Evaluation of Bermudagrass for Drought Resistance

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Introduction

Bermudagrass is the most commonly used turfgrass species in the southern United States. It is important that breeding and development efforts improve both the drought resistance as well as overall adaptation of these species to facilitate irrigation water savings and persistence under drought. A 2010 – 2015 multi-state warm-season turfgrass development effort funded by the United States Department of Agriculture – National Institute of Food & Agriculture (USDA-NIFA) was conducted to develop turfgrass with improved drought resistance. This transdisciplinary effort was undertaken by the turfgrass programs at Oklahoma State University (OSU), Texas A&M University (TAMU), North Carolina State University (NCSU), the University of Georgia (UGA) and the University of Florida (UF). Over 1,900 experimental lines across the four species (bermudagrass, zoysiagrass, seashore paspalum and St. Augustinegrass) were developed during and 105 advanced drought resistance lines remain under study at this time by over 20 investigators, 30 graduate students and support staff in five states. This poster focuses on the continuing field evaluation of 10 experimental bermudagrass advanced lines for drought resistance under field conditions at Stillwater, OK.

Objective

To evaluate the live green cover, leaf firing, normalized vegetative index and turf quality response of 10 experimental turf bermudagrasses and three commercial standards under drought conditions in the field.

Materials and Methods

Two studies (Trials 1 and 2) were conducted at the Oklahoma State University Botanic Garden west of Stillwater, OK (Figures 1-3). All plant materials were provided by two turfgrass breeders involved in the SCRI-NIFA funded project at OSU and UGA. Commercially available industry standards ‘Celebration’ and ‘TifTuff’ (having improved drought resistance) (Yurisic, 2016) and ‘Tifway’ (intermediate drought resistance) (Kim et al., 1988) were included in each trial. The trials were designed as randomized complete blocks with four and three replications respectively in Trials 1 and 2. The trials were maintained using a 3.8 cm mowing height. The trials were established in July 2014 and non-limited irrigation was applied for maximum growth and establishment. Soil available phosphorus and potassium were determined to be optimal based on soil testing, so only nitrogen was applied in these trials as a fertilizer source. Urea fertilizer was used to provide 49 kg N ha^{-1} month^{-1} during the growing season in 2014 and a total of 195 kg N ha^{-1} in 2015 and 147 kg N ha^{-1} before imposing drought treatment in 2016.

In 2016, irrigation water was turned off on June 16th and July 17th respectively to Trials 1 and 2. These trials were maintained under no irrigation and no rainfall upon the start of a dry down cycle. Waterproof tarps were used to cover the trials to exclude rainfall as needed. Entries were evaluated for turf quality (TQ), leaf firing (LF) and normalized difference vegetation index (NDVI) at least once each week during the dry down cycle. Digital image analysis was used to assess live green cover (LGC) each week. TQ rating was based on the National Turfgrass Evaluation Program (NTEP) rating scale from 1 to 9, 1 = brown or dead turf canopy and 9 = green and outstanding or ideal turf (Morris et al., 1998). Additional parameters were monitored but are not discussed in this poster.

The analysis of variance was generated using ‘PROC GLM’ in Statistic Analysis System (SAS) 9.4 version software. Entry, rating date and their interactions were highly significant ($p<0.0001$), so Fisher’s Protected LSD ($p=0.05$) was used to compare the mean of TQ, LF, NDVI and LGC within rating dates (Tables 1 and 2).

Table 1. Mean turf quality (TQ), leaf firing (LF), normalized difference vegetation index (NDVI) and live green cover (LGC) values of Trial 1 on 0, 37 and 68 days after treatment (DAT).

	0 DAT				37 DAT				68 DAT			
Entry	**LGC**	**LF**	**NDVI**	**TQ**	**LGC**	**LF**	**NDVI**	**TQ**	**LGC**	**LF**	**NDVI**	**TQ**
Celebration	99.4bcd	9.0a	0.78bcd	8.0a	80.1cd	8.0b	0.63abc	5.0cd	82.5ab	7.5ab	0.59ab	4.5bc
TifTuf	99.3de	9.0a	0.76e	8.0a	81.1cd	7.3c	0.63abc	5.0cd	63.5c	6.5b	0.49c	4.0c
OSU1220	99.8a	9.0a	0.81a	7.8ab	88.2ab	8.0b	0.65ab	5.8ab	84.2ab	7.5ab	0.59ab	4.8b
OSU1221	99.5a-d	9.0a	0.80ab	7.5abc	85.0abc	8.0b	0.63abc	5.5bc	81.8ab	7.5ab	0.57ab	4.8b
OSU1225	99.5bcd	9.0a	0.78bcd	7.0c	81.8bcd	8.0b	0.63abc	5.5bc	71.0bc	7.5ab	0.55abc	4.8b
OSU1257	99.7ab	9.0a	0.76de	8.0a	76.3de	7.5bc	0.61c	5.8ab	65.6c	6.5b	0.53bc	4.5bc
OSU1273	99.5bcd	9.0a	0.77cde	7.3bc	89.1a	8.8a	0.66a	6.3a	88.8a	8.5a	0.62a	5.5a
Tifway	99.2e	9.0a	0.76de	7.8ab	69.8f	6.5d	0.52d	4.8d	36.8d	3.5c	0.34d	3.0d
UGB103	99.5a-d	9.0a	0.80ab	7.5abc	79.4cde	7.5bc	0.63abc	5.5bc	70.2bc	7.0b	0.52bc	4.8b
UGB117	99.7abc	9.0a	0.80abc	8.0a	63.0g	7.0cd	0.53d	4.8d	47.2d	4.3c	0.41d	3.0d
UGB118	99.4de	9.0a	0.80a	7.5abc	76.3de	8.0b	0.64abc	5.3bcd	77.2abc	7.0b	0.61a	4.5bc
UGB120	99.7ab	9.0a	0.79ab	7.5abc	73.2ef	8.0b	0.61bc	5.0cd	70.9bc	7.3b	0.55abc	4.0c
UGB136	99.4cde	9.0a	0.80ab	7.0c	95.6a-d	8.0b	0.65a	5.8ab	73.1abc	7.0b	0.57ab	4.5bc

Fisher’s protected LSD test: within columns, means followed by the same letter are not significantly different at the p=0.05 level.

Figure 1.Turfgrass response at 30 days into drought (DAT) on Trial 1 with zoysiagrass (on near side) and bermudagrass (on far side).

Figure 2. View of Trial 2 being protected by a water proof tarp during a rain event.

Table 2. Mean turf quality (TQ), leaf firing (LF), normalized difference vegetation index (NDVI) and live green cover (LGC) values of Trial 2 on 0, 44 and 90 days after treatment (DAT).

	0 DAT				44 DAT				90DAT			
Entry	**LGC**	**LF**	**NDVI**	**TQ**	**LGC**	**LF**	**NDVI**	**TQ**	**LGC**	**LF**	**NDVI**	**TQ**
Astro	96.1de	9.0a	0.76a	5.7f	43.5f	6.7c	0.38e	3.7e	28.5e	2.3d	0.28d	2.0d
Celebration	98.2abc	9.0a	0.65b	6.0ef	78.1bcd	7.7bc	0.58bcd	5.0bc	54.9bc	5.3bc	0.43c	3.0bc
TifTuf	98.2abc	9.0a	0.76a	7.0bc	94.1a	9.0a	0.7a	5.7ab	91.9a	8.0a	0.68a	5.3a
OSU1220	97.6a-d	9.0a	0.76a	7.0bc	77.3bcd	8.0ab	0.58bcd	5.0bc	59.2bc	6.0bc	0.5bc	3.7b
OSU1221	97.4a-d	9.0a	0.78a	7.0bc	93.7a	8.7ab	0.7a	6.0a	88a	8.0a	0.66a	5.0a
OSU1225	98.0abc	9.0a	0.74ab	7.0bc	77.1bcd	8.0ab	0.57bcd	5.3abc	60.9bc	6.3b	0.5bc	3.3b
OSU1257	97.1cde	9.0a	0.74ab	7.0bc	85.4ab	8.0ab	0.63b	5.3abc	67.9b	6.3b	0.54b	3.7b
OSU1273	96.9cde	9.0a	0.78a	6.3de	71.9cde	7.7bc	0.55cd	4.7cd	53.7bc	4.7c	0.45b	3.0bc
TGSU-3	98.4abc	9.0a	0.78a	6.3de	75.8bcd	7.7bc	0.55cd	4.0de	57.1bc	4.7c	0.42c	3.0bc
Tifway	97.2b-e	9.0a	0.75ab	7.0bc	60.2e	6.7c	0.44e	3.7e	35.8de	2.3d	0.31d	2.3cd
UGB103	98.1abc	9.0a	0.78a	7.3ab	68.9de	8.0ab	0.56bcd	5.3abc	54.1bc	5.0bc	0.45bc	3.3b
UGB117	99.0ab	9.0a	0.78a	7.7a	67.7de	8.0ab	0.53d	4.7cd	45.5cd	4.7c	0.42c	3.0bc
UGB118	98.4abc	9.0a	0.80a	6.7cd	70.9de	8.0ab	0.6bc	4.7cd	57.1bc	5.7bc	0.5bc	3.3b
UGB120	95.5e	9.0a	0.74ab	7.3ab	63.3e	8.0ab	0.53d	4.7cd	49.8cd	5.0bc	0.45c	3.0bc
UGB136	99.2a	9.0a	0.80a	7.0bc	83.6abc	8.0ab	0.61bc	5.3abc	57.4bc	5.7bc	0.5bc	3.3b

Fisher’s protected LSD test: within columns, means followed by the same letter are not significantly different at the p=0.05 level

Results and Discussion

The Bermudagrass drought tolerant standard TifTuf had the highest TQ, LF, NDVI and LGC ratings at around 68 days and 90 days after treatment (DAT), respectively, in each trial (Table 1 and 2). All ten experimental bermudagrasses selected for improved drought resistance in the earlier project had higher TQ, LF, NDVI and LGC ratings during drought in these trials than the industry standard Tifway. OSU experimental line ‘OSU1221’ ranked in the top statistical group for LGC and NDVI at 68 DAT in Trial 1 and in the top group for LCG, LF, NDVI and TQ at 44 and 90 DAT in Trial 2. During the induced drought, OSU1221 had higher mean TQ, LF, NDVI and LGC than several other entries and never lower than TifTuf. Celebration performed better than other commercially released bermudagrass cultivars except TifTuf in both trials. Tifway ranked in the bottom statistical groups in both trials at the end of both trials. ‘Astro’ had the lowest performance means regardless of parameter measured in Trial 2.

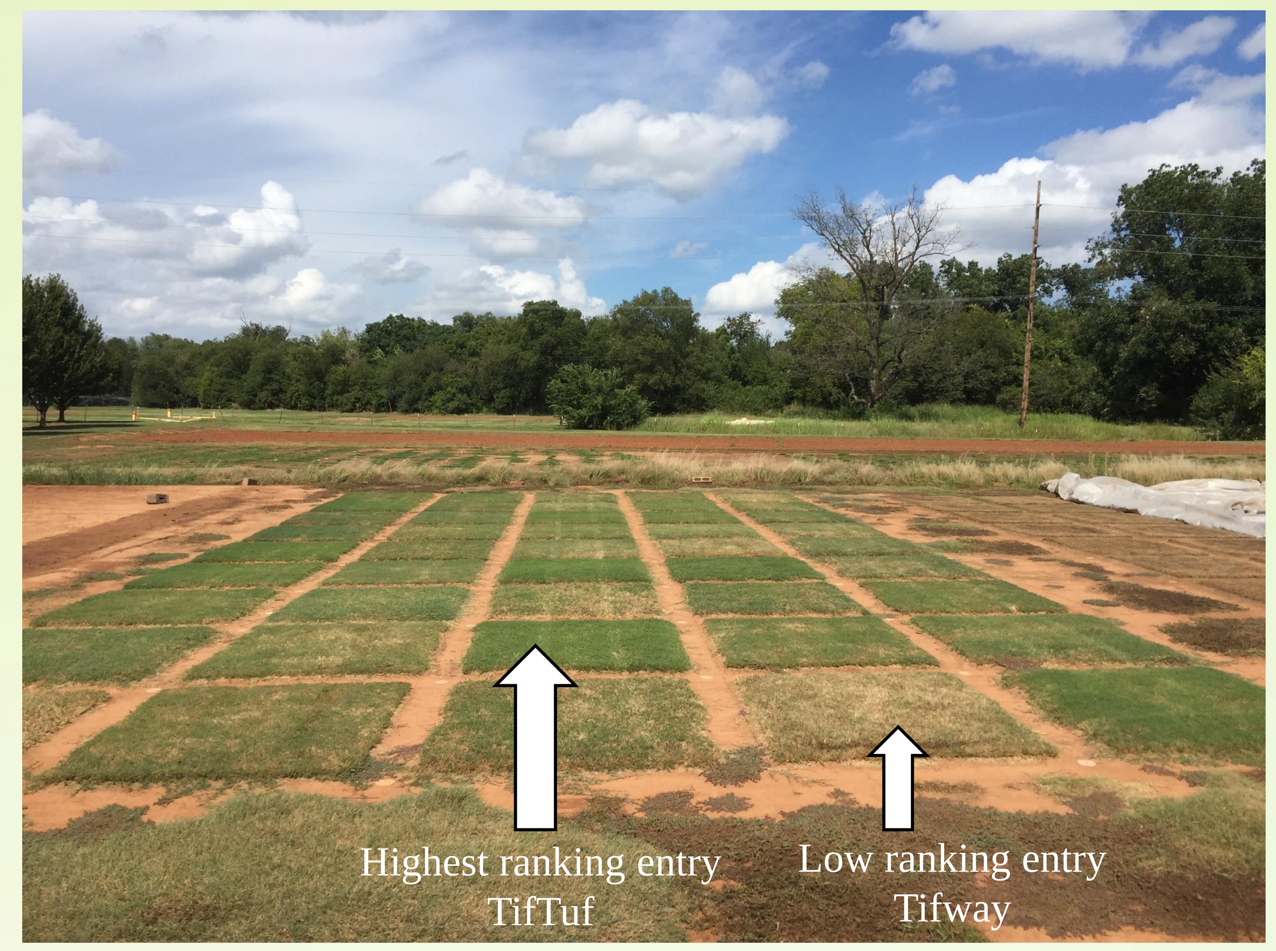

Figure 3. Varying levels of leaf firing were visible on bermudagrasses under study in Trial 2 at 67 days into the drought stress period.

Conclusions

The results of these studies provide information to turfgrass breeders concerning the performance of their promising experimental lines under drought stress relative to industry standards. Drought resistant standards TifTuf and Celebration ranked high in drought resistance relative to Tifway. All bermudagrass experimental lines thus far show improved quality as compared to the industry standard Tifway. Drought resistance of the commonly used Astro bermudagrass was not known and it ranked low for drought resistance in Trial 2. Additional research is needed across variable management regimes in multiple extreme environments and geographical locations to test the robustness and breadth of adaptation of the experimental lines to aid the turfgrass developers concerning release/commercialization decisions.

Acknowledgements

Funding for this research was provided by the United States Department of Agriculture – National Institute of Food and Agriculture (USDA – NIFA) Specialty Crop Research Initiative (SCRI), the Oklahoma Turfgrass Research Foundation (OTRF), and the Oklahoma Agricultural Experimental Station (OAES).

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