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Researchers at Virginia Tech investigated several spring and fall cultivation treatments to minimize both organic matter in the thatch/mat layer and recovery time of bentgrass putting green turf from the cultivation treatment. Data indicate that annual removal of 15-20% of the surface area should be removed in conjunction with sand topdressing to keep putting green organic matter adequately diluted.

PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 400 projects at a cost of \$31 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

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Organic Matter Dilution Programs for Sand-based Putting Greens

Erik Ervin and Adam Nichols

SUMMARY

Researchers at Virginia Tech investigated several spring and fall cultivation treatments to minimize both organic matter in the thatch/mat layer and recovery time of bentgrass putting green turf from the cultivation treatment. The results of their three-year study include:

- The control plots finished with the greatest thatch/mat organic matter (4.3%), but this 0.5 to 1% increase compared to more aggressive treatments, did not result in lower visual quality.
- At the end of 2008, only those coring treatments that removed 14.8% to 19.6% significantly reduced % organic matter compared to the topdressed control.
- At the end of 2009, all treatments, except verticutting alone, significantly decreased % organic matter in the thatch/mat layer compared to the topdressed control.
- Using large tines (0.5" id) at a close spacing both spring and fall each year (19.6% surface removal) worked best in terms of reducing final organic matter at 3.1%, but required approximately 5 to 15 extra days of recovery each season for recovery compared to the small tine and/or verticutting treatments.
- Annual removal of 15 to 20% surface area should be the goal for adequate dilution of organic matter in creeping bentgrass greens.

USGA-sponsored research by Dr. Bob Carrow and his colleagues at the University of Georgia in the 1990's provided Georgia-specific data for cultivation and topdressing recommendations for sand-based greens commonly known as "organic matter dilution" programs (1, 2). O'Brien and Hartwiger (3) summarized the details of this approach recommending annual cultivation practices that removed 15 to 20% surface area and incorporated 40 to 50 ft³ sand/1,000 ft², with the

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ultimate goal of maintaining surface rootzone organic matter at 4 % or less. Aggressive organic matter dilution programs are intended to slow loss of aeration porosity and subsequent infiltration rates thereby allowing superintendents to more easily manage their putting greens and lessen the effects of summer bentgrass decline (3).

Materials and Methods

Our research was done on 10-year-old 'Penn A-4' practice putting greens at the Independence Golf Club, near Richmond, VA. Prior to initiation of the study, analysis of four randomly selected cup-cutter cores revealed a thatch/mat layer (0-2" deep) with 5.8% organic matter. Various combinations of small tines (0.25" inside diameter (id)), big tines (0.50" id), and verticutting (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).



Using large tines (0.5" id) at a close spacing both spring and fall each year (19.6% surface removal) worked best in terms of reducing final organic matter at 3.1%, but required approximately 5 to 15 extra days of recovery each season.

Treatments	Surface Area Removed (%)			Thatch/Mat % OM		
	March	Sept	Total	Nov 2008	Nov 2009	Nov 2010
1 control (sand only)	0	0	0	5.2 a	4.3 a	4.3 ab
2 0.25" coring, 2 passes; spring and fall	5	5	10	4.9 ab	3.4 c	3.8 cd
3 verticutting (3-mm blade); spring and fall	11.8	11.8	23.6	5.0 ab	3.9 ab	4.0 bc
4 0.25" coring + verticutting, spring; 0.25" coring, fall	2.5+11.8	2.5	16.8	5.2 a	3.7 bc	4.5 a
5 0.5" coring, spring; 0.25" coring, 2 passes, fall	11.8	5	14.8	4.8 b	3.3 cd	3.3 de
6 0.5" coring, spring and fall	9.8	9.8	19.6	4.8 b	3.0 d	3.1 e
7 0.5" coring, spring; verticutting + 0.25" coring, 2 passes, fall	9.8	5+11.8	26.6	5.1 ab	3.3 cd	3.2 e
	LSD (0.05)			0.38	0.42	0.49

Table 1. Surface area removed (%) and organic matter content (% wt/wt, loss at ignition) of 'A-4' creeping bentgrass as affected by various cultivation treatments.

Verticutter blade spacing was 1 inch while depth was 0.75 inches. Coring tine spacing was 1.33 X 1.5 inches, with a coring depth of 2 inches. Heavy sand topdressing of approximately 12 ft³ (1,200 lbs/1,000 ft²) was applied on both days of cultivation, supplemented by four light topdressings of 0.15 ft³ every 4-6 weeks between cultivations, for a seasonal total of about 24.6 ft³/1,000 ft². Cultural management of these greens were identical to all others on the golf course, receiving preventive pesticide applications, daily mowing at 0.125 inches, and annual nitrogen fertilization of 4.4, 3.3, and 4.3 lbs N/1,000 ft² in 2008, 2009, and 2010, respectively.

To track percent cover or recovery rate following cultivation treatments in 2009 and 2010, digital images were taken every 7 to 14 days with a light box and analyzed with SigmaScan software. Linear regression was then used to predict the number of days required for each treated plot

to return to 99% cover or a non-disrupted putting surface.

Results

The focus is on measurements of percent organic matter (% organic matter 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 estimates (from digital image analysis) of days required to achieve 99% cover following cultivation treatments.

At the end of 2008, only those coring treatments that removed 14.8% to 19.6% (treatments 5 and 6) significantly reduced % organic matter compared to the topdressed control (Table 1). Use of smaller tines alone (treatment 2), verticutting alone (treatment 3), or combinations of the two (treatment 4), failed to reduce % organic matter in 2008.

At the end of 2009, all treatments, except verticutting alone, significantly decreased %



Research was done on 10-year-old 'Penn A-4' practice putting greens at the Independence Golf Club, near Richmond, VA.

organic matter in the thatch/mat layer compared to the topdressed 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 inches (treatment 5) resulted in the least organic matter (3.1%) over the three years. Data also suggest that verticutting to 0.75 inches 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.

Very little change in % organic matter was measured due to treatments between 2009 and 2010. The only changes of note from 2009 to 2010 were an increase from 3.7 to 4.5% in treatment 4 (verticutting + small tine cultivation) and a slight increase (3.4 to 3.8%) in treatment 2 (small tines, twice over). Only where large tines were used to remove 14.8% or greater surface area (treatments 5-7) was it observed that % organic

matter levels were kept at significantly lower levels (3.1 to 3.3%) compared to the topdressed control (Table 2).

Fastest spring recovery (averaged over 2009 and 2010) of 29.5 days was measured for treatment 3 (verticutting). Large diameter coring (treatments 5-7) or small diameter coring + verticutting on the same day (treatment 4) required 35.5 to 40 days for spring recovery (Table 2). Late summer/early fall recovery data were very similar for cultivation treatments that remained the same as their spring counterpart. In particular, treatment 3 (verticutting) recovered in only 25.5 days (Table 2), while large diameter coring alone (treatment 6) required six fewer days of recovery (34 days versus 40 days) in the fall compared to the spring coring. Fastest September recovery of 8.5 days was observed with treatment 4 where only 2.5% surface removal occurred.

Data interpretation for treatments 2, 5, and

#	Treatment Details	Spring % removal March	Days to 99% cover	Fall % removal Sept	Days to 99% cover	Total % removal	Average Disrupted Days
1	control (sand only)	0	0	0	0	0	0
2	0.25" id core, 2 passes, spring and fall	5	32.5*	5	31*	10	32
3	verticut, 3-mm blade; spring and fall	11.8	29.5	11.8	25.5	23.6	27.5
4	0.25" id core + verticut 3-mm blade spring; 0.25" id core fall	2.5 +11.8	35.5	2.5	8.5	16.8	22
5	0.5" id core spring; 0.25" id core, 2 passes, fall	9.8	38.5*	5	30.5*	14.8	34.5
6	0.5" id core spring and fall	9.8	40	9.8	34	19.6	37
7	0.5" id core spring; verticut, 3-mm blade + 0.25" id core, 2 passes, fall	9.8	38.5	5 +11.8	41.5	26.6	40

*Two passes with the 0.25" inside diameter (id) tines resulted in undue tearing, hole overlap, and furrowing on the putting surface that served to delay recovery in treatments 2 and 5 in September.

Table 2. Total estimated days of disrupted putting quality in 2009 and 2010 (averaged) as affected by percent surface removal by various core cultivation and verticutting treatments

7 is confounded by 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 calculated 5%. Our plots were in 6 foot wide lanes that did not allow us to run our second coring pass at an angle to the first pass. Thus, many holes were being hit twice. 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 2 passes of the 0.25" id tines. Undue sod heaving was occurring, so verticutting was delayed until three to four weeks after coring, greatly extending the time required for recovery.

Visual quality ratings at various dates in 2008 and 2010 (Table 3) show that the control plots (sand topdressed only) did not suffer summer decline as might be expected without core aeration or deep verticutting for three consecutive years. Statistically, the control plots finished with the greatest thatch/mat organic matter (4.3%), but this 0.5 to 1% increase compared to more aggressive treatments, did not result in lower visual quality.

These results point to the importance of sand topdressing in diluting organic matter and maintaining a high quality putting green. Would only applying sand topdressing of at least 24 ft³/1,000 ft²/yr continue to provide acceptable

#	Treatment Details	Total % removal	Putting Green Visual Quality Rating*			
			July 2008	September 2008	August 2010	November 2010
1	control (sand only)	0	6.5 ab	7.5 ab	7.1 ab	7.8 a
2	0.25" id core, 2 passes; spring and fall	10	6.3 b	6.9 c	6.8 b	7.8 a
3	verticut, 3-mm blade; spring and fall	23.6	6.3 b	7.1 bc	6.6 b	7.5 ab
4	0.25" id core spring + verticut, 3-mm blade fall	16.8	6.3 b	7.3 abc	7.3 a	7.6 ab
5	0.5" id core spring; 0.25" id core, 2 passes, fall	14.8	6.5 ab	7.8 a	6.6 b	7.5 ab
6	0.5" id core spring and fall	19.6	6.1 b	7.1 bc	6.8 b	7.5 ab
7	0.5" id core spring verticut, 3-mm blade + 0.25" id core, 2 passes, fall	26.6	6.8 a	7.8 a	6.8 b	7.4 b
LSD (0.10)			0.4	0.5	0.4	0.3
* (1-9; 9=best); These ratings represent putting green quality either before cultivation treatments or after complete recovery from cultivation.						

Table 3. Average visual quality ratings (1-9) of 'A-4' creeping bentgrass as affected by various cultivation treatments.

putting green quality at this site near Richmond, VA for another one, three, or five years? Unfortunately, we do not have this information and cannot use these data to confidently predict if such would be the case. These results demonstrate the need for conducting long-term (5-15 year) field research trials.

Our ultimate goal was to determine cultivation treatments that are sufficient to adequately reduce thatch/mat % organic matter, while also disrupting putting surface quality for the least amount of time. The least disruptive treatment in terms of percent surface removal (treatment 2, 10%) healed relatively quickly (32 days) and reduced thatch/mat organic matter to an accept-

able level of 3.8% after three years. However, the fact that we lost ground between 2009 (3.4%) and 2010 (3.8%) may point to this practice not being sufficient in the long term.

Verticutting alone each spring and fall (treatment 3) resulted in the second fastest recovery of any treatment (27.5 days), but failed to significantly reduce organic matter to a level below the untreated. Treatment 4 resulted in the fewest average days of disruption over the season (22), but finished 2010 with the same amount of organic matter (4.5%) as the topdressed control. Verticutting and small tine coring may heal fast, but appears to be insufficient for organic matter dilution.

Using large tines (0.5" id) at a close spacing both spring and fall each year (19.6% surface removal, treatment 6) worked best in terms of minimizing final organic matter at 3.1%, but required approximately 5 to 15 extra days each season for recovery compared to the small tine and/or verticutting treatments. Finally, being very 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 organic matter dilution compared to treatments that removed 15 to 20% surface area.

Summary

In summary, three years of data indicate that various coring approaches can be combined with verticutting and consistent sand topdressing to achieve the goal of organic matter dilution. Annual removal of 15 to 20% surface area should be the goal for adequate dilution of organic matter in creeping bentgrass greens. While verticutting alone provides fast healing, our data indicate that it needs to be combined with at least one annual 10% coring for adequate organic matter dilution.

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