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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 350 projects at a cost of $29 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***.

Editor

Jeff Nus, Ph.D.
1032 Rogers Place
Lawrence, KS 66049
jnus@usga.org
(785) 832-2300
(785) 832-9265 (fax)

Research Director

Michael P. Kenna, Ph.D.
P.O. Box 2227
Stillwater, OK 74076
mkenna@usga.org
(405) 743-3900
(405) 743-3910 (fax)

USGA Turfgrass and Environmental Research Committee

Timing of Irrigation for Cooling Bentgrass Greens With and Without Fans

E.A. Guertal and D.Y. Han

SUMMARY

At Auburn University, the general objective of three research projects has been to examine the combined and separate effects of fans and syringing on the health and performance of bentgrass putting greens in Alabama. Results indicate:

- The use of fans reduced soil temperature and increased root length density on a creeping bentgrass putting green.
- The timing of irrigation application (AM or PM) did not affect root length density.
- In 2007, the timing of irrigation application did not usually affect soil temperature, while in 2008 AM application of irrigation water reduced soil temperatures more compared to PM irrigation.

In the southeastern United States, hot and humid summers contribute to bentgrass (*Agrostis stolonifera* L.) decline, creating a poor putting surface during the summer months. Typically, the bentgrass becomes thin or patchy, has greatly reduced root growth, and thus becomes susceptible to disease and algae encroachment. Tools to combat this bentgrass decline include frequent preventative fungicide applications, use of heat-tolerant bentgrass cultivars, use of cooling fans, and applying water by syringing. Although the last two inputs in this list (fans and syringing) are widely used, there are few data which document the effectiveness of these maintenance practices. At Auburn University, the general objective of three research projects has been to examine the combined and separate effects of fans and syringing on the health and performance of bentgrass putting greens in Alabama.

E. A. GUERTAL, Ph.D., Professor, Turf Soil Fertility; and D. Y. HAN, Ph.D., Associate Professor and Extension Specialist, Turfgrass Management; Department of Agronomy and Soils, Auburn University, Auburn, AL.

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Our first research project (conducted from 2000-2001) examined the combined and separate effects of fans and syringing on soil temperature and root length density on a 1-year-old bentgrass putting green. In this study, fans were run for 5 hours each day and syringing was applied 3 times throughout the day. This two-year study found that the combination of fans and syringing most effectively cooled a bentgrass putting green, reducing soil temperature and increasing root-length density (1).

A subsequent two-year study (2002-2003) moved the fans to a newly seeded bentgrass green where the fans could be run for 24 hours with and without syringing. In that study, the use of fans, both in combination with syringing and used alone, increased root length and weight, and also reduced soil temperatures. Running the fans for 24 hours provided an extended cooling period, with lower soil temperatures in fan and fan+syringing plots compared to temperatures recorded in the no-fan plots. An additional find-

The research fan plots at the Auburn University Turfgrass Research Unit (TGRU), with one set of mist heads applying irrigation to selected plots.

ing in this second study was that syringing alone negatively affected root length, with decreased root lengths when only syringing (and no fans) was applied (3).

In 2007, a new research study was initiated on the same area of the second fan/syringing study. Since we had previously demonstrated the benefits associated with a 24-hour run time for cooling fans and fans plus syringing, the objective of this third research study was to examine the combined and separate effects of: 1) time of irrigation application and 2) fan cooling and to determine the effects of these treatments on soil temperature and root length density in a bentgrass putting green.

Materials and Methods

In September 2001 a bentgrass (cv 'Crenshaw') putting green was seeded at the Auburn University Turfgrass Research Unit (TGRU), Auburn, AL. The green was constructed using the native loamy soil (Maryvn fine sandy loam; fine-loamy, kaolinitic, thermic Typic Kanhapludult). After a two-year rest period in which no research was conducted on the green, the new fan/irrigation study was initiated on the research green in April of 2007.

The study was arranged in a split-plot design with fans as main blocks and irrigation timing (hereafter called 'irrigation') as the split-plot factor. Main blocks of fan treatments were 10 feet x 20 feet and the irrigation split blocks measured 10 x 10 ft. There was a three-foot alley around each plot. Mowing height for the duration of the study was 1/8 inch. Herbicides were applied as needed to control common weeds, and fungicides were not applied during the experimental period. The experiment was conducted from June through August of each year.

To apply the fan treatment, one 20-inch diameter non-oscillating fan (0.75 kW, 1725 rpm; Tempest Technology, Fresno, CA) was mounted at a 3-foot height at the end of each fan block. To minimize the effect of fan speed at distances close to the fans, the plot area did not start until 10 feet away from each fan. Fans were run for 24 hours,

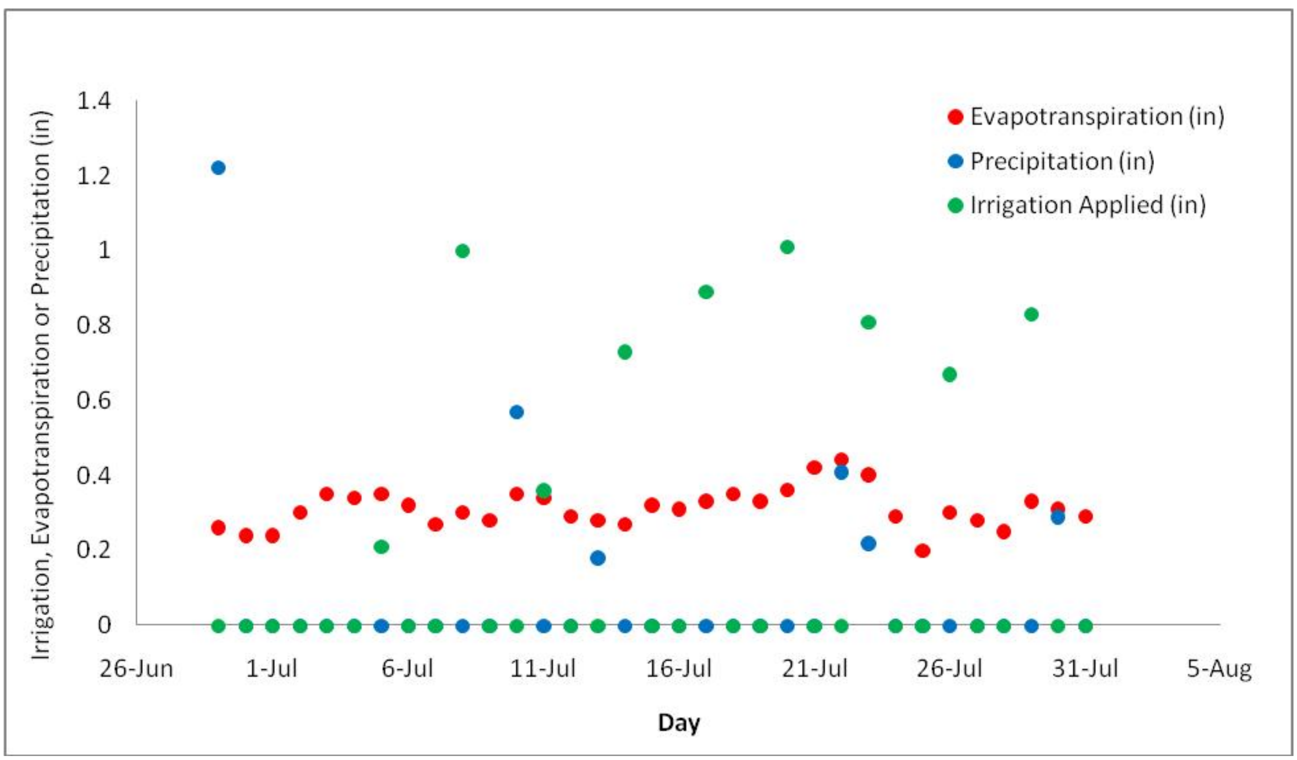

Figure 1. Precipitation (in), irrigation (in), and evapotranspiration (in) during July, on the research plots during July, 2008 located on the Auburn University Turfgrass Research Unit (TGRU), Auburn, AL.

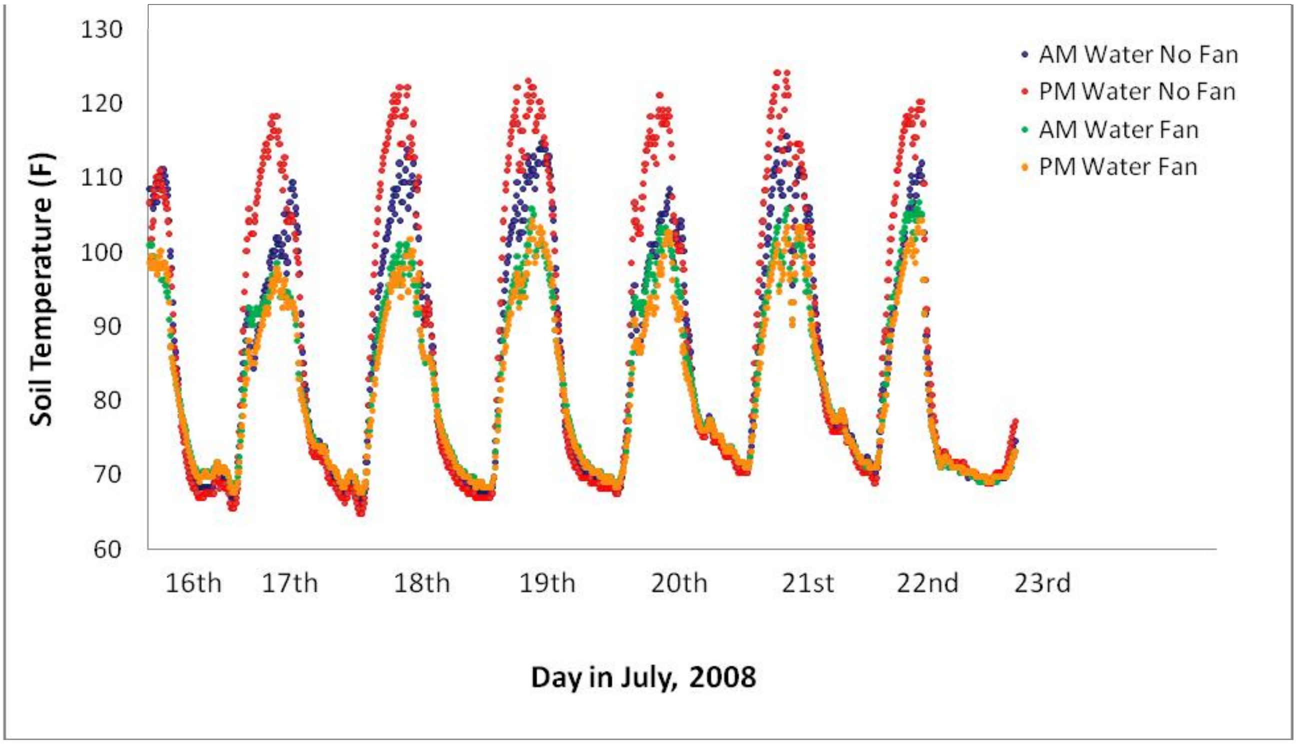

Figure 2. Soil temperature at a half-inch depth in a bentgrass putting green as affected by fan and time of irrigation during July, 2008, on the research plots located on the Auburn University Turfgrass Research Unit (TGRU), Auburn, AL.

except for approximately ½ hour every third day (AM or PM for respective treatments) when irrigation was applied to the plot areas.

Irrigation treatments were applied by low-volume misting irrigation heads (Rain Bird, Azusa, CA) placed at each corner of the plots. To apply the irrigation treatments, a record was kept of daily evapotranspiration loss using Alabama Weather Information Service (AWIS) data collected from an AWIS weather station located at the TGRU. Using the results of previous research, which showed that every-fourth-day irrigation provided best bentgrass growth (2), we selected every third day for our irrigation regime.

Evapotranspiration loss was collected for each day, totaled every three days, and any contribution from precipitation subtracted from the three-day evapotranspiration total. Precipitation was measured via an on-site rain gauge located 100 feet from the research plot area. If precipitation occurred during the middle of an irrigation treatment day, that water amount was treated as an irrigation that occurred on the following day.

During the two years that we conducted this study, mid-day precipitation occurred three times, with all other precipitation events occurring in the morning before irrigation was applied or in the evening. The amount of water lost through evapotranspiration (minus any recorded precipitation) was applied to selected plot areas as either a morning (800 hours) or afternoon (1600 hours) application, with plastic laid over the plots that were not receiving the AM or PM watering to prevent spray drift.

Collected data included soil temperature at a ½ inch depth (just below the thatch of the putting green), and weekly root-length density collection. To collect the soil temperature a Hobo brand (Onset Computer Corporation, Pocasset, MA) temperature sensor was installed in each plot with the sensor and connecting cable buried so that it would not interfere with daily mowing. Soil temperatures were collected at 5-minute intervals and collected data was downloaded each week of the study.

Each week, five (1/2-inch diameter x 6 inches deep) cores were randomly collected from each plot and cores were grouped into one sample. Samples were returned to the lab, hand-washed free of all debris, and root-length density was

Treatment	Average Root Length (m)	
	2007	2008
With Fan	27.0† a‡	40.2 a
Without Fan	24.0 b	34.4 b
AM Irrigation	26.4 a	38.0 a
PM Irrigation	24.6 a	36.7 b

†Root length shown is the average of 11 and 8 measurements for 2007 and 2008, respectively. To measure root length a total of 5 samples was collected from each plot at each sampling (0-8 inch sampling depth) and all samples bulked for one measurement per plot.

‡ Within each year and main effect (fan or irrigation timing), means followed by the same letter are not signifiicantly different. (P=0.10)

Table 1. Average total root length by year as affected by fans and time of irrigation application at the Turfgrass Research Unit, Auburn, AL, during 2007 and 2008.

determined using a light-imaging root scanner (Comair Root Length Scanner, HDH Systems Intl., Port Melbourne, Victoria, Aust.).

Results

Both 2007 and 2008 were years marked by severe droughts in the Southeast. From the standpoint of an irrigation study, this was useful, as precipitation never overcame evapotranspiration, creating a deficit loss situation that most days required the application of irrigation water. Figure 1 illustrates a typical month of the cycle of evapotranspiration, precipitation, and irrigation application. The blue circles show daily precipitation for this period in July, 2008, and the red circles show evapotranspiration losses per day. The green circle indicates the amount of irrigation that was applied to supply 100% of the loss from the previous three days of evapotranspiration (minus precipitation).

Over the period shown there was only one period (from June 29 - July 2) in which supplemental irrigation was not needed due to precipitation in excess of evapotranspiration. Over the two years of the study, there were 4 days (out of 21 possible application days) in 2007 in which irrigation was not needed, and there were 4 days (out of 21 possible applications days) in 2008 in which irrigation was not needed.

As with previous work (1), this project demonstrated the cooling ability of a combination of fans and water. Unlike previous work, water applications in this study were not frequent mist applications, but were instead a morning or afternoon irrigation, with that irrigation event applied every three days. In Figure 2, irrigation treatments were applied on July 17th and 20th, with no measured precipitation until July 23rd. Any treatment that received 24 hours of fan cooling had a significantly cooler soil temperatures (1/2 inch depth) compared to treatments that were not cooled by a fan. There was no significant difference in soil termperatures as affected by time of irrigation application (AM or PM) when the fans were running.

When no fans were used, however, a morning application of water created greater soil cooling than when irrigation was applied in the afternoon (Figure 2). This effect was especially noticeable in 2008 when extended periods of hot and dry weather greatly stressed the bentgrass, and a morning application of irrigation water

The use of fans, both in combination with syringing and used alone, increased root length and weight, and also reduced soil temperatures.

helped the green cool and survive through each hot day.

In 2007 and 2008, average root length density was affected by the use of fans, but not by irrigation timing (Table 1). Whenever the fans were running, affected plots had a greater average total root length density. Root length density was not affected whether the plots were irrigated in the morning (8:00 a.m.) or afternoon (4:00 p.m.).

Acknowledgements

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