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Effects of Finer-Textured Topdressing Sand on Creeping Bentgrass Putting Green Turf

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Key Points:

- Topdressing improved the turf quality of the putting surface, reduced the OM concentration of the mat layer, and frequently produced a drier surface compared to non-topdressed plots.
- Medium-fine sand increased the fineness of sand within the mat layer, but this did not appear to influence volumetric water content compared to medium-coarse sand. Medium-coarse and medium-fine sand topdressing were similarly effective at reducing surface wetness.
- Fine-medium sand topdressing was not as effective at drying the surface due to the substantial increase in fine and very fine particles within the mat layer.
- Core cultivation and backfilling with medium-coarse sand was effective at reducing surface wetness and OM concentration as well as reducing the fineness of sand within the mat layer of medium-fine and fine-medium topdressed plots.

Sand topdressing of putting greens during the season is often avoided due to the potential of coarse sand particles interfering with play and dulling mower blades. This project is evaluating the effect of topdressing sand size on the playability and physical properties of putting green turf. Specific objectives include determining the effects that core cultivation and eliminating coarse particles from topdressing sand has on turf performance and the surface physical properties of a 'Shark' creeping bentgrass (*Agrostis stolonifera*) turf.

This trial was initiated in May 2016 on a 19-month-old 'Shark' creeping bentgrass maintained at 2.8-mm on a sand-based root zone. A 3 x 2 x 2 factorially arranged randomized complete block design with four replications included the factors of sand size (medium-coarse, medium-fine, fine-medium), quantity of mid-season (June to September) topdressing (50 and 100 lbs./ 1,000 sq. ft. every 10 to 14 days), and cultivation (non-cultivated or core cultivation plus backfill in May and October). Two non-topdressed controls (at both levels of cultivation) were included for comparisons resulting in 14 total treatments (Table 1). The medium-coarse sand met USGA recommendations for putting green construction; whereas the fine sand content of medium-fine and fine-medium topdressing sands exceeded USGA recommendations and contained little to no coarse particles (Table 2).

Turf color, density and quality was visually rated June through October. Volumetric water content (VWC) of the surface 0- to 38-mm and 0- to 76-mm depth zone was monitored routinely. Mower clippings from each plot were collected the day after topdressing three times during 2016 and 2017, to determine the quantity and particle size distribution of sand collected during mowing. Clipping samples collected in 2017 are being combusted to remove clippings and then sieved in the laboratory to determine particle size distribution. Core samples were collected before and one-year after treatment initiation to characterize the thickness of the thatch-mat layer and content of sand and organic matter (OM). Four 3-inch diameter undisturbed core samples were collected one-year after treatment in May 2017.

Sand Collected by Mower (Table 3)

Topdressing with medium-coarse sand increased the quantity and portion of sand collected during mowing compared to medium-fine and fine-medium sands during 2016. The portion of topdressing sand collected by the mower increased as the topdressing rate increased.

Mat Layer Depth and Organic Matter (OM) Concentration (Table 4)

Topdressing increased the depth of the mat layer and decreased the OM concentration compared to non-topdressed controls. Topdressing at 100 lbs./1,000 ft^2 developed a thicker mat layer depth and lower OM concentration compared to topdressing at 50 lbs./1,000 ft^2. Core cultivation reduced OM concentration but did not influence mat layer depth.

Sand Size Distribution in Mat Layer After One Year of Treatments (Table 5)

Core samples collected in 2017 are currently being measured in the lab; however, our initial assessment (1 of 4 subsamples) indicated that sand size of topdressing has affected the sand size distribution within the mat layer. Fine-medium and medium-fine sand topdressing increased the fineness of sand within the mat layer compared to topdressing with medium-coarse sand. Topdressing at 100 lbs./1,000 ft^2 with fine-medium sand intensified this response; whereas the fineness of sand in the mat layer was not strongly affected by the topdressing rate of medium-fine sand (data not shown).

Additionally, the resulting sand size distribution in the mat layer was dependent on topdressing rate and level of core cultivation (Figure 5a). Plots that were core cultivated and backfilled with medium-coarse sand offset the increased fineness of the mat layers formed by topdressing with fine-medium and medium-fine sand (Figure 5b).

Volumetric Water Content (VWC; Figures 1 to 3)

Core cultivation decreased VWC at the 0- to 38-mm surface depth zone throughout 2017 compared to non-cultivated plots (Figure 1). The effect of sand size on surface wetness depended on the cultivation factor. Without core cultivation, medium-coarse and medium-fine sand topdressing produced a drier surface compared to plots topdressed with fine-medium sand (Figure 2a). However, this sand size effect was either less prominent or not observed when plots were core cultivated (Figure 2b). Under core cultivation, the VWC of non-topdressed control plots was similar to topdressed plots (data not shown).

Table 1. Summary of the individual treatment combinations of topdressing (sand size and rate) and cultivation as well as two controls (no topdressing during the growing season) being evaluated on 'Shark' creeping bentgrass turf grown on a sand-based rootzone.

	Factors in the Experiment			
Treatment No.	Sand Size[†]	Topdressing Sand Rate during the Growing Season[‡]	Cultivation[¶]	Annual Quantity of Sand Applied
		lbs. / 1,000 sq. ft.		lbs. / 1,000 sq. ft.
1	Medium-coarse	50	Non-cored	1,300
2	Medium-coarse	50	Core + Backfill	1,700
3	Medium-coarse	100	Non-cored	1,800
4	Medium-coarse	100	Core + Backfill	2,200
5	Medium-fine	50	Non-cored	1,300
6	Medium-fine	50	Core + Backfill	1,700
7	Medium-fine	100	Non-cored	1,800
8	Medium-fine	100	Core + Backfill	2,200
9	Fine-medium	50	Non-cored	1,300
10	Fine-medium	50	Core + Backfill	1,700
11	Fine-medium	100	Non-cored	1,800
12	Fine-medium	100	Core + Backfill	2,200
13	None	0	Non-cored	0
14	None	0	Core + Backfill	1,200

[†], First-mentioned size class represent the predominant size fraction in the sand.

[‡], Topdressing applied every two weeks from 10 June through 12 October (10 applications) in 2016 and every 10-14 days from 12 June to 28 September (10 appliactions) in 2017. Topdressing at 50 lbs. per 1,000 sq. ft. represented a 'dusting' quantity (O'Brien and Hartwiger, 2003); whereas, topdressing at 100 lbs. filled the surface thatch and lower verdure layers.

[¶], Core cultivation to the 1 ½-in depth was performed twice a year (10 May and 2 November in 2016; 15 may and 9 October in 2017) using ½-inch diameter hollow tines spaced to remove 10% of the plot surface area annually. Coring holes were backfilled with 600 lbs. per 1,000 sq. ft. of medium-coarse sand. Non-cored plots were topdressed with the respective sand size at 400 lbs. per 1,000 sq. ft. (300 lbs. per 1,000 sq. ft. in October 2016) to fill the surface thatch and verdure layers to the same extent as backfilled, cored plots.

Table 2. Particle size distribution of three sands used to topdress plots on a 'Shark' creeping bentgrass turf grown on a sand-based rootzone.

Sand	1000 µm Very Coarse	500 µm Coarse	250 µm Medium	150 µm Fine	53 µm Very Fine
	---------- % (by weight) retained ----------				
Medium-coarse	0	33.8	57.7	8.4	0.1
Medium-fine	0	0.1	76.7	22.7	0.5
Fine-medium	0	5.7	25.8	66.8	1.7

Table 3. Analysis of variance of sand picked-up with one pass of a mower (1.9 m^2) on the day after topdressing during 2016.

Sampling Date	7-Jul		17-Aug		28-Sep	
Mowing Height	0.110 inch		0.110 inch		0.125 inch	
Source of variation	Sand Picked-up‡	Portion of Sand Applied¶	Sand Picked-up	Portion of Sand Applied	Sand Picked-up	Portion of Sand Applied
	lbs./1,000-ft^2	%	lbs./1,000-ft^2	%	lbs./1,000-ft^2	%
Sand Size (SS)	***	***	***	***	***	***
Topdressing Rate (TR)	***	*	***	***	***	***
SS*TR	***	NS	***	NS	NS	NS
Core Cultivation (CC)	NS	NS	NS	NS	NS	NS
SS*CC	NS	NS	NS	NS	NS	NS
TR*CC	NS	NS	NS	NS	NS	NS
SS*TR*CC	NS	NS	NS	NS	NS	NS
Main Effect						
Sand Size						
Medium-coarse	4.0	0.5	5.4	0.8	1.3	0.2
Medium-fine	1.9	0.3	3.2	0.4	0.7	0.1
Fine-medium	1.9	0.3	1.8	0.2	0.6	0.1
LSD (5%)	0.4	0.1	0.5	0.1	0.1	0.0
Topdress Rate (lbs/1000 ft^2)						
50 lbs./1,000 ft^2	1.6	0.3	2.1	0.4	0.5	0.1
100 lbs./1,000 ft^2	3.6	0.4	4.8	0.5	1.2	0.1
LSD (5%)	0.3	0.0	0.4	0.1	0.1	NS
Core Cultivation						
None	2.4	0.3	3.3	0.5	0.8	0.1
Twice a year	2.8	0.4	3.7	0.5	0.9	0.1
LSD (5%)	NS	NS	NS	NS	NS	NS

* Significant at p≤0.05; ** significant at p≤0.01; *** significant at p≤0.001; NS: nonsignificant ‡ Sand and clippings combusted at 360 °C for 24 hours and weighed after removal of ash. ¶ Weight of sand collected by mower ÷ weight of topdressing applied to mowing area x 100

Table 4. Orthogonal contrasts and analysis of variance of the depth and organic matter concentration of the mat layer one-year after initiation of treatments in May 2017.

Orthogonal Contrasts	Depth[¶]	Organic Matter[‡]
	mm	%
Non-cultivated: Topdressed	17.4 ***	6.7 ***
vs. Non-topdressed	13.7	9.2
Cultivated: Topdressed	17.0 *	5.5 ***
vs. Non-topdressed	15.2	7.1
Source of Variation		
Sand Size (SS)	ns	ns
Topdress Rate (TR)	***	***
SS x TR	ns	ns
Core Cultivation (CC)	ns	***
SS x CC	ns	ns
TR x CC	ns	ns
SS x TR x CC	ns	ns
Main Effects		
Sand Size		
Medium-coarse	17.2	6.1
Medium-fine	17.4	6.1
Fine-medium	16.9	6.1
LSD (5%)	ns	ns
Topdressing Rate		
50 lbs./1,000-ft^2	16.4	6.4
100 lbs./1,000-ft^2	17.9	5.8
LSD (5%)	0.7	0.3
Core Cultivation		
Non-cultivated	17.4	6.7
Core Cultivated	17.0	5.5
LSD (5%)	ns	0.3

[¶] The average mat layer depth was 6.3-mm at the initiation of treatments in May 2016.

[‡] The average organic matter concentration was 6.7 % at the initiation of treatments in May 2016.

* Significant at p≤0.05; ** significant at p≤0.01; *** significant at p≤0.001; ns: not significant

Table 5a. Orthogonal contrasts and analysis of variance of sand particle sizes within the mat layer one-year after initiation of treatments in May 2017.

	Size Class/Particle Diam. (mm)				
	V. coarse	Coarse	Medium	Fine	V. Fine
	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.15	0.15-0.05
	%	%	%	%	%
Orthogonal Contrasts					
Non-cultivated: Topdressed	2.9 ***	19.4 ***	47.7 ns	24.2 ***	5.8 ***
vs. Non-topdressed	4.6	25.4	46.4	19.7	3.8
Core Cultivated: Topdressed	2.8 *	19.7 ns	52.3 ns	20.9 *	4.3 ns
vs. Non-topdressed	3.5	21.7	51.9	19.2	3.7
Source of Variation					
Sand Size (SS)	**	***	***	***	***
Topdress Rate (TR)	*	ns	ns	ns	**
SS*TR	ns	ns	***	***	***
Core Cultivation (CC)	ns	ns	***	***	***
SS*CC	ns	**	***	***	***
TR*CC	ns	ns	ns	ns	ns
SS*TR*CC	*	*	ns	ns	ns

* Significant at p≤0.05; ** significant at p≤0.01; *** significant at p≤0.001; ns: not significant

Table 5b. The interaction effects of sand size and topdressing rate, and sand size and core cultivation on the proportion of sand sizes within the mat layer one-year after initiation of treatments in May 2017.

Interactions		Size Class				
		V. coarse 2.0-1.0 mm	Coarse 1.0-0.5 mm	Medium 0.5-0.25 mm	Fine 0.25-0.15 mm	V. Fine 0.15-0.05 mm
		%	%	%	%	%
Sand Size	Topdressing Rate					
Medium-coarse	50 lbs./1,000 ft^2	3.0	24.8	51.2 c	18.1 d	2.9 d
Medium-coarse	100 lbs./1,000 ft^2	2.8	25.2	52.6 bc	16.6 e	2.8 d
Medium-fine	50 lbs./1,000 ft^2	3.2	17.7	54.0 b	**21.5 c**	3.6 c
Medium-fine	100 lbs./1,000 ft^2	2.9	15.8	56.4 a	**21.4 c**	3.6 c
Fine-medium	50 lbs./1,000 ft^2	2.7	17.7	44.5 d	**27.3 b**	**7.8 b**
Fine-medium	100 lbs./1,000 ft^2	2.4	**16.2**	**41.4 e**	**30.4 a**	**9.5 a**
	LSD (5%)	ns	ns	1.4	0.9	0.5
Sand Size	Core Cultivation					
Medium-coarse	Non-cultivated	2.9	26.6 a	50.5 c	17.2 e	2.8 e
Medium-coarse	Cultivated	2.9	23.4 b	53.2 b	17.4 e	3.0 de
Medium-fine	Non-cultivated	3.1	15.6 d	54.5 ab	**23.0 c**	3.9 c
Medium-fine	Cultivated	3.0	17.9 c	55.9 a	19.9 d	3.3 d
Fine-medium	Non-cultivated	2.6	**16.1 d**	**38.0 e**	**32.4 a**	**10.9 a**
Fine-medium	Cultivated	2.5	17.8 c	47.9 d	**25.3 b**	**6.5 b**
	LSD (5%)	ns	1.1	1.4	0.8	0.4

¶ Different letter indicates statistically difference between treatments at $\alpha = 0.05$

‡ Bold font indicates failure to meet USGA guidelines

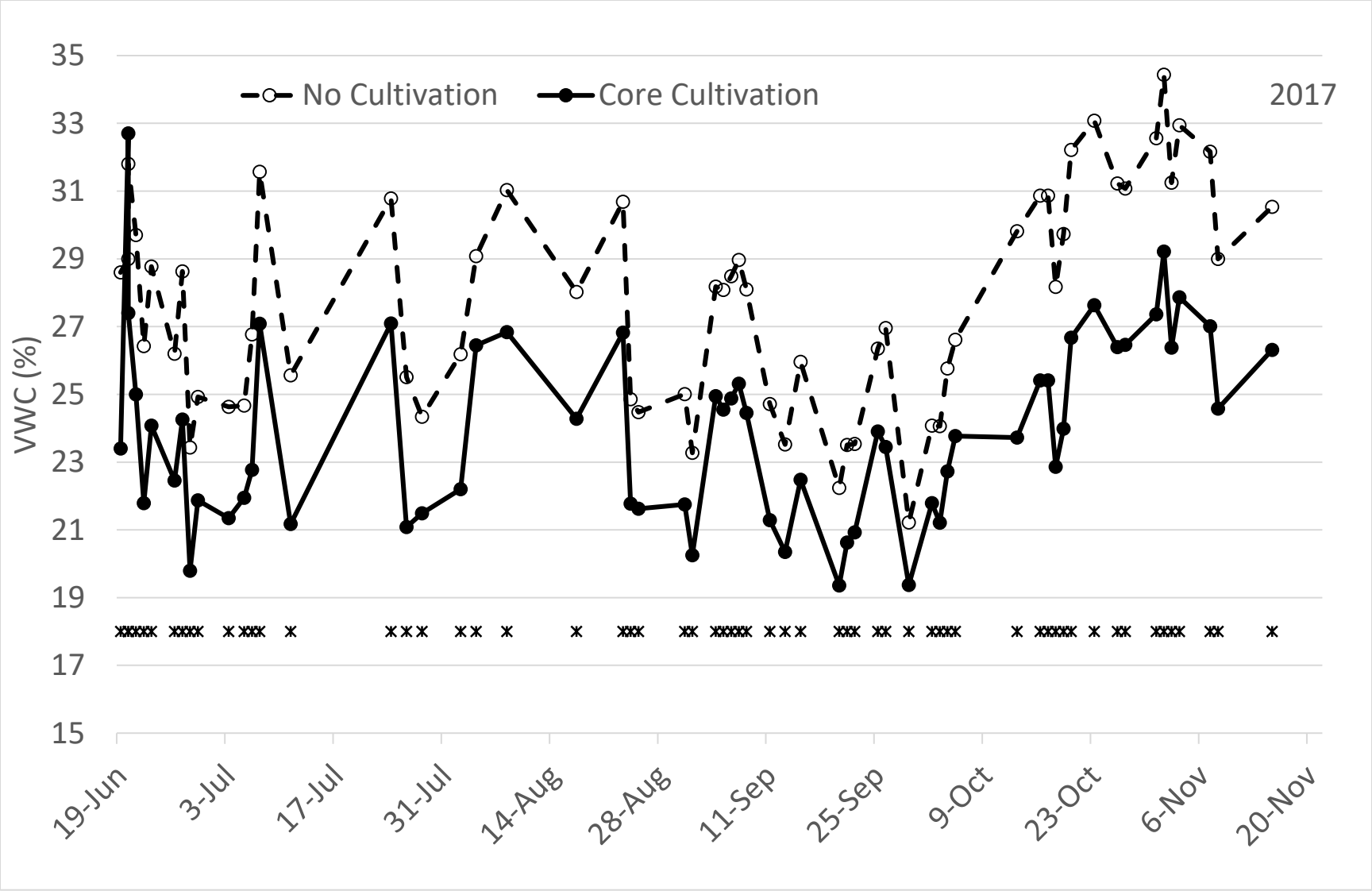

Figure 1. The core cultivation main effect on volumetric water content at the 0- to 38-mm surface depth zone of a 'Shark' creeping bentgrass turf maintained at 2.8-mm in North Brunswick, NJ during 2017.

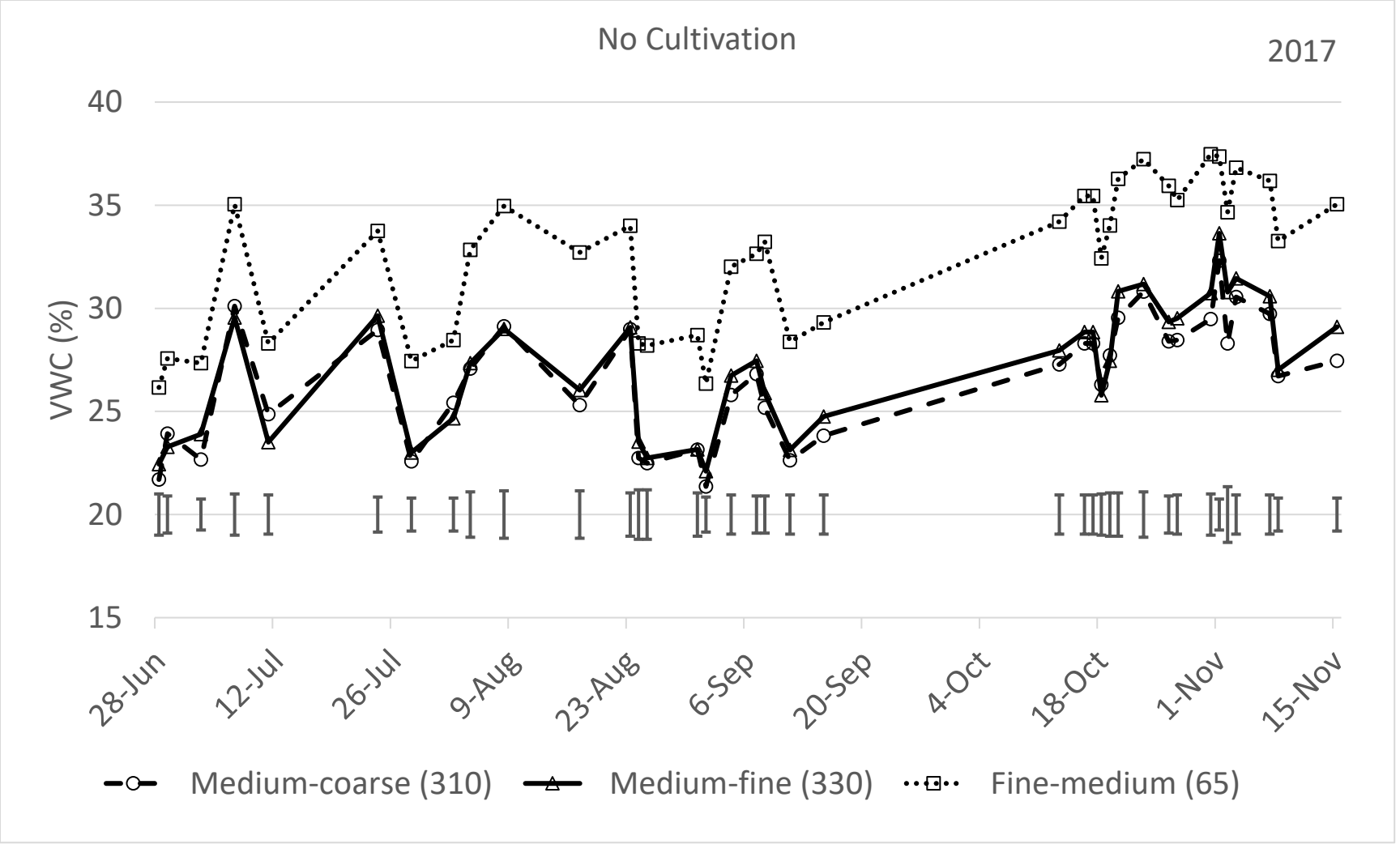

Figure 2a. The sand size effect under no cultivation on volumetric water content at the 0- to 38-mm surface depth zone of a 'Shark' creeping bentgrass turf maintained at 2.8-mm in North Brunswick, NJ during 2017.

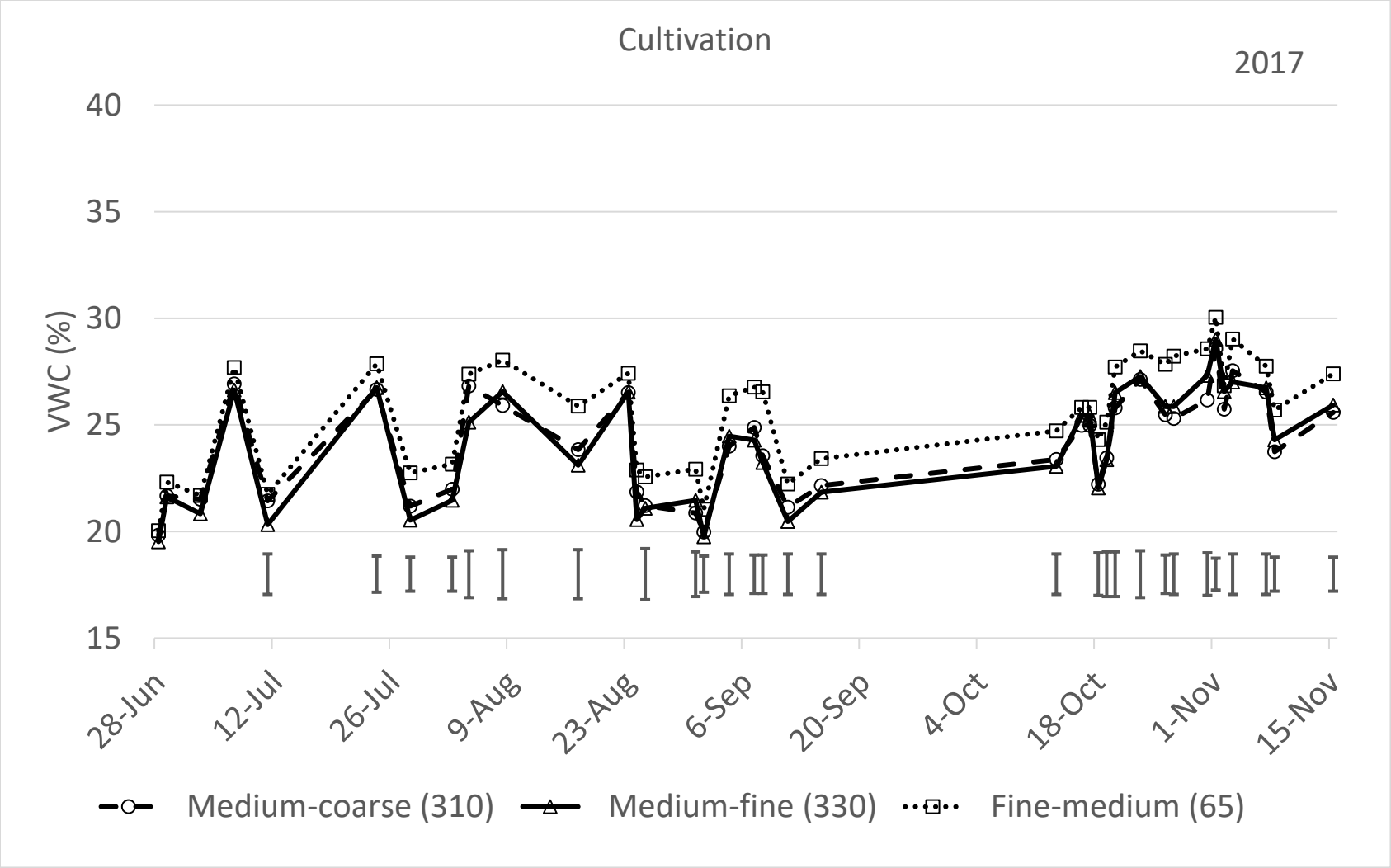

Figure 2b. The sand size effect under core cultivation on volumetric water content at the 0- to 38-mm surface depth zone of a 'Shark' creeping bentgrass turf maintained at 2.8-mm in North Brunswick, NJ during 2017.

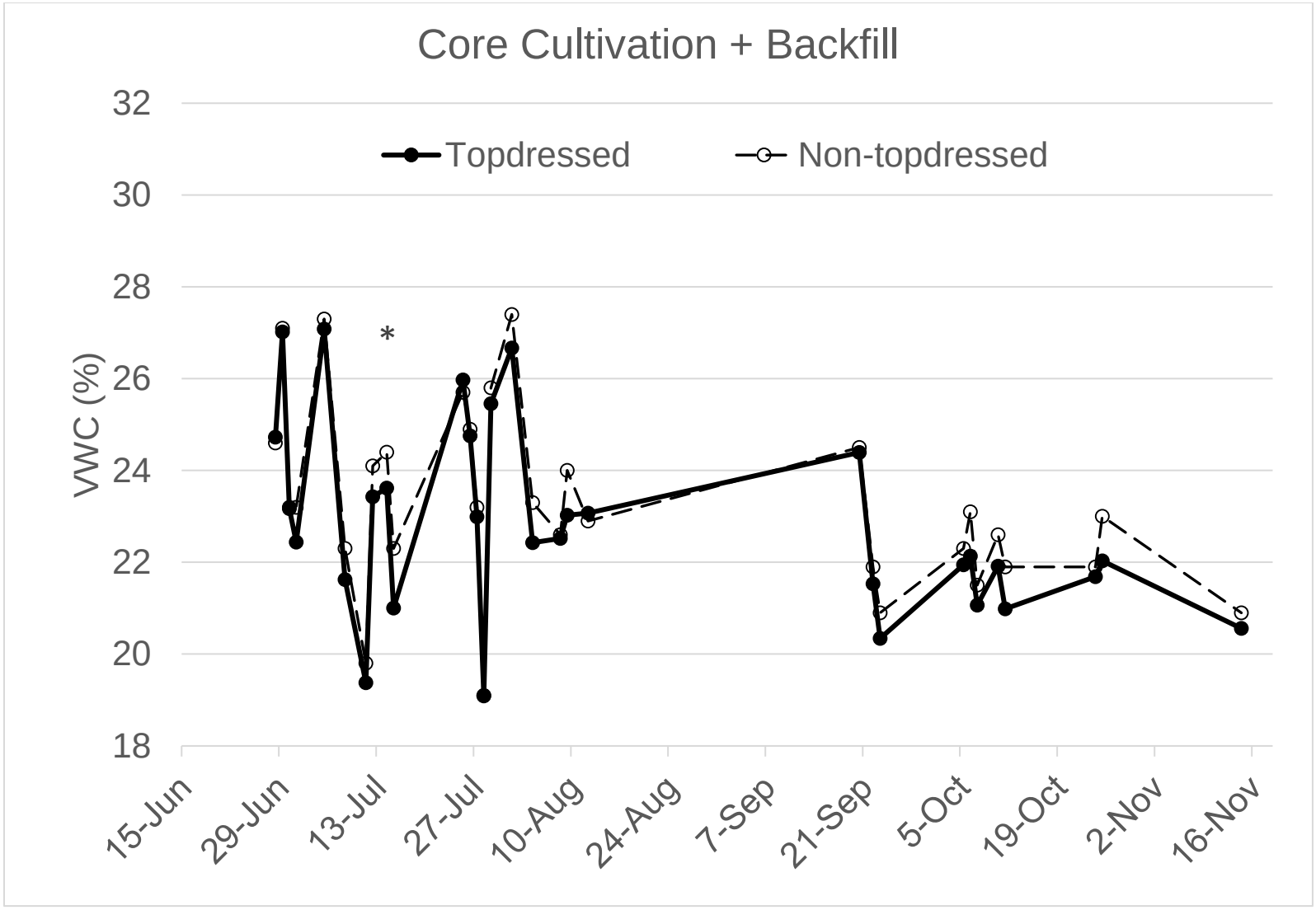

Figure 3a. The pooled effect of topdressing under core cultivation compared to non-topdressed plots on volumetric water content at the 0- to 38-mm surface depth zone of a 'Shark' creeping bentgrass turf maintained at 2.8-mm in North Brunswick, NJ during 2017.

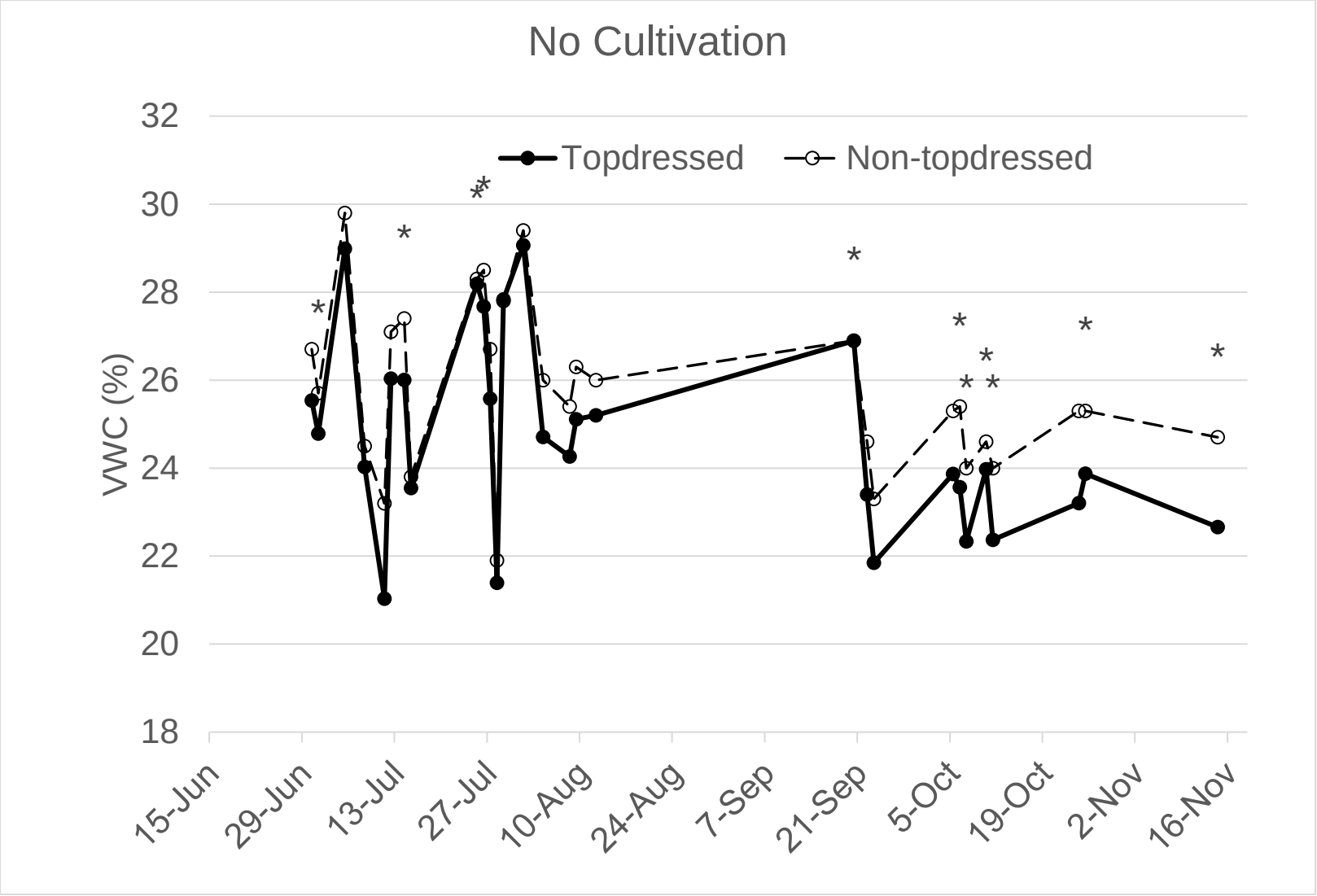

Figure 3b. The pooled effect of topdressing under no cultivation compared to non-topdressed plots on volumetric water content at the 0- to 38-mm surface depth zone of a 'Shark' creeping bentgrass turf maintained at 2.8-mm in North Brunswick, NJ during 2017.