TITLE: Mowing Height and Drought Effects on a Texas Bluegrass Hybrid Compared with Kentucky bluegrass

OBJECTIVE: Evaluate the effects of mowing height and drought on the visual quality, photosynthesis, canopy spectral reflectance, and soil moisture of a Kentucky bluegrass ('Apollo') and a hybrid bluegrass ('Thermal Blue'). Recovery from drought after re-watering was also investigated.

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INTRODUCTION:

A growing challenge facing the turfgrass industry is limited availability of water for irrigation. Local water-use restrictions may be imposed during drought that limit growth and cause severe declines in the visual quality of many cool-season turfgrasses. In golf courses, lower mowing heights in fairways may result in additional stress to turfgrass during drought because lower mowing typically reduces root growth and development. Texas bluegrass hybrids, which are genetic crosses between native Texas bluegrass and Kentucky bluegrasses, may have greater heat and drought resistance than other cool-season grasses. Hybrid bluegrasses have similar visual qualities to Kentucky bluegrass, which is a fine-textured, cool-season turfgrass commonly used in lawns and golf courses in the United States. Consequently, new cultivars of hybrid bluegrasses are being investigated as potential water-saving, heat-resistant alternatives to current cool-season turfgrasses. Research is needed to identify species or cultivars of cool-season turfgrasses that may perform better under drought stress, including maintenance at lower mowing heights.

MATERIALS AND METHODS:

This study was conducted from 3 August to 8 October, 2004, and from 27 June to 15 September, 2005, under an automated rainout shelter (180 m^2) at the Rocky Ford Turfgrass Research Center near Manhattan, KS. Thirty two plots (1.36 m x 1.76 m) of a Kentucky bluegrass and a hybrid bluegrass were arranged in a randomized complete block design with four replications; plots were bordered by metal edging (10 cm depth) to prevent lateral soil water movement between adjacent plots. Three treatments were applied to the plots: 1) a low mowing height (3.81 cm); 2) reduced irrigation (replacement of 60% of the water lost from plant and soil surfaces via evapotranspiration [ET]) at higher mowing height (7.62 cm); and 3) combination of low mowing height (3.81 cm) and reduced irrigation (60% ET replacement). A control was also included that was well watered (100% ET replacement) and mowed at the greater height (7.62 cm). Plots were mowed twice a week with a walk-behind rotary mower. Water was applied twice weekly through a fan spray nozzle attached to a hose; a meter was attached to ensure proper application rate. To determine irrigation requirements, evapotranspiration (ET) was calculated by using the Penman-Monteith equation (FAO, 1998) and climatological data obtained at a weather station located at Rocky Ford Turfgrass Research Center.

Turf visual quality was rated on a scale of 1 to 9 (1=poorest quality, 6=minimally acceptable, and 9=highest quality) according to color, texture, density, and uniformity. Quality ratings were recorded weekly by the same individual during the 2-year study. Photosynthesis was measured biweekly on clear days between 1000 and 1400 CST with a LI-6400 portable gas exchange system using a custom surface chamber. Permanent polyvinyl chloride collars (10-cm diam.) were placed randomly at one location in each plot and were driven approximately 5 cm into the soil. Canopy spectral reflectance was measured weekly on clear days at approximately 1200 CST with a Cropscan multispectral radiometer (MSR) (model MSR16, Cropscan Inc., Rochester, MN). Canopy reflectance was measured in eight wavelengths including 507, 559, 613, 661, 706, 760, 813, and 935 nm. The normalized difference vegetation index (NDVI) was computed as ([R935-R661] / [R935 +R661]), where Rx indicates reflectance at wavelength x. The ratio of near infrared to red (NIR / R) was computed as R935 / R661. In all plots, the volumetric soil water content (θ_v) in the 0 to 50 cm profile was measured weekly using time domain reflectometry and in drought plots at 5 cm using dual-probe heat-pulse sensors.

RESULTS:

Low mowing height

In general, our data indicated that this hybrid bluegrass (Thermal Blue) generally performed poorer than this Kentucky bluegrass (Apollo) in well-watered plots at the low mowing height. Visual quality, which may be the most important parameter to the turfgrass manager, was not affected in Kentucky bluegrass by low mowing but was reduced in the hybrid bluegrass (Figs. 1A and 1B). The deleterious effects of low mowing on photosynthesis and canopy reflectance, which indicate reductions in the vigor or size of the turfgrass canopy, were generally greater in the hybrid than in Kentucky bluegrass (data not shown).

Drought

Drought significantly reduced the visual quality of both species in 2005, but the effects of drought on visual quality were less severe in 2004 (Figs. 1C and 1D). In 2005, drought reduced mean visual quality by 28% in Kentucky bluegrass and by 25% in hybrid bluegrass compared with the control. In 2004, visual quality decreased in drought plots as the study progressed although significantly only in the hybrid bluegrass. The greater decline in visual quality with drought in 2005 than in 2004 was likely caused by corresponding higher temperatures during the study. High air temperature may compound drought stresses by adding heat stress; low soil moisture in drought plots reduces ET and evaporative cooling in canopies of drought, compared with well-watered plots. Visual quality between species was similar, although visual quality in the hybrid bluegrass tended to be lower than in Kentucky bluegrass in drought plots in 2004.

Soil moisture was consistently lower in the hybrid bluegrass (Fig. 2A), which indicates the hybrid bluegrass may have been more efficient at extracting soil moisture during drought, including at near the surface (5 cm; data not shown) (i.e., where root density is greater). In general, however, values of photosynthesis and canopy reflectance were lower in the hybrid than in Kentucky bluegrass (data not shown), which indicates that any advantage in soil moisture extraction capability by this hybrid during drought are not reflected in greater performance compared with Kentucky bluegrass.

Effects of low mowing height and drought combined

Visual quality was strongly reduced in Kentucky bluegrass and in the hybrid bluegrass by the combination of low mowing and drought, and the effects during both years were similar to or more pronounced than in separate treatments of low mowing or drought (Figs. 1A to 1F). In 2005, visual quality was significantly lower in the hybrid bluegrass than in Kentucky bluegrass for about the first half of the study period (Fig. 1F). Visual quality in 2005 averaged 14% lower in the hybrid bluegrass than in the Kentucky bluegrass.

The combination of low mowing and drought significantly reduced photosynthesis in both species compared with the control (data not shown). Between species, however, photosynthesis was consistently lower in the hybrid bluegrass than in Kentucky bluegrass in low mowed and drought plots in 2005. Soil moisture in the 0-50 cm profile steadily decreased in combination low mowing and drought plots in 2005, but soil moisture decreased faster in Kentucky bluegrass than in the hybrid (Fig. 2B). Soil moisture was significantly lower in Kentucky bluegrass than in the hybrid during most of the study, which was similar to the trend in soil moisture at 5 cm (not shown). Consistently lower soil moisture in Kentucky bluegrass indicates that Kentucky bluegrass extracted more water from the soil than the hybrid bluegrass, which in combination with generally higher visual quality suggests (Figs. 1E and 1F) that this Kentucky bluegrass (Apollo) is better suited for conditions of low mowing height and drought than this hybrid bluegrass (Thermal Blue).

Recovery after drought and summer stress

The hybrid bluegrass recovered more quickly in drought plots after termination of the drought treatment and re-watering on 70 DOT (Fig. 1D). Visual quality, which was measured weekly for four weeks after re-watering, increased more rapidly in the hybrid bluegrass than in Kentucky bluegrass and was significantly higher in the hybrid than in Kentucky bluegrass during the last two weeks of the recovery period. The recoveries of the hybrid bluegrass and Kentucky bluegrass were similar, however, in the combination low mowing and drought treatment (Fig. 1F).

CONCLUSIONS:

In summary, these data indicate that this Kentucky bluegrass (Apollo) generally performed better than this hybrid bluegrass (Thermal Blue) at the lower mowing height, during drought, and in the combination of lower mowing height and drought. Therefore, no advantage in drought resistance was observed in this hybrid compared with Kentucky bluegrass in this study, with the exception of faster recovery time after drought.

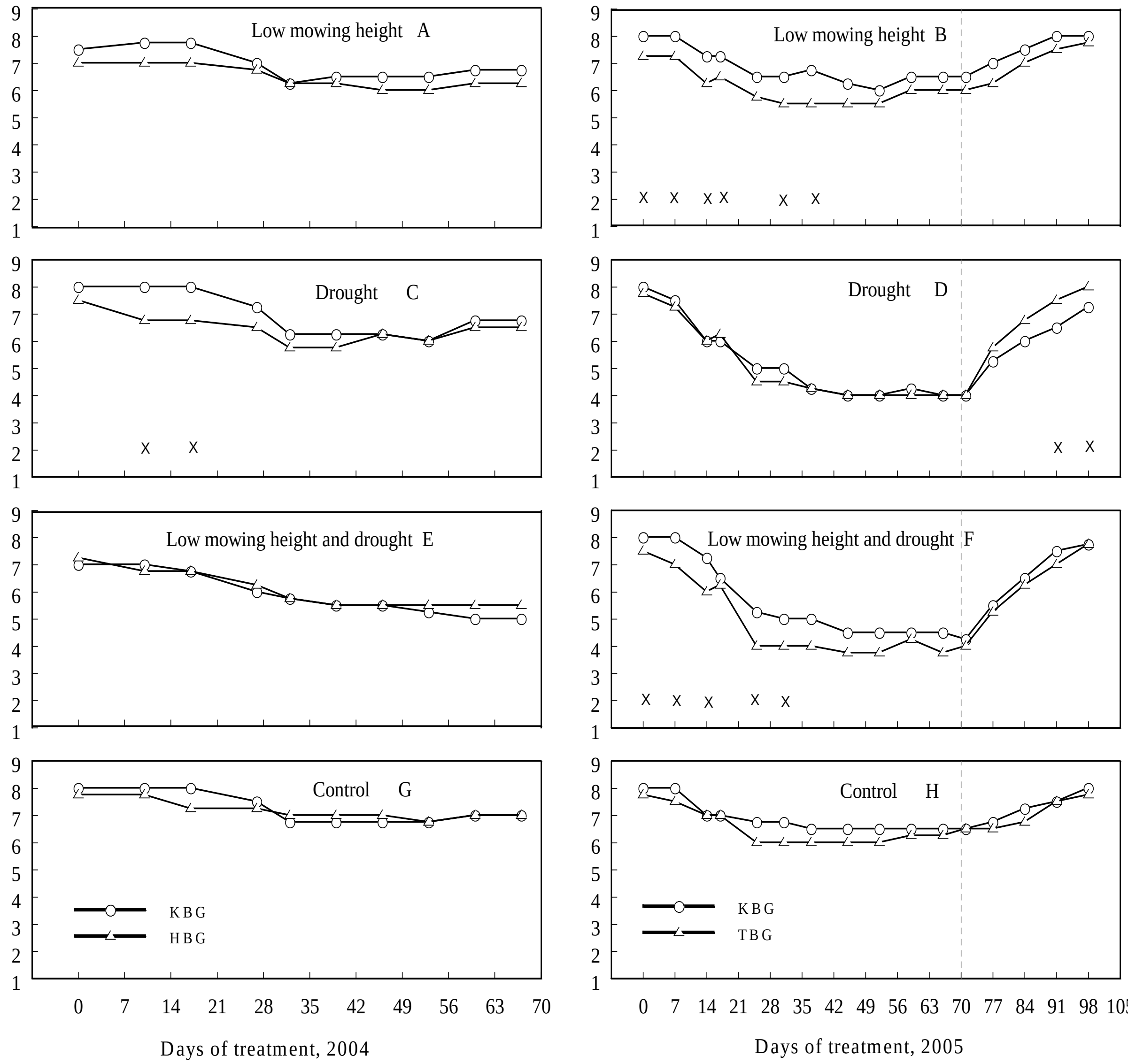

Figure 1. Visual quality of a Kentucky bluegrass (KBG) and a Texas bluegrass hybrid (TBG) rated on a scale of 1 to 9 (1=poorest and 9=highest) in treatments: Low mowing height (A, B), drought (C, D), combination low mowing height and drought (E, F), and control (G, H) in 2004 and 2005. Symbols (+) along the abscissa of each graph indicate significant difference between HBG and KBG (P<0.05) on a given day after treatment initiation (Days of treatment).

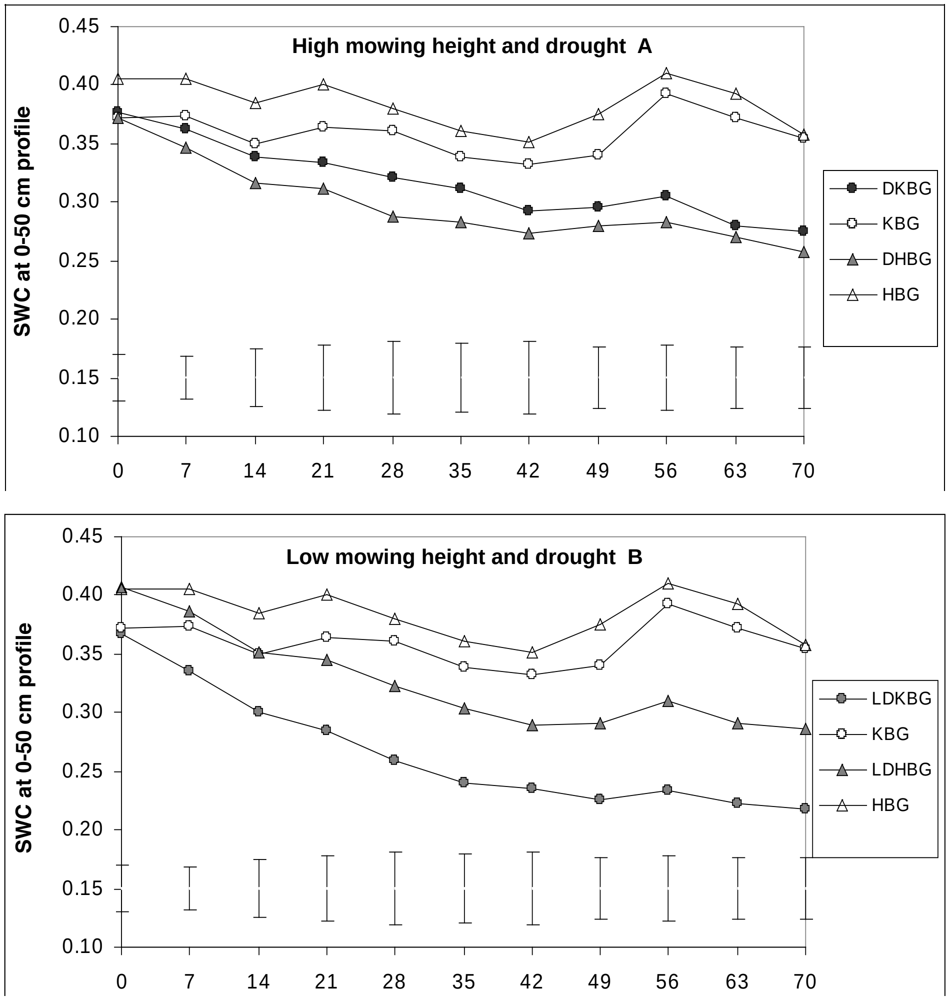

Figure 2. The effects drought (A) and the combination of low mowing and drought (B) on volumetric soil water content (SWC) at 0-50 cm in Kentucky bluegrass (KBG) and in a hybrid bluegrass (HBG). Closed symbols represent SWC in each respective treatment (D=drought; LD=low mowing and drought combination) and open symbols represent the control (higher mowing height, well watered). Vertical bars indicate LSD values ($P<0.05$) among treatments on a given day after treatment initiation (Days of treatment).