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#### TABLE 2

Turfgrass quality of 42 bermudagrass cultivars after four and eight weeks of full sun (control) and 64 percent continuous shade at the Clemson University greenhouse complex. NTEP turf quality (1 to 9).

and the second second	Turfgrass Quality				
	We	eek 4	We	eek 8	
Cultivar	Full Sun	Shade	Full Sun	Shade	Rank
Celebration	7.5a-c <sup>‡</sup>	6.5ab	7.3a-d A	4.5a-c B	2/2
TiftNo.4	7.3a-d	6.2a-d	7.8a A	4.8ab B	2/2
TiftNo.1	7.2b-e	6.3a-c	7.2a-d A	4.3a-d B	2/2
Transcontinental	7.0c-f	6.0а-е	6.8b-f A	4.3a-d B	2/2
Aussie Green	7.5a-c	7.2a	7.8a A	5.3a B	2/2
MS-Choice	6.8c-g A§	5.8b-e B	7.3a-d A	3.7c-h B	0/2
Princess 77	7.2b-e A	5.3b-h B	6.8b-f A	3.7c-h B	0/2
SWI-1045	7.2b-e A	5.5b-g B	7.0а-е А	3.7c-h B	0/2
SWI-1041	7.8ab A	5.3b-h B	7.3a-d A	3.5c-1 B	0/2
SWI-1012	7.0c-f A	5.3b-h B	7.0а-е А	4.0b-f B	0/2
Tifway	7.5a-c A	5.0d-i B	7.5a-c A	3.2e-i B	0/2
Tifsport	7.2b-e A	5.5b-g B	7.7ab A	3.3d-i B	0/2
SWI-1014	7.5a-c A	5.5b-g B	7.2a-d A	3.2e-i B	0/2
GN-1	6.2g-j A	4.5f-i B	6.2e-g A	3.2e-i B	0/2
Patriot	6.3f-i A	4.5f-i B	6.5d-f A	2.5i B	0/2
Sundevil	6.7d-h A	5.0d-i B	6.8b-f A	3.7c-h B	0/2
SR 9554	6.3f-i A	4.8e-i B	6.7c-f A	3.0f-i B	0/2
Arizona Common	5.5j A	4.2hi B	5.5g A	3.0f-i B	0/2
p-value	0.0001f	0.0001	0.0001	0.0001	

*†* Rank indicates number of times cultivar placed in top statistical category when grown under 64 percent shade. Greatest shade tolerance = 2/2, greatest shade sensitivity = 0/2.

‡ Values within a column followed by the same letter are not significantly different at P≤0.05 by protected LSD. § Values within a row within each week for turfgrass quality followed by the same letter are not significantly different at P≤0.05 by protected LSD.

f Indicates statistical difference at p≤0.05.

\* For a complete list of results from all cultivars, please e-mail: cmbaldw@clemson.edu

#### Continued from page 60

using analysis of variance (ANOVA) within the Statistical Analysis System. An alpha of 0.05 was used to determine any statistical significance among treatments.

Tested cultivars produced significantly higher chlorophyll concentrations at week four when grown in shade, but this response proved to be transient.

#### **Turfgrass quality**

By week four, poorest-performing cultivars included GN-1 (4.5), Patriot (4.5) and Arizona Common (4.2), while Aussie Green (7.2), Celebration (6.5), TiftNo.4 (6.2), Tift-No.1 (6.3) and Transcontinental (6.0) maintained acceptable turf quality (TQ) ratings following four weeks of 64 percent shade (Table 1, p. 60).

In a previous study, Celebration was noted for its relative shade tolerance compared to other bermudagrass cultivars (Bunnell et al., 2005). Industry standards, Tifway and Tif-Sport, had TQ scores of 5.0 and 5.5, respectively. Results agree with Jiang et al. (2004) as TifSport bermudagrass was deemed shade sensitive when compared to various seashore paspalum cultivars.

After eight weeks of continuous 64 percent shade, all cultivars had severe tissue discoloration (Table 1). However, Aussie Green (5.3), TiftNo.4 (4.8) and Celebration (4.5) maintained significantly higher TQ scores compared to Patriot (2.5), SR 9554 (3.0) and Arizona Common (3.0). Gaussoin et al. (1988) also noted Arizona Common as highly shade-intolerant when compared to 31 other bermudagrass cultivars.

Transcontinental, Aussie Green, Celebration, TiftNo.4 and TiftNo.1 were the only cultivars not to show a significant decline in TQ by week four when grown in shade compared to full sun. However, at week eight all cultivars grown in shade had a significant decline in TQ compared to full-sun.

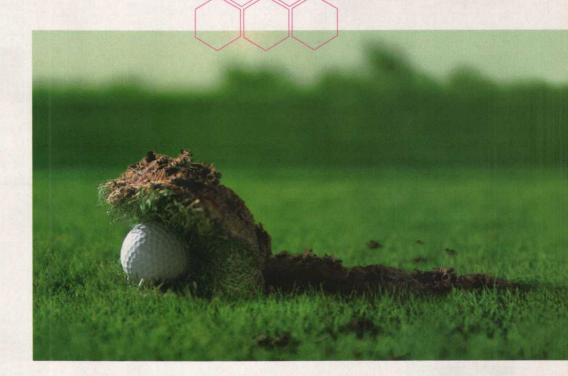
#### Chlorophyll, root length

The shade-grown cultivar with highest chlorophyll concentration was TiftNo.4 at week four (2.47) and week eight (2.77), while TifSport and Arizona Common had lowest chlorophyll concentrations at week four (1.54) and week eight (1.31), respectively (Table 2). In shade, SWI-1041, Princess 77 and TiftNo.1 had 28-percent greater chlorophyll than Tifway, GN-1 and SWI-1014 at week four. By week eight, SWI-1012 and SWI-1045 had 52-percent greater chlorophyll when grown in shade than GN-1 and SWI-1014.

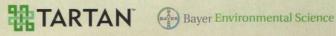
Interestingly, cultivars produced significantly higher chlorophyll concentrations at week four when grown in shade, however, this response was transient (Table 2). By week eight, most cultivars chlorophyll concentration declined. Greatest decline for shade-grown *Continued on page 64* 

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#### TABLE 3

Overall shade tolerance rank of 42 bermudagrass cultivars after 8 weeks of full sun (control) and 64 percent continuous shade at the Clemson University greenhouse complex.

Cultivar	Rank <sup>†</sup>	Cultivar	Rank
Celebration	6	Mohawk	1
TiftNo.4	5	SWI-1001	1
TiftNo.1	5	Tifway	1
Transcontinental	5	Midlawn	1
SWI-1003	4	Tifsport	1
Sunbird	4	OR 2002	1
Aussie Green	3	Ashmore	1
MS-Choice	3	CIS-CD5	1
Princess 77	3	CIS-CD6	1
SWI-1045	3	CIS-CD7	1
SWI-1041	3	Panama	1
SWI-1012	3	La Paloma	1
B-14	2	Yukon	1
Riviera	2	OKC 70-18	1
SWI-1046	2		1
TiftNo.3	2		0
Southern Star	2	GN-1	0
TiftNo.2	2	Patriot	0
Sunstar	1	Sundevil	0
SWI-1044	1	SR 9554	0
FMC-6	1	Arizona Common	0

tRank indicates number of times a cultivar placed in the top statistical category when grown under 64 percent continuous shade. Greatest shade tolerance = 6, greatest shade sensitivity = 0.



#### QUICK TIP

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#### Continued from page 62

cultivars compared to full sun was SWI-1014, with a 76-percent decline, while Aussie Green only had a 29-percent reduction.

Cultivars grown under 64 percent shade showed little root-length variation, however, differences were statistically different. The most striking difference was TifSport producing 75 percent greater root length than Arizona Common. Overall, root length was least affected by shade compared to other parameters measured. Shade-grown cultivars, Arizona Common, SWI-1014 and Sundevil had 63-percent, 59-percent, and 41-percent decreases, respectively, compared to control (full sun).

Root biomass was severely restricted when cultivars were grown under 64 percent shade. MS-Choice, Transcontinental and Celebration produced about 158 percent greater root biomass than GN-1, Arizona Common and SR 9554.

Each cultivar, regardless of shade tolerance

or sensitivity, had a significant reduction in root biomass. Aussie Green grown in shade had least root mass reduction (133 percent) compared to full sun, while SWI-1014 had greatest root mass decline (332 percent) compared to full sun.

Results indicate the genetic variability of shade tolerance exists among bermudagrasses and future bermudagrass improvement focusing on shade tolerance is promising. Bermudagrass cultivars, in particular newer commercially available and experimental ones, demonstrated great genetic diversity. Based on rank of significant parameters (TQ, chlorophyll, root biomass and root length), the best cultivars were Celebration, TiftNo.4, TiftNo.1 and Transcontinental. Cultivars with intermediate shade tolerance included Aussie Green, MS-Choice, Princess 77, SWI-1045, SWI-1041 and SWI-1012. Most shade-sensitive cultivars were SWI-1014, Arizona Common, Sundevil, SR 9554, GN-1 and Patriot.

Future research will further analyze the relatively shade-tolerant and shade-intolerant cultivars to provide insight into the physiological mechanisms associated with such variation that exists among bermudagrass shade responses.

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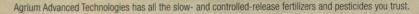
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# Soil Profile Dictates Topdressing Programs

#### By Adam C. Moeller and Cale A. Bigelow

opdressing, or the regular application of thin layers of sand to golf course putting greens, has been used as an important cultural practice since the early days of Old Tom Morris at St. Andrews Golf Links (Labbance and Witteveen, 2002). The benefits of sand topdressing for thatch management and surface firmness, smoothness and grain control are well recognized.

Insufficient sand topdressing may result in excessive organic matter accumulation in the upper-soil profile. Excessive organic matter, or thatch, results in greater pest damage, shallow rooting, poor soil air exchange and may cause the turf to be more prone to scalping.

The most-effective surface organic matter management programs for putting greens normally combine hollow tine aerification with regular sand topdressing. In addition to a seasonal heavy application to back-fill aerification holes, sand should be applied frequently enough to match seasonal shoot growth and to prevent an organic layer from forming.

In recent years, this has been conducted biweekly using light applications of sand during the growing season to dilute organic matter and smooth out wear areas. If applications are spaced too far apart using too much sand, then layering occurs and little thatch management actually takes place.

#### Topdressing application frequency

In the past three decades, the frequency of topdressing applications has changed significantly. The introduction of new application equipment turned a former time-consuming, laborintensive process into a relatively quick and easy management practice. This has enabled golf course managers the ability to apply very small, precise amounts of sand more regularly.

Add to this the prevalence of improved high shoot density creeping bentgrass cultivars [*Agrostis stolonifera L.* var *palustris* (Huds.) Farw.] that produce higher amounts of organic matter and elevated golfer expectations for firm, smooth and fast-playing surfaces, and you have a recipe that demands more frequent topdressing.

Although topdressing application frequency has increased, the overall annual amount seems to be declining. Ultralight topdressing on a weekly basis is not always enough to keep up with organic matter accumulation.

It is important to remember that for effective thatch

management, it is necessary to match the rate of organic matter production with appropriate amounts of topdressing material. Some greens may require more topdressing than others due to differences in growing environments, fertility programs, traffic and compaction. Cool-season turfgrass organic matter production is highest during periods of cool temperatures (32 to 55 degrees Fahrenheit) and in areas with poor air circulation and high moisture (Carrow, 2003).

The frequency of applications and topdressing rates may need to be increased for regions that experience any of these conditions for the majority of the year.

#### Sand particle sizes

A long-term successful topdressing program normally includes the use of a material with a particle-size distribution that matches the underlying rootzone. For properly constructed sand-based rootzones this is relatively easy since you simply purchase a sand that matches the construction sand. Native soil greens present a challenge. However, using a sand that meets USGA specifications (Figure 1) is advisable because these sands are developed to provide optimal soil physical properties; good water retention and drainage; and resistance to compaction (USGA Green Section Staff, 2004).

Sands meeting USGA specifications normally contain  $\geq 60$  percent in the medium-coarse size fraction. On many closely mowed newer putting greens, coarse topdressing sand particles may be easily picked up by greens mowers. Finer sand is easier to work into the turf canopy, especially at lower mowing heights, and with new high shoot density bentgrass cultivars, and a desire to have less impact on play, are all persuading turf managers to switch to finer sands. The long-term implications of this practice are not well understood.

Within reason, topdressing particles slightly coarser than an existing rootzone will not adversely affect long-term soil physical characteristics. Conversely, topdressing sand that is dramatically finer than an existing rootzone may have serious negative consequences on soil physical properties. As putting greens age, saturated hydraulic conductivity or percolation declines naturally due to the loss of macropore space from organic matter accumulation or sometimes silt and clay migration into the upper profile.

A similar loss of macropore space occurs when finer sand is used for topdressing. Additionally, a distinct layer forms at the surface resulting in a perched water table. This layer restricts drainage and air movement, resulting in a softer, wetter surface more prone to scalping.

Improperly timed topdressing during summer stress periods can cause leaf abrasions, which may cause a loss of turf density and aesthetics (Dernoeden, 2002).

Mechanical injury can also occur when forcing sand particles into the turf canopy with brushes or other attachments. Stiff brushes and high temperatures can make plants more susceptible to stress-induced diseases and weed infestation. If a turf stand is stressed or weak, even light applications of topdressing should be delayed until plants are healthy and actively growing.

#### Sand selection

Selecting topdressing sand is a very important decision and should be made with a long-term performance characteristics and thatch management program in mind. Analysis of particle-size distribution should always be done before using any topdressing sand to ensure that it matches or is slightly coarser than an existing sand rootzone. This is best handled by an accredited soils testing laboratory. However, if you have a set of sieves this test can be done in matter of minutes. A minimum of six sieves plus the pan is required. The sieves sizes include: 2mm, 1mm, 0.5mm, 0.25mm, 0.15mm, 0.5mm.

A sample of at least 60 grams (about 1 tablespoon) is needed; shake for a minimum of five minutes to ensure adequate separation of finer particles and determine the weight of each size class. An appropriate sand will contain 60 percent medium-coarse particles and should not posses more than 20 percent fines.

Other things to consider are: sand shape and purity, calcareous vs. silica, source location, cost, and delivery options.

#### TABLE 1

Percent moss as affected by five thatch management programs, three creeping bentgrass cultivars and two annual nitrogen levels, 2005.

	And the second second	Moss incidence	
		2005	
Management program <sup>†</sup>	Sand particle size	24 July	
		% moss cover	
HT + Seas. Top.	Medium-coarse	0.1 bc*	
HT + Freq. Top.	Medium-coarse	0.4 bc	
HT + Seas. Top.	Medium-fine	0.9b	
HT + Freq. Top.	Medium-fine	1.9a	
Freq. Top. Only	Medium-coarse	0.1c	
Cultivar			
A-4		0.0b	
L-93		0.2b	
Penncross	about a unar anti-/ gra	1.7a	
Annual N level <sup>‡</sup>			
2.3 lbs. N yr-1		0.9a	
4.0 lbs. N yr-1		0.4b	

t Hollow tine aerification occurred on 14 April and 14 September.

# Nitrogen was applied either as liquid or granular formulations depending on application rates and dates.

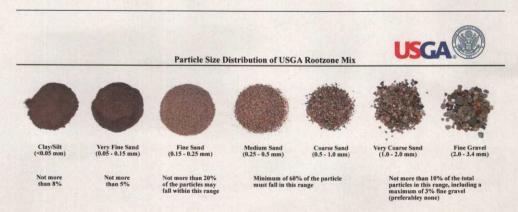
\* Means in the same column followed by the same letter are not significantly different according to Fisher's protected LSD t-test (p=0.05)

Sand shape is sometimes overlooked when considering topdressing material. Angular sand resists shifting better than rounded sand. Either sand shape will work for topdressing, but it is generally recommended that you attempt to match the existing rootzone because the new material will ultimately make up the upper profile.

#### **Current research**

Research is ongoing in the third year at Purdue University evaluating the effectiveness of various putting green sand topdressing programs.

Our research objectives are to develop specific topdressing requirements for low (Penncross), medium (L-93), and high (A-4) shoot density bentgrass cultivars maintained at two different nitrogen levels. Clearly there are large Continued on page 68





#### QUICK TIP

Water is our most precious natural resource and the most important resource for turfgrass growth and survival. Plants typically consist of 75 percent to 85 percent water. Unlike humans who have the ability to move and find water, immobile plants must extract water from their local environment. But a plant that is potassium deficient will have more trouble pulling water into its roots. Maintaining adequate levels of potassium will enable a plant to better regulate its water status. Controlled-release sources of potassium can play an important part in your fertilizer program, especially on your greens where potassium readily leaches. Using **POLYON® 0-0-50** micro and even our 0-0-45 mini, incorporated into aerification holes, can provide long-term sources of potassium to your turf.

#### Continued from page 67

differences between the shoot density of cultivars and their ability to maintain density during the summer months. This likely affects topdressing needs and strategies as well.

We are monitoring the long-term changes in rootzone physical properties of a sand-based putting green rootzone topdressed with two sand sizes. These programs also vary with sand application frequency with and without seasonal hollow tine cultivation. The sand (one cubic foot per week) is lightly brushed into the turf canopy. Additionally, performance characteristics such as appearance, volumetric soil water content, surface hardness, dollar spot incidence, and moss encroachment are being documented.

Moss (*Bryum agentium*) encroachment is more evident on our research plots that received frequent topdressing each week throughout the summer months. Moss incidence was highest in Penncross plots topdressed weekly with fine sand in 2005 (Table 1, p. 67).

It is important to note that this was a warmer than normal year and the turf was likely under some heat stress. Volumetric water content (0 to 5.7-centimeter depth) in plots receiving regular medium-fine sand is increasing probably due to the fine sand holding more water (data not shown). This may also be affecting the growing environment and favoring moss.

#### Conclusion

Sand topdressing is still an essential cultural practice to maintain the highest-quality putting green. Remember, one size does *not* fit all.

It is important to critically evaluate your topdressing program. If you are applying topdressing more frequently, ask yourself if you are actually meeting the critical annual amount necessary to minimize thatch and excessive organic matter and ensure firm, smooth surfaces.

Analysis of topdressing material prior to sand selection can prevent potential long-term layering issues and detrimental effects to soil physical characteristics caused when a sand finer than an existing rootzone is used for topdressing. Mechanical damage can easily occur if plants are stressed and topdressing should be delayed until the turf is actively growing and healthy.

Our research aims to answer many common topdressing questions to help present a better

understanding of the topdressing requirements for high-quality putting greens.

Adam C. Moeller is a graduate research assistant in agronomy at Purdue University.

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Web site: www.turfgrasstrends.com Reprints: TurfgrassTrends@reprintbuyer.com What does my 6-year-old daughter think I do every day? I decided the best way to find out was to interview her

t a recent school function for my 6-year-old daughter, I overheard one of the moms ask my daughter what her father did for a living. My daughter, Lily, answered, "He's a golfer."

What

Although I did rather appreciate the first admiring look from the woman as she gave me a double take, wondering which pro golfer I was and if she had recently seen me on television, I had to correct my daughter, stating that I'm not a golfer but a golf course superintendent. The woman was clearly not as impressed, but gave me a bit of a smile, albeit uninspired.

This got me wondering how much my daughter actually knows about what I do for a living. During the summer months, I occasionally take her to work with me on some of the more casual days. Although I tend to have a light workload on these days, she does see some of the things I do at the golf course. We each talk about our day at the din-

Superintendent Ron Furlong talked to his daughter Lily while she played with her dinosaurs and watched "Prehistoric Planet."

PHOTOS BY: RON FURLONG

ner table in the evenings, so surely she must consume some of the verbal dribbling I offer to the family about my problems with golfers, turf disease and drainage concerns.

Daddy Does

But what does she truly know? What does her young mind think her daddy does every day?

I decided the best way to find out was to interview her. The only way she would agree to do this was if she could continue to watch "Prehistoric Planet" on Discovery Kids during the interview. I consented.

The interrogation of my daughter had the initial intention of leading her, through a series of brilliantly conceived questions, toward unveiling her

Continued on page 70

#### BY RON FURLONG

### What Daddy Does

Lily wants to grow up to be a paleontologist, not a golf course superintendent.

#### Continued from page 69

true feelings about my job and what my job means for her, as well as her feelings about the game of golf. However, after the questions I felt more like she led me through them than the other way around.

**Daddy:** Lily, what do I do for a living? Lily: What do you mean? Daddy: What do I do for a job? Lily: Golfing. Daddy: Golfing? Lily: Golf superintendent, I mean. Actually, I'm not sure. You tell the workers what to do. And work on things. Daddy: Like what things? Lily: I'm not sure. She's straining at this point to give me any concentration. A snarling T-Rex has most of her attention. Daddy: Well, you've come with me to work, right? What do we do? Lily: You and me? Daddy: Yes. Lily: Sometimes I play on the computer. I mean my Web sites. And we eat in the restaurant. Uggh! Daddy: What? Lily: Look, Pop! This is where the ants attack and eat the baby dinosaur. (She has seen this

Lily: Look, Pop! This is where the ants attack and eat the baby dinosaur. (She has seen this episode before.) They're flesh-eating! Arrggh! Here they come! Look at that! (After the action dies down I continue the interview.) Daddy: What's your favorite part of going to the golf course? Lily: When I get to golf. Daddy: What do you like about golfing? Lily: I like to whack it really far. Daddy: What do you think about golf? Lily: It's fun. A lot of people do it. Daddy: Is daddy a good golfer? Lily: Yes. What?

**Daddy:** What do you know about my job? **Lily:** That you're good at it. (Did I mention she's sweeter than sugar?)

**Daddy:** Thanks, honey. What do you think about my job?

Lily: I don't know.

**Daddy:** What are your feelings about chemicals?

**Lily:** They're dangerous. Look! (The ants have consumed all the flesh and are moving off in a massive swarm.)

Daddy: Dangerous like the ants?

Lily: I guess.

**Daddy:** What's important about golf courses? **Lily:** I don't know.

**Daddy:** What's important about my job? **Lily:** I don't know.

**Daddy:** What's your favorite color? (I had to check to make sure she was still listening to me.)

Lily: Pop! You know. Pink!

**Daddy:** What is the worst part, for you, about my job?

Lily: That you have to work on weekends. Daddy: What do you want to be when you

grow up?

**Lily:** Either a marine biologist or a ... what's it's called again? The dinosaur job?

Daddy: Paleontologist.

Lily: Yeah. Paleontologist.

**Daddy:** How about a golf course superintendent?

Lily: Like you?

Daddy: Yeah.

**Lily:** I don't know. Maybe. Are we almost done?

**Daddy:** A couple more, sweetie. Who is your favorite golfer?

**Lily:** You. (She got a hug for this answer) **Daddy:** How about a favorite golfer that is on TV?

Lily: Tiger Woods. Daddy: Can you name another golfer? Lily: Hmmm. No.

"You tell the workers what to do. And work on things."

- LILY FURLONG