High Temperature and Drought Effects of a Texas Bluegrass Hybrid Compared with Kentucky Bluegrass and Tall Fescue

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Introduction

High temperature and drought stresses are major problems during summer months in cool-season turfgrasses. Kentucky bluegrass (Poa pratensis L.) is a high quality, cool-season turfgrass which is commonly used on lawns and roughs of golf courses in the U.S. When high quality is desired, its use may be limited in transition zones due to its sensitivity to heat and drought stresses. Tall fescue (Festuca arundinacea Schreber), also a cool-season grass, is sometimes used in roughs and very popular in lawns because of its good drought resistance, but some individuals including many golf course superintendents do not like its coarse texture compared to Kentucky bluegrass. New Texas bluegrass (Poa arundinacea Tzuk) hybrids which are a genetic cross between native Texas bluegrass and Kentucky bluegrass, has been released as a heat and drought tolerant turfgrass with similar fine-textured qualities as Kentucky bluegrass. However, little scientific details are available about the effects of high temperature and drought on Texas bluegrass hybrids.

Objectives

- Investigate the effects of high temperature and drought stresses on photosynthesis in a Texas bluegrass hybrid (Thermal Blue), Kentucky bluegrass (Apollo), and tall fescue (Dynasty).
- Compare electrolyte leakages among species of least cell membranes after exposure to irrigation deficits and high temperature; higher electrolyte leakages indicate cell membrane breakdown and thus, lower tolerance to stresses.
- Determine the effects of heat and drought stresses on visual quality.
- Evaluate heat and drought tolerances of the 3 cool-season turfgrasses.

Materials and Methods

- Three turfgrass species were planted in 35 cm diameter (10 cm deep) pots filled with mixture of sand and topsoil (1:1, v:v) in a greenhouse for 4.5 months.
- Turfgrass were then exposed for 48-h days to high temperature (35/25°C, 14/10 h day/night) and optimum (22/15°C, 14/10 h day/night) under water deficit (ED, ET Replacement) and well-watered (100% ET Replacement) irrigation regimes.
- Experimental design was split-plot. Whole plots were temperature treatments and irrigation regimes, and subplot was species.
- A conductance meter (YSI Model 32) was used to measure electrolyte leakage.
- Photon flux density and poplation inversion with Li-6400 (LiCor) equipped with a custom surface chamber (Fig. 1); total photosynthesis (Pt) was estimated as the sum of light interception and respiration.
- In well-watered, high temperature treatments, Pt was consistently and significantly higher in Thermal Blue than in Dynasty beginning in day 24 (Fig. 2A).
- In optimum temperature, drought stressed treatments, Pt declined among species and difference was not significant (Fig. 2C).
- Total Photosynthesis (Pt)

Results

- Visual Quality (see also Fig. 5)

In well-watered, high temperature treatments the visual quality of Thermal Blue was generally lower in both Pt and visual quality late in the study.
- In well-watered, high temperature treatments, Thermal Blue exhibited significantly higher Pt and visual quality and significantly lower EL than Apollo and Dynasty.
- High temperature and drought combination reduced visual quality among species although Thermal Blue was generally higher in both Pt and visual quality late in the study.
- High temperature and drought combination caused EL to increase among species although EL was significantly higher in Apollo and Dynasty than in Thermal Blue late in the study (P<0.05).
- In optimum temperature, drought stressed treatments, Pt and visual quality declined and EL increased with no significant differences among species.
- Thus, no significant differences in drought tolerance were found among species.
- In general, Thermal Blue exhibited higher heat tolerance than Apollo and Dynasty in a growth chamber study.

Discussion

- In back rows: KBG (60% evapotranspiration [ET]); KBG (80% ET); KBG (100% ET); TF (60% ET); TF (80% ET); and TF (100% ET).
- Front row is high temperature and back row is low temperature.
- Figure 3. Effects of high temperature and drought on electrolyte leakage (EL) in Thermal Blue, Apollo, and Dynasty. Vertical bars indicate LSD values (P=0.05) among species.
- In well-watered, high temperature treatments, EL was significantly lower in Thermal Blue than in Apollo and Dynasty (Fig. 3B).
- In optimum temperature, drought stressed treatments, EL increased among species although EL was significantly higher in Apollo and Dynasty than in Thermal Blue late in the study (P<0.05).
- In optimum temperature, drought stressed treatments, Pt and visual quality declined and EL increased with no significant differences among species.
- Thus, no significant differences in drought tolerance were found among species.
- In general, Thermal Blue exhibited higher heat tolerance than Apollo and Dynasty in a growth chamber study.

Graphs

- Figure 2. Effects of high temperature and drought on total photosynthesis in Thermal Blue, Apollo, and Dynasty. Vertical bars indicate LSD values (P=0.05) among treatments on a given day following treatment initiation (Day of treatments).
- Figure 3. Effects of high temperature and drought on electrolyte leakage (EL) in Thermal Blue, Apollo, and Dynasty. Vertical bars indicate LSD values (P=0.05) among treatments on a given day following treatment initiation (Day of treatments).
- Figure 4. High temperature and drought effects of Apollo, Thermal Blue, and Dynasty on their visual qualities. Vertical bars indicate LSD values (P=0.05) for treatment comparisons as a given day of treatments.
- Figure 5. Visual appearance of Apollo (AO), Thermal Blue (TB), and Dynasty (DF) in the P treatment after 26 days of high temperature and irrigation deficits treatments. Point row in high temperature and back row in low temperature. Thermal Blue was high in both front and back row, but Apollo and Dynasty were lower in front row (100% ET); TB (60% ET); TB (80% ET); DF (60% ET); DF (80% ET); and DF (100% ET).