# 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 fairways and roughs of golf courses in the U.S. When high quality is desired, its use may be limited in transition areas due to its sensitivity to heat and drought stresses. Tall fescue (*Festuca arundinacea* Schreb.), 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 coarser texture compared to Kentucky bluegrass. New Texas bluegrass (*Poa arachnifera* Torr.) 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-texture qualities as Kentucky bluegrass. However, little scientific data 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 leaf 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 36 polyvinylchloride (PVC) tubes (10 cm diam.,60 cm high) filled with mixture of sand and topsoil (1:1,v:v) in a greenhouse for 4.5 months.
- Tubes were transferred and acclimated to growth chambers at optimum temperature (22ºC day (14 h), 15ºC night (10 h)) for 2 weeks.
- Turfgrasses were then exposed for 48 days to high temperature (35/25ºC, 14/10 h day/night) and optimum (22/15ºC, 14/10 h day/night) under water-deficit (60% ET replacement) and well-watered (100% ET replacement) irrigation regimes.
- Experimental design was split-plot. Whole plots were temperature treatments (individual growth chambers) in a randomized complete block design. Species/cultivar and irrigation were subplots.
- Net photosynthesis and respiration measured with a Li-6400 (Licor) equipped with a custom surface chamber (Fig.1); total photosynthesis (Pt) was estimated as the sum of net photosynthesis and respiration.
- Conductance meter (YSI Model 32) was used to measure electrolyte leakage.

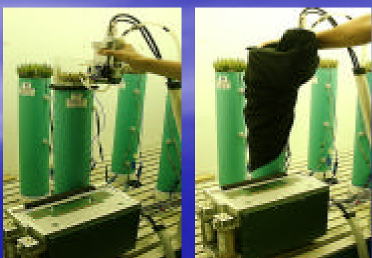

Figure 1. Licor 6400 (Li-6400) with a custom surface chamber was used to measure net photosynthesis (left) and total respiration rates (right). For respiration measurements, a black cloth covered the chamber which prevented light penetration and photosynthesis.

## Results

**Total Photosynthesis (Pt):**

- High temperature & drought stress combination caused a rapid decline in Pt among species; Pt in Thermal Blue was generally higher towards end of study (Fig. 2A).
- In well-watered, high temperature treatments, Pt was consistently and significantly higher in Thermal Blue than in Dynasty beginning on day 24 and in Apollo on day 42 (Fig. 2B).
- In optimum temperature, drought stressed treatments, Pt declined among species and differences were not significant (Fig.2C).

**Living Leaf Electrolyte Leakage (EL):**

- High temperature & drought stress combination caused EL to increase among species and EL was significantly higher in Apollo and Dynasty than in Thermal Blue late in the study (Fig. 3A).
- High temperature had no effect on EL in well-watered Thermal Blue, but EL increased significantly in well-watered Apollo and Dynasty (Fig. 3B).
- Drought stress in optimal temperature treatments had no significant effect on EL among species (Fig.3C).

**Visual Quality (see also Fig. 5):**

- High temperature & drought stress combination reduced visual quality among species. Visual quality in Thermal Blue was significantly higher than in Dynasty and Apollo late in the study (Fig. 4A).
- In well-watered, high temperature treatments the visual quality of Thermal Blue was significantly higher than Dynasty and Apollo (Fig. 4B).
- In optimum temperature, drought stressed treatments, visual qualities declined among species and differences were not significant (Fig. 4C).

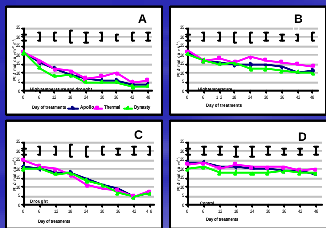


Figure 2. Effects of high temperature and drought on total photosynthesis (Pt) in Apollo, Thermal Blue, and Dynasty. Vertical bars indicate LSD values (P=0.05) among treatments on a given day following treatment initiation (Day of treatments).

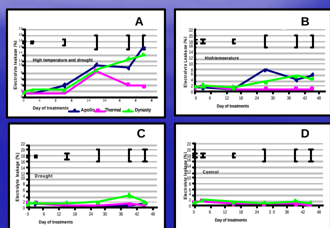


Figure 3. Effects of high temperature and drought on electrolyte leakages in Apollo, Thermal Blue, and Dynasty. Vertical bars indicate LSD values (P=0.05) among treatments on a given day following treatment initiation (Day of treatments).

## Conclusions

- 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 caused a reduction in Pt and 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.

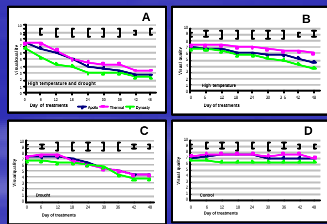


Figure 4. High temperature and drought effects of Apollo, thermal blue, and Dynasty on their visual qualities. Vertical bars indicate LSD values (P=0.05) for treatment comparisons as a given day of treatments.

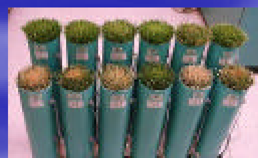

Figure 5. Visual appearance of Apollo (KBG), Thermal Blue (TB), and Dynasty (TF) in the 1st replication after 36 days of temperature and irrigation deficit treatments. Front row is high temperature and back row is low temperature treatment. From left to right in both front and back rows: KBG (60% evapotranspiration [ET]); KBG (100% ET); TB (60% ET); TB (100% ET); TF (60% ET); and TF (100% ET).

## Acknowledgements

We greatly appreciate financial support from The Scotts Company, Golf Course Superintendents Association of America, and the Kansas Turfgrass Foundation.