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Fans and syringing for cooling bentgrass greens: Further exploration

Are fans alone sufficient to cool creeping bentgrass in hot summers in the southeastern United States?

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Despite its limited heat tolerance, creeping bentgrass (*Agrostis stolonifera* L. var. *palustris* [Huds.] Farw.) is often planted on southeastern putting greens because it provides a high-quality putting surface and year-round green color. Superintendents use various cultural methods to maintain creeping bentgrass in hot and humid conditions, including fans for cooling greens, syringing to provide evaporative cooling and reduce temperature, and mowing at the highest acceptable height to increase photosynthetic leaf area. Basically, any device or practice that can move more air and create cooler conditions probably benefits creeping bentgrass growing in humid conditions.

Creeping bentgrass vs. heat

Both soil and air temperature affect shoot and root growth, turf quality and carbohydrate storage of creeping bentgrass. In growth chamber studies, reducing the soil temperature from 95 F (35 C) to 90 F (32 C) at an ambient air temperature of 95 F (35 C) increased leaf chlorophyll and tiller density and enhanced shoot growth in both Penncross and L-93 creeping bentgrass. Reducing the soil temperature to 84 F (29 C) increased root growth (9) and root carbohydrates. Extended durations of cooling increased the effectiveness of stress reduction, but results suggested that 12 hours of soil cooling was adequate. Nighttime cooling was more effective than daytime cooling at alleviating heat stress and increasing root growth (6).



Figure 1. Creeping bentgrass turf plots were treated with fans running 24 hours a day with and without syringing or with syringing alone.

Because high air and soil temperature, high humidity, poor air movement, warm nights and low mowing heights contribute to stress on creeping bentgrass, many current cultural practices for dealing with heat stress also increase evapotranspiration. Increasing air movement is one strategy used to aid evapotranspiration. As early as 1966, it was shown that small air currents of 3.8 mph (1.8

meters/second) lowered leaf canopy temperature (2).

Syringing is another method of reducing heat stress. In North Carolina, syringing, in the absence of wilt, at 11 a.m. and 1 p.m., did not significantly reduce canopy temperatures one hour after application (1). This suggests that syringing alone may not significantly reduce turfgrass canopy temperature.

Photo courtesy of D. Han

In previous work at Auburn, we have found that both fans and syringing lowered soil temperature when fans were operating only during the hottest part of the day (11 a.m. to 5 p.m.) on a Crenshaw creeping bentgrass putting green (3). The fan and syringing treatments had a synergistic effect on soil temperature, with the combined treatment lowering temperature more than additive effects of the two treatments alone. We also found a slight increase in root-length density on some, but not all, sampling dates with the fan treatment, but not with the syringe treatment.

Given the widespread use of fans and syringing to manage temperature stress on creeping bentgrass on southeastern golf courses, relatively little research has been published on the effects of these practices. The literature has no information about the effects of running fans for extended periods. Some golf courses use fans 24 hours a day, and others use them from sunrise to sunset. Few wait until 11 a.m. to turn them on, and almost none turn the fans off until the hottest part of the day is over. In this project, our objectives were to determine the effects of running fans 24 hours a day on turf soil temperature, shoot and root growth, and the need for syringing.

Materials and methods

In April 2002, a creeping bentgrass green was constructed at the Auburn University Turfgrass Research Unit in Auburn, Ala. The green was constructed using the native soil (Marvyn fine sandy loam; fine-loamy, kaolinitic, thermic Typic Kanhapludult) and seeded with Crenshaw creeping bentgrass at a rate of 1.0 pound/1,000 square feet (50 kilograms/hectare). We constructed the green so that the terrain and the trees surrounding it on three sides obstructed natural air movement across the green as much as possible and provided a stressful environment for the creeping bentgrass.

The putting green was grown-in and managed as a typical southeastern creeping bentgrass green through June 2002, with fan and syringing treatments starting in July. In 2002, the green was mowed at $\frac{3}{16}$ inch (0.48 centimeter) during the study period, and by 2003 the mowing height was reduced to $\frac{1}{8}$ inch (0.32 centimeter).

The study was arranged in a randomized complete block (four replications) with

SOIL TEMPERATURES, 2002

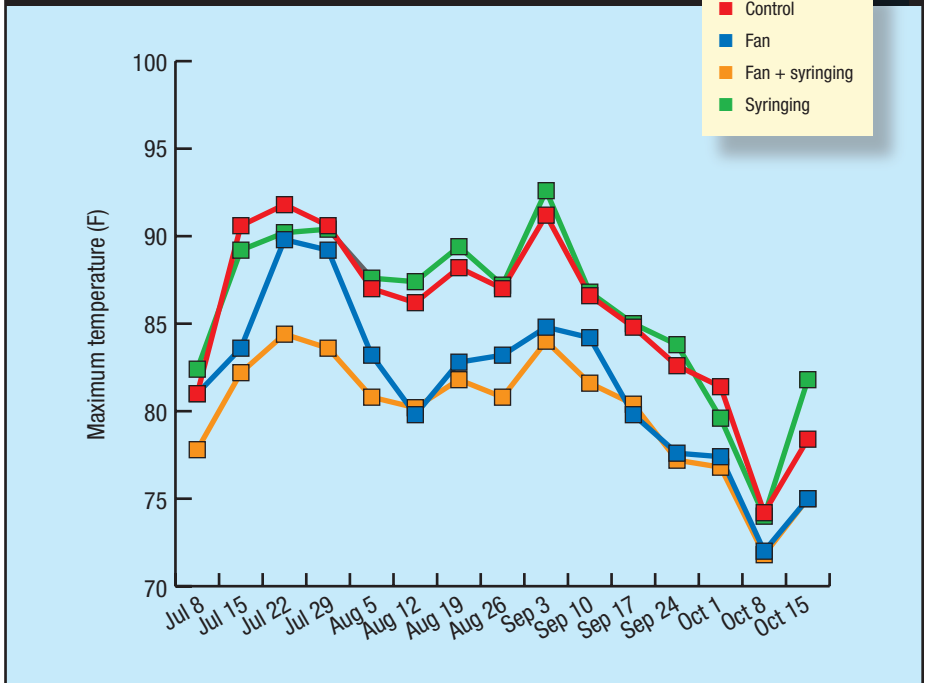


Figure 2. Maximum weekly mean soil temperature at a depth of $\frac{1}{2}$ inch (1.3 centimeters) during the summer of 2002.

SOIL TEMPERATURES, 2003

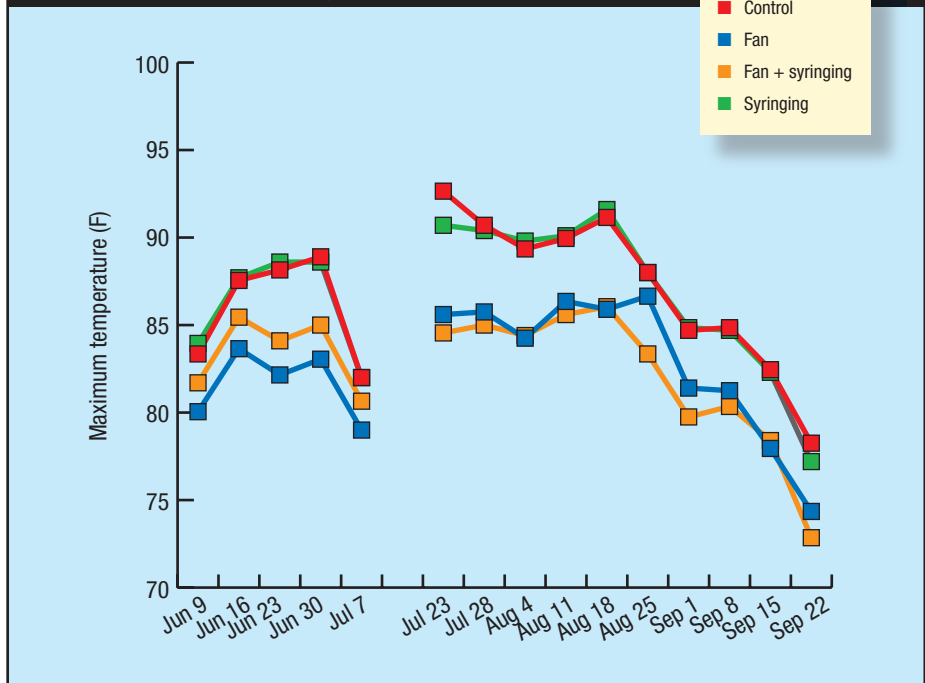


Figure 3. Maximum weekly mean soil temperature at a depth of $\frac{1}{2}$ inch (1.3 centimeters) during the summer of 2003. The gap indicates a period of three weeks when data could not be collected because of equipment problems.

ROOT LENGTH DENSITY, 2002

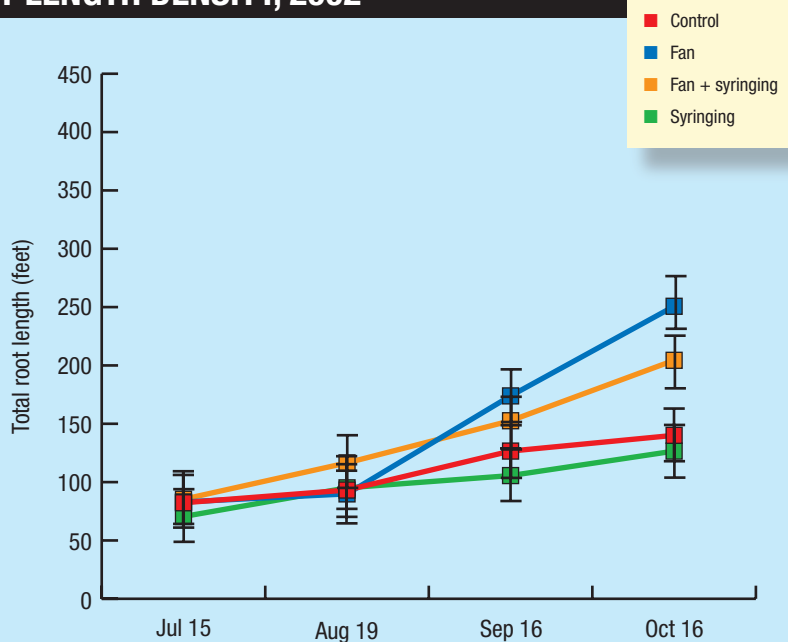


Figure 4. Root-length density of Crenshaw creeping bentgrass during 2002. Error bars represent least significant differences for each experiment.

ROOT LENGTH DENSITY, 2003

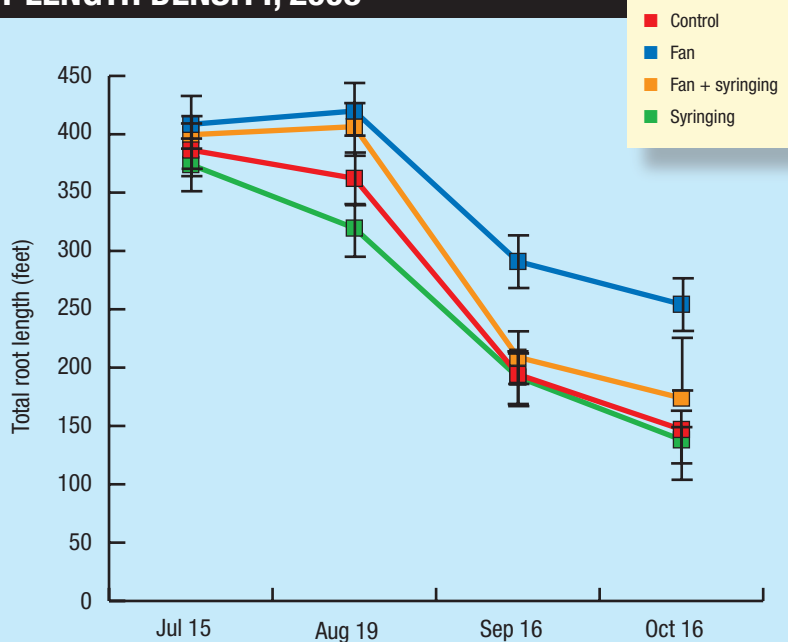


Figure 5. Root-length density of Crenshaw creeping bentgrass during 2003. Error bars represent least significant differences for each experiment.

a split-plot design. Fan treatments were assigned to main plots and the syringe treatments to subplots. The main plots of the fan treatments were 10 × 20 feet (3 meters × 6 meters), with the syringe split blocks measuring 10 × 10 feet (3 meters × 3 meters). A 2.5-foot (0.76-meter) untreated alley surrounded each subplot, minimizing the effects of overspray from the syringe heads.

Fan treatment

For the fan treatment, one 20-inch-diameter (53-centimeter-diameter) nonoscillating fan (75 kilowatts [1,725 rpm]) was mounted at a height of 3 feet (0.91 meter). One fan blew across the length of each fan block. The average fan speed across each block was 2.6 mph (1.7 meters/second), the same as in previous research at Auburn (4) and similar to other research (8). The fans ran 24 hours each day throughout the experiment.

Syringe treatment

For the syringe treatment, we placed low-volume misting heads (Rain Bird 1800 series with a 10Q nozzle) at each corner of the plots. Syringing occurred five times each day (10 a.m., noon, 2 p.m., 4 p.m. and 6 p.m.) for one minute per syringing cycle, providing $\frac{1}{40}$ inch (0.7 millimeter) of water per syringing. Overhead irrigation supplied 1 inch (2.5 centimeters) of water per week to the entire green. The overhead irrigation typically operated once a day at 8 a.m. for 25 minutes, with supplemental irrigation in the afternoon at 5 p.m. for an additional 15 minutes if necessary.

Data collection

In each year of the study (2002 and 2003), fan and syringing treatments started when the high air temperature consistently exceeded 86 F (30 C) and continued until fall. In 2002, data collection took place from July 8 to Oct. 16. In 2003, data were collected from June 9 until Sept. 29, except from July 3 to July 23, when an equipment malfunction prevented the collection of soil temperature data.

Soil temperature was measured at a depth of $\frac{1}{2}$ inch (1.3 centimeters) by continuously measuring (every 5 minutes) loggers. External probes were placed in the center of each plot and connected via wires to loggers in valve boxes located in the alley between plots.

Every four weeks during the data collec-

tion period, root samples (0-6 inches, [0-15 centimeters]) were removed for mass and root-length density analysis. A probe $\frac{3}{4}$ inch (2 centimeters) in diameter was used to take five samples from each plot. Collected roots were dyed with Congo red, and the total lengths of all roots were analyzed using a root-length scanner. Quality ratings using the NTEP scale (1-9, where 9 = perfect turf) were taken weekly. Every four weeks, from July to October in 2002 and 2003, five cores, each $2\frac{1}{4}$ inches (5.72 centimeters) in diameter, were taken from each plot, and the number of shoots from each core was counted.

Results and discussion

Soil temperature

Fans significantly cooled the green throughout the course of this study. In some weeks, cooling was significantly greater with the fan + syringing treatment than with the fan alone, but in many weeks, the fan treatment alone provided as much cooling as fan + syringing. Figure 2 (summer 2002) and Figure 3 (summer 2003) show the maximum soil temperature at probe depth ($\frac{1}{2}$ inch [1.3 centimeters]). Unfortunately, an equipment malfunction prevented collection of temperature data for the first three weeks of July 2003.

The weeks when the fan + syringing treatments were more effective than the fans alone generally corresponded to weeks with low rainfall. Even though plots received supplemental irrigation at the rate of 1 inch (2.5 centimeters) per week, soil moisture may not have been sufficient to provide evaporative cooling in the absence of syringing, whereas rainfall during the week may have added enough water to make syringing unnecessary. Our results suggest that if the turfgrass receives enough water through rainfall and irrigation, syringing may not be necessary to cool the greens when fans are run 24 hours per day. The relationship of irrigation and/or rainfall to the effectiveness of fans without syringing is a prime topic for further investigation.

Root-length density and mass

In both years, the fan treatment had greater root density than the control, fans + syringing or syringing alone (Figures 4, 5). No interaction was observed between the fan treatment and the syringing treatment. The overall dynamics of root growth varied

VISUAL TURF QUALITY, 2002

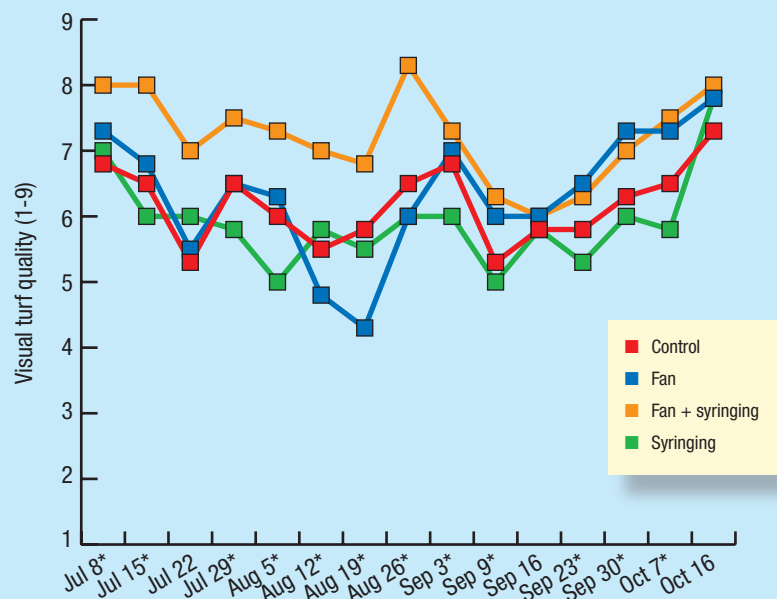


Figure 6. On most collection dates in 2002, there were significant differences in visual turf quality. Asterisks indicate dates when there were significant differences among treatments.

VISUAL TURF QUALITY, 2003

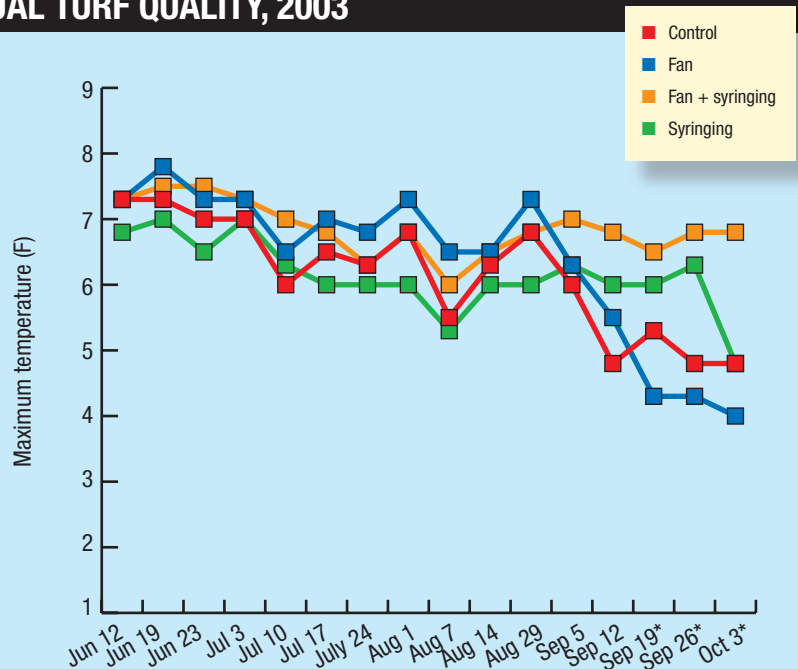


Figure 7. In 2003, there were no significant differences in visual turf quality among treatments until the Sept. 19 collection date. Asterisks indicate dates when there were significant differences among treatments.

RESEARCH

between 2002 and 2003, however. In 2002, total root-length density of all plots increased as the summer progressed. In 2003, root-length density was much higher in June than at any time in 2002, but declined during the summer. This type of summer root decline is more typical of what can be expected for creeping bentgrass greens when temperatures exceed 86 F (30 C) (5,7). The green was planted in April 2002, and it may be that root density increased in summer 2002 because the green was still establishing a root system during the first summer after planting. However, in both 2002 and 2003, root-length density was significantly greater in plots receiving the fan treatment than in the control plots, but the treatment with syringing alone had root-length density similar to that of the control, and there was no synergistic effect when the fan and syringing treatments were combined.

Plots receiving the fan treatment had significantly more root mass than the controls, especially in 2002. As with root-length density, the overall trend was for root mass to increase in 2002 but decrease in 2003. In 2003, root mass declined much more quickly than root-length density.

Visual turfgrass quality

Although in many weeks the soil temperature was not significantly different between the fan and no-fan plots, in September and October 2002 there were three collection dates when the plots with fans had higher visual turf quality than those without fans (Figure 6). We speculated that this may have been due to the cumulative effects of the cooler root-zone temperatures throughout the summer. However, in 2003, it was the syringing treatment that improved turfgrass quality in September and October (Figure 7). In this case, we concluded that the extra water provided by the syringing treatment was either improving the quality though providing extra irrigation or causing a cooling effect in the turfgrass canopy that we were unable to measure with our temperature probes buried in the soil.

Conclusions

- In some weeks fan + syringing significantly lowered soil temperatures, and in others the use of fans alone was just as effective as the fan + syringing treatment.
- The use of fans increased the length and

THE RESEARCH

says . . .

- **Creeping bentgrass** is planted on numerous putting greens in the southeastern United States even though it has limited heat tolerance.
- **In some weeks**, the fan + syringing treatment significantly lowered soil temperatures, and in others, the use of fans alone was just as effective.
- **The use of fans** increased the length and mass of creeping bentgrass roots, but syringing did not.
- **In 2002**, the fan + syringing treatment significantly improved turf quality on most rating dates. In 2003, there were no significant differences in visual turf quality for most of the summer, but the fan and/or syringing treatment did improve visual turf quality in September and October.

mass of creeping bentgrass roots, but syringing did not.

- In 2002, the fan + syringing treatment significantly improved turf quality on most rating dates. For most of the summer in 2003, there were no significant differences in visual turf quality, but in September and October the fan and/or syringing treatment did improve visual turf quality.

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Acknowledgments

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