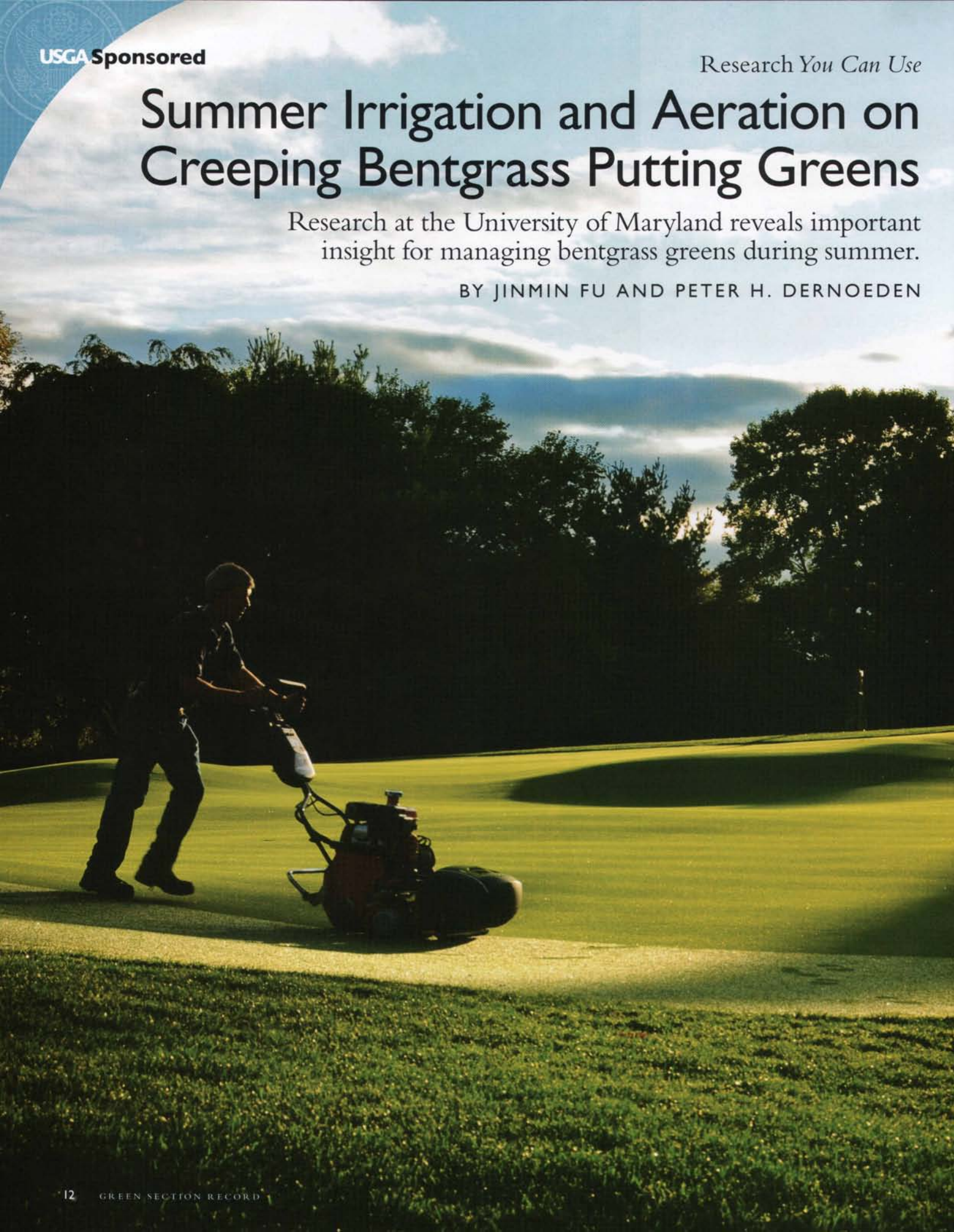
Summer Irrigation and Aeration on Creeping Bentgrass Putting Greens

Research at the University of Maryland reveals important insight for managing bentgrass greens during summer.

BY JINMIN FU AND PETER H. DERNOEDEN



OBJECTIVES

- Evaluate physiological processes and rooting of putting-green-height creeping bentgrass in response to two irrigation management and three core aeration regimes.
- Determine the effects of core aeration and irrigation frequency on creeping bentgrass summer performance and root longevity during periods of high temperature stress.
- Provide information on the effects of soil temperature and soil water content on carbohydrate metabolism and its relationship to summer bentgrass decline.

Start Date: 2005
Project Duration: Three years
Total Funding: $90,000

There has been little study on the impact of irrigation and core aeration management on rooting in creeping bentgrass grown in a sand-based rootzone under field conditions. Research conducted at the University of Maryland adds insight into these vital management tools.

Providence creeping bentgrass was grown on a sand-based rootzone meeting USGA recommendations. Plots were subjected to two irrigation programs: light and frequent versus deep and infrequent. Lightly/frequently irrigated plots were irrigated daily on rain-free days to maintain a moist condition in the upper 1.5-2.5", whereas deeply/infrequently irrigated plots were irrigated at leaf wilt to a depth > 9.5".

A majority of roots (55%) were found in the upper 2.4" of soil at the end of the summer, regardless of irrigation regime. Deeply/infrequently irrigated bentgrass produced a greater number of roots, longer roots, and a larger root surface area and a smaller root diameter (2007) versus lightly/frequently irrigated bentgrass.

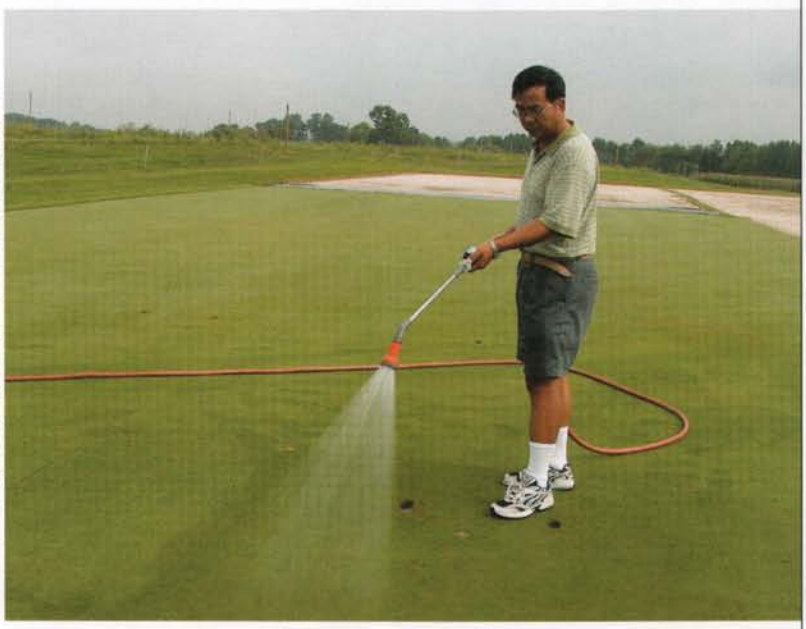
Soil temperatures were on average 1.4°F greater in lightly/frequently irrigated bentgrass. Deeply/infrequently

Spring core aeration holes were filled to the surface with topdressing, but in summer, aerated plot cores were brushed to reincorporate the soil, and no additional topdressing was applied.

Photosynthesis and whole plant respiration were determined by enclosing the turf canopy in a transparent plexiglass chamber attached to a carbon dioxide analyzer.

Spring plus summer treatments involved coring in April, combined with three summer corings using hollow tines.

Data indicated that summer core aeration should be avoided during the first summer of establishment. If necessary, core aerate only to the depth of the thatch-mat layer.



Deeply/infrequently irrigated bentgrass produced a greater number of roots, longer roots, a larger root surface area, and a smaller root diameter versus the lightly/frequently irrigated bentgrass.

Rooting tubes were inserted into each plot to measure rooting as affected by different irrigation and aeration regimes.

irrigated bentgrass had lower canopy photosynthetic rates, but respiration was similar to lightly/frequently irrigated bentgrass. Canopy temperatures were 4.0°F higher in deeply/infrequently versus lightly/frequently irrigated bentgrass.

Deeply/infrequently irrigated bentgrass had lower color and quality and lower chlorophyll levels in 2006 and most of 2007. By late summer, however, color and quality and higher chlorophyll levels were detected in deeply/infrequently versus lightly/frequently irrigated bentgrass. Deeply/infrequently irrigated bentgrass developed a less thick thatch-mat layer, which contained less organic matter versus lightly/frequently irrigated bentgrass.

Deeply/infrequently irrigated bentgrass *leaves* had higher water-soluble carbohydrate and total non-structural carbohydrate levels in 2006, but higher storage carbohydrate levels in both years. Deeply/infrequently irrigated bentgrass had higher storage carbohydrate and non-structural *root* carbohydrate levels than lightly/frequently irrigated bentgrass in both years. Deeply/infrequently irrigated bentgrass accumulated proportionately more non-structural carbohydrate in roots versus leaves. Nearly twice as much water was applied to lightly/frequently versus deeply/infrequently irrigated plots in both years.

Regarding core aeration, three regimes were assessed: spring only, spring plus three summer corings, and a non-cored check. Spring core aeration holes were filled to the surface with topdressing, but in summer, aerated plot cores were brushed to re-incorporate soil and no additional topdressing was applied. The study was conducted in a mature stand of Southshore in 2005, but a new site of Providence was established in 2005 and rooting was assessed in 2006 and 2007.

In 2005 in the mature Southshore, total root counts and total root length were increased by summer coring versus spring coring. In 2006, summer

CONNECTING THE DOTS

An interview with Dr. Pete Dernoeden *regarding research on the effects of irrigation and coring strategies for maintaining creeping bentgrass putting greens.*

Q: *Do your results suggest that superintendents who use a light, frequent irrigation strategy produce greater organic matter in their greens (i.e., thicker thatch layer)?*

A: The study clearly showed that light, frequent irrigation enhanced organic matter production in the thatch-mat layer. This was attributed to the ability of plants to produce more tissue in the presence of plentiful soil moisture versus less growth that occurred in drier soils of deeply/infrequently irrigated plots in summer.

Q: *Superintendents need to be aware of how cultural practices affect turf carbohydrate levels. How important is an irrigation regime in affecting the turf's carbohydrate levels, and are there implications for the turf's overall health and ability to recover from damage?*

A: Both coring and deep, infrequent irrigation resulted in improving the carbohydrate status of plants. Coring improved soil aeration and nutrient availability, while deep, infrequent irrigation limited growth and thus reduced carbohydrate usage. The trade-off was reduced quality for two weeks after coring, and lower green color ratings in bentgrass that was frequently subjected to wilting.

Q: *How do light/frequent versus deep/infrequent irrigation strategies compare in terms of overall (i.e., seasonal) water use? Are these implications for leaching potential, nutrient efficiency, and fungicide activity for disease control?*

A: We quantified the amount of water applied to lightly/frequently and deeply/infrequently irrigated plots, and twice as much water was applied to lightly/frequently irrigated plots. The increased amount of water applied to lightly/frequently irrigated plots would be expected to increase leaching and microbial competition for nutrients and possible enhanced degradation of some pesticides. Furthermore, light/frequent irrigation would be expected to promote moss, algae, annual bluegrass competitiveness, and some diseases such as Pythium blight and brown patch. Also, wet greens hold a lofted shot better, but they are damaged more by ball marks.

Q: *What is your message to superintendents who are convinced that light/frequent irrigation produces a better playing surface than deep/infrequent irrigation?*

A: There is no question that light/frequent irrigation promoted a more aesthetic surface. From a playability perspective, light/frequent irrigation also would contribute to more shots staying/holding on greens and slower green speeds and thus lower scores and perhaps happier golfers. From an agronomic perspective, however, deeply/infrequently irrigated turf would be expected to promote a more stress-tolerant turf with fewer pest problems, and it would result in increased green speed.

Q: *Your studies indicate that spring and spring plus summer cored plots develop a thicker thatch layer than non-cored plots. Isn't this contrary to popular belief that coring speeds up thatch breakdown?*

A: Coring is performed for several reasons, including improving air and water infiltration, promoting rooting and root longevity, and presumably to reduce thatch. In fact, most studies show that coring alone has little or no impact on reducing thatch. The current study evaluated spring and summer coring without routine topdressing (although spring cored holes were filled and sand was reincorporated following summer coring). Data clearly showed that coring alone had no impact on organic matter formation. These findings were similar to coring studies conducted by Dr. Murphy and Dr. McCarty and co-workers in Michigan and South Carolina, respectively. Research conducted by Dr. McCarty and co-workers also demonstrated that an aggressive program of coring combined with verticutting and frequent topdressing is required to stay ahead of thatch production.

Q: *One conclusion was that coring should be avoided during the first summer after establishment. True?*

A: First and foremost, the study indicated that coring the summer following establishment not only does not affect thatch production, but that it reduces root number and length compared to one spring coring and no coring. Also, quality ratings were much lower in cored plots in the first summer following establishment versus the second year when turf was more mature. In short, coring was harmful to the immature green, and there were no benefits to counterbalance the first summer negatives.

Just think about it for a minute. One very important reason for coring is to alleviate compaction and improve aeration and water movement into and through a rootzone. In a new, sand-based green built to USGA particle size specifications, poor drainage and aeration should not be an issue the first year. Hence, there really should be no compelling need to core the first summer. Since grow-in involves very high inputs of nitrogen, thatch formation will be a concern. If levels become excessive, then a superintendent may consider less invasive coring and light topdressing. That is, coring tines should be cut to equal the depth of the thatch layer. Less deep and invasive coring would be expected to have less of an impact on the young root system as well as leaves and sheaths, and turf recovery should be more rapid versus deeper coring an immature green the first summer of establishment. Thus, one of our recommendations for future research projects was to consider evaluating tines of shorter length and different diameters for their effect on thatch accumulation in greens in the first year of establishment. Since coring alone would not be expected to impact organic matter production, future studies should incorporate a topdressing program as well. If anything, the topdressing will dilute the organic matter and improve the growing environment for plant stems and roots near the surface.

Q: *What were the results when you investigated tine diameter, and what are your recommendations?*

A: We did use larger diameter tines in spring than summer, but we did not critically evaluate different tine diameters or types. Data showed that the carbohydrate status of plants is higher and more favorable for turf recovery in spring than summer. Thus, the greater damage from the wider diameter tine in spring is balanced by the greater levels of carbohydrates (used in recovery) at this time of year. In summer, plants are not growing as rapidly as in spring or autumn, and bentgrass carbohydrate levels are at their lowest levels in July and August. Thus, plants would have more difficulty recovering from injury induced by larger than smaller diameter tines in summer.

Q: *Most often, turfgrass research projects are two to three years in duration and are conducted on newly established sites. Do you think the results of your study would have been different if the study had been conducted on putting green turf that was more than 10 years old?*

A: I think one of the most important findings of this study was to establish where living roots exist in the profile and how many there are during the summer from the year of establishment to

(continued on next page)

(continued from previous page)

maturity. There was a much greater root system in the first year of establishment versus the second year. For example, between September of the first and second year of establishment, there were 68% and 32% fewer roots in lightly/frequently irrigated versus deeply/infrequently irrigated plots in 2007 than were observed in 2006, respectively. While I think many superintendents have made a similar observation, this finding has not been previously quantified or reported in the literature. This study clearly indicated that while rooting was promoted by coring and deep, infrequent irrigation, the actual magnitude of the differences was largest in the uppermost 6 cm of the rootzone.

Regardless, even small increases in root number and length and total root surface area deeper in the profile would be an asset during periods of stress and would be expected to scavenge more water and nutrients. However, most roots, regardless of irrigation method and coring versus not coring, were found in the upper 6.0 cm of this well-drained and aerated rootzone. Roots need oxygen to live, and a poorly drained rootzone is a prescription for trouble in the summer. In older greens, as soils become more compacted and plugged, the result will be slower water drainage and less favorable soil aeration. This is the Achilles heel of older greens, since these conditions would likely result in a more diminutive and poorly functioning root system. Hence, a root system in an older green would be expected to respond favorably to both summer coring and lower overall levels of soil wetness associated with deep, infrequent irrigation.

Q: *Although this was an excellent look at managing creeping bentgrass during summer, if you had the opportunity to redesign this experiment, are there aspects that you would change? What questions need further investigation?*

A: Every research project creates new questions and a need to further pursue the unknown. If a scientist had the time, funding, skilled and devoted labor, and patience, there is much that could be done to improve on our study. One thing you have to keep in mind is that the minirhizotron imaging technique that we used to quantify rooting parameters is labor intensive, extremely time consuming, and tedious. For example, the roots in each image (and there were over 14,000 photographed images involved in this study) must be traced, and no two people are likely to do this the same. Hence, to preserve accuracy, it is a one-person job, requiring months of time. Hopefully, a less labor-intensive method will be developed to enable scientists to monitor living roots in the field. It would be interesting to conduct a study in a push-up green versus one that was sand-based and in greens of various ages. Researchers' imaginations often run away, but reality sets in on what can be reasonably accomplished. But it also would be interesting to consider different growing environments, such as shaded sites. Since the nature and hydraulics of any push-up green are likely to vary greatly from one golf course to the next, the findings may be more difficult to interpret. Hence, it would be more prudent to evaluate rooting in sand-based rootzones since they are the preferred method of putting green construction, and sand particle sizes can be reasonably standardized. One could also correctly argue that region, species, cultivar, and many other edaphic and environmental factors should be addressed. The bottom line is that a group of collaborators could spend their careers on such a project and more questions would still arise.

Jeff Nus, Ph.D., *manager, Green Section Research.*

core aeration reduced rooting in the immature Providence. Total root counts and total root length generally were greater in the entire profile in spring plus summer cored versus spring or non-cored bentgrass in the more mature Providence in 2007.

Data indicated that summer core aeration should be avoided in the first summer of establishment. If necessary, only core aerate to the depth of the thatch-mat layer. The percent total root counts in the 0-2.4" of soil ranged from 61% to 74%, from 58% to 59%, and from 62% to 77% among all three coring treatments in late summer of 2005 (mature Southshore), 2006 (immature Providence), and 2007 (mature Providence), respectively.

Spring and spring plus summer cored plots developed a thicker thatch layer than non-cored bentgrass. The amount of organic matter (loss on ignition) in the thatch-mat layer increased in all three regimes, but the levels remained the same among regimes. However, the organic matter concentration (gravimetric organic: dry weight of cores) was lower in cored plots. Organic matter concentration less than 110 g kg^{-1} was associated with better turf performance.

Spring and spring plus summer coring reduced quality for about two weeks, but generally coring resulted in higher color ratings than non-cored bentgrass. Late summer quality was better in cored plots. Chlorophyll a and a+b levels were higher for spring and spring plus summer cored bentgrass in both years.

SUMMARY POINTS

- Deep, infrequent irrigation produced a greater number of roots, longer roots, a larger root surface, lower soil temperatures, less thatch, and generally higher water-soluble and total non-structural carbohydrates than light, frequent irrigation.
- Data indicated that summer core aeration should be avoided in the first summer of establishment.
- Spring and spring plus summer cored plots exhibited reduced quality for about two weeks, but generally had higher color ratings and chlorophyll a and a+b levels than non-cored plots by late summer.

RELATED INFORMATION

http://usgatero.msu.edu/v08/n06.pdf
http://usgatero.msu.edu/v07/n22.pdf
http://turf.lib.msu.edu/ressum/2008/10.pdf
http://turf.lib.msu.edu/ressum/2007/13.pdf
http://turf.lib.msu.edu/ressum/2006/17.pdf

Jinmin Fu, Ph.D., *horticulture professor, Wuhan Botanical Garden, The Chinese Academy of Science, Wuhan City, Hubei, China; and* Peter H. Dernoeden, Ph.D., *professor, Department of Plant Science and Landscape Architecture, University of Maryland, College Park, Maryland.*