Evaluating Drought Resistance and Recovery of Cool-Season Fairway Grasses

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Bentgrass species are widely utilized on golf course fairways in cool climatic regions. Among the 200 species of bentgrass that exist, creeping (*A. stolonifera*), colonial (*A. capillaris*), and velvet (*A. canina*) bentgrasses have received the greatest breeding improvements and are the most widely utilized *Agrostis* species for turf. Each bentgrass species retains particular qualities relating to density, color, and resistance to biotic and abiotic stresses. Of the three species, creeping bentgrass is by far the most widely utilized bentgrass, particularly for golf course putting green and fairway turf. Recent research suggests that colonial and velvet bentgrasses may require fewer inputs, including water, fertilizer, and/or pesticides. As a result, efforts have been aimed at developing improved cultivars of colonial and velvet bentgrasses for low-input environments.

One of the most important challenges facing the golf-turf industry is dealing with drought stress and water conservation. Because fairways comprise a majority of irrigated turfgrass on golf courses, the ability to maintain quality fairways with minimum irrigation is crucial. Previous research identified significant difference in drought tolerance, irrigation requirements, and water use among creeping, colonial, and velvet bentgrasses. However, greater information is required to examine cultural practices that may reduce irrigation requirements and improve turf quality of fairway grasses under reduced irrigation. Some studies have demonstrated an improvement in turf quality under reduced irrigation with the use of wetting agents. To date, however, there have not been any field studies to quantify the influence of wetting agents on improving turf performance of cool-season fairway species that vary in drought sensitivity and irrigation requirements. Therefore, the objectives of this research are to: (i) quantify the effects of two wetting agents on the drought performance and irrigation requirements of annual bluegrass and three bentgrass species when water is completely withheld; and (ii) evaluate the effects of wetting agents on recovery of these species from drought stress when water is available through irrigation/rainfall.

The project was conducted in a fully automated, mobile rainout shelter (35' x 66') at the Joseph Troll Turf Research Facility in South Deerfield, MA. Powered by an electric motor and set on rails, the shelter will automatically move over the plot area when rain begins to fall and returns back to its original position when rain stops. The shelter excludes unwanted rainfall from test plot areas and allows quantitative control of soil moisture and irrigation while retaining the advantages of practical field conditions.

Materials and Methods:

The following bentgrass cultivars were selected based on contrasting drought tolerance and turf performance in field trials in the Northeast:

Creeping	Colonial	Velvet
L-93	Tiger II	Greenwich
13M	Revere	Legendary
Penncross		
T-1		

Grasses were seeded at a rate of 1 lb per 1000 ft^2 into plots measuring 14 ft^2 in October 2008. Turf plots were managed following typical cultural practices for fairways in the northeast and mown at 3/8 inch.

The experiment consisted of four treatments:

(i) Well-watered control, irrigated three times per week to field capacity
(ii) Drought, irrigation completely withheld
(iii) Drought + Wetting Agent 1
(iv) Drought + Wetting Agent 2

Two wetting agent applications were made prior to initiation of the dry-down period (end of May and mid June) according to label recommendations. Wetting agent treatments were applied using a calibrated CO_2 sprayer. All applications were made in 80 ml of water per square meter (8 L /100m^2), and control plots were treated with water only. Wetting agents were watered immediately following application.

Treatments were arranged in a split block design, with irrigation treatment as the main plot and cultivar as the sub-plot. Each treatment/cultivar combination was replicated four times, for a total of 128 plots.

Results:

Following two wetting agent applications, irrigation was withheld from plots starting on 25 June. However, turf quality of all plots was severely reduced due to heat stress regardless of treatment. The extended high soil temperatures experienced at the field plots was extremely unusual for our region in New England, and it was necessary to re-water all plots to prevent the turf from dying. Overall, we found that the heat stress may have confounded the effects of the dry-down in our study, since the physiological effects from the high temperatures developed very rapidly in plots that were not watered (regardless of whether wetting agent was applied).

General turf performance was evaluated by visual rating of turf quality on a 1-9 scale, 1 being the most brown and desiccated and 9 being the most green and turgid canopy. In addition to visual ratings, a multispectral radiometer (MSR) was also used to evaluate normalized difference vegetation index (NDVI), which serves as a measure of green leaf biomass or color, and leaf area index (LAI) as a measure of canopy density. In general, well-watered plots maintained the highest quality among treatments when averaged over cultivars. For treatments where irrigation was withheld, application of Wetting Agent 1 resulted in higher quality compared to plots where no wetting agent was applied, but this response was dependent on cultivar. MSR readings also indicated trends for higher canopy color and density indices for plots with wetting agent treatments.

Soil moisture content at 0-20 cm soil depth was measured using time domain reflectometry (TDR) with probes vertically installed in the soil. When averaged across cultivar, there were no significant differences in soil moisture content among the drought treatments. All three drought treatments had lower soil moisture content compared to the well-watered plots. When looking at two commonly used cultivars on golf course fairways, Penncross and L-93, there was higher moisture content in plots receiving Wetting Agent 1 compared to other drought treatments.

Leaf samples of L-93 and Penncross creeping bentgrass were sent to the Stable Isotope Facility at University of Utah for analysis of carbon isotope discrimination (CID). This method has been used as an indirect measure of water use efficiency in crops, and has been successfully used in several turfgrass species including bentgrasses. In general there is a negative correlation between CID and water use efficiency, such that lower CID values are associated with higher water use efficiency. Based on the September 2, 2010 harvest, there were no significant differences in CID among the four treatments.

Summary:

In summary, well-watered plots maintained the highest soil moisture content throughout the experiment, which contributed to higher canopy color, density, and overall turf quality among the four treatments. When comparing the drought treatments across all cultivars, there were little significant differences among plots with or without wetting agent for the measured parameters. We believe this was due to the severity of heat stress, as our soil temperatures were consistently above 85°F for a majority of the summer treatment. When examining individual cultivars, there was a trend for higher soil moisture and turf quality characteristics in plots treated with WA 1. This was true for the most commonly used cultivars on golf course fairways, including Penncross and L-93.