coring pass was made, surface tearing and furrowing occurred, causing a higher percent surface damage than the predicted 5%. We are unsure why this occurred, as new tines on a new machine were used. Our supposition is that undue rootzone wetness and an algae-weakened putting surface caused failure of this double-pass treatment. As a side-note, the summer of 2009 in Virginia was one of record cool temperatures coupled with above-average rainfall. Extra damage on these two treatments (2 and 5) appeared to extend recovery by an extra 10 days relative to spring recovery times. Interpretation of the recovery time for treatment 7 should be tempered by the fact that verticutting could not be completed over the top of plots that received two passes of the 0.25" id tines. Undue sod heaving occurred, so verticutting was delayed until 26 days after coring, greatly extending recovery to 52 days.

Table 2. Total estimated days of disrupted putting quality in 2009 as affected by percent surface removal by various core cultivation and verticutting treatments.

		Spring % removal		Fall % removal			
#	Treatment Details	March 31	Days to 99% cover	Sept 10	Days to 99% cover	Total % removal	Total Disrupted Days, 2009
1	Untreated	0%	0	0%	0	0%	0
2	0.25" id core, 2 passes; Sp&Fa	5%	24	5%	34*	10%	58*
3	Verticut, 3 mm blade; Sp&Fa	11.8%	24	11.8%	21	23.6%	45
4	0.25" id + Verticut, 3 mm blade Sp; 0.25" id core, Fa	2.5% +11.8%	31	2.5%	7	16.8%	38
5	0.5" id core Sp; 0.25" id core, 2 passes, Fa	9.8%	35	5%	33*	14.8%	88*
6	0.5" id core Sp&Fa	9.8%	36	9.8%	38	19.6%	74
7	0.5" id core Sp; Verticut, 3 mm blade + 0.25" id core, 2 pass, Fa	9.8%	35	5% +11.8%	52**	26.6%	87**

*Two passes with the 0.25" inside diameter (id) tines on Sept 10 resulted in undue tearing, hole overlap, and furrowing on the putting surface that served to delay recovery in treatments 2 and 5 in September; this type of tearing did not happen with treatment 2 in the spring, so recovery was faster.

**Treatment 7 cultivation did not all occur on Sept 10, as verticutting after 0.25" id double-pass coring was causing undue sod lifting/damage. Verticutting was delayed until 26 days after coring, unduly lengthening recovery time to 52 days for this treatment.

How to Apply the Research on the Course
Our ultimate goal is to determine cultivation treatments that are sufficient to adequately reduce thatch/mat %OM, while also disrupting putting surface quality for the least amount of time. Therefore, we need to examine data in both tables to make some preliminary recommendations or conclusions.

1. The least disruptive treatment in terms of percent removal (treatment 2, 10%), healed quickly (24 to 34 days) and reduced thatch/mat OM to an acceptable level of 3.4% after two years.

2. Verticutting-alone each spring and fall (treatment 3) resulted in the second fastest recovery of any treatment (21 to 24 days), but failed to significantly reduce OM to a level below the untreated.

3. Treatment 4 resulted in the least amount of days of disruption over the season (38), while also reducing OM to an acceptable 3.7%. The approach for this treatment was to bite the bullet in the spring and complete an aggressive surface removal (small tine coring + verticutting: 14.3%), so as to allow a very minor coring event in September (small tine coring: 2.5%). Total recovery time was 7 days less than verticutting-alone, with a slightly faster rate of OM reduction.
4. Using large tines (0.5" id) at a close spacing in both spring and fall each year (19.6% surface removal, treatment 6) worked best in terms of final OM at 3.0%, but required approximately two extra weeks each season for recovery relative to two passes with small tines or verticutting-alone.

5. Finally, being ultra-aggressive by removing 26.6% surface area (treatment 7) per year did not work in this trial. Recovery time was significantly delayed, without achieving greater OM dilution relative to treatments that removed 10 to 20% surface area.

In summary, two years of data indicate what most golf course superintendents already know: "There is more than one way to skin a cat." Various coring approaches can be mixed and matched with verticutting and consistent sand topdressing to achieve the goal of OM dilution and the accompanying benefit of exceptional putting green performance. Preliminarily, our data indicate that as little as 10% surface area removal via spring and fall coring may be sufficient for Virginia conditions, while 15 to 20% annual removal should almost always keep you on the safe side. While verticutting-alone provides fast healing, our data indicate that it needs to be combined with at least one annual coring for adequate results.

Erik Ervin, PhD *(ervin@vt.edu) is an associate professor working in the Department of Crop and Soil Environmental Sciences at Virginia Polytechnic Institute and State University.* Brandon Horvath, PhD *is an assistant professor working in the Department of Botany and Plant Pathology at Virginia Polytechnic Institute and State University, Virginia Beach, VA.* Adam Nichols *is a M.S. student working at the Department of Crop and Soil Environment Science at Virginia Polytechnic Institute and State University, Blacksburg, VA.*