TITLE: Effects of High Temperature and Drought on a Hybrid Bluegrass Compared with Kentucky Bluegrass and Tall Fescue

OBJECTIVE: Evaluate effects of high temperature and drought on physiology and growth of ‘Apollo’ Kentucky bluegrass (*Poa pratensis* L.), ‘Dynasty’ tall fescue (*Festuca arundincea* Schreb.), and ‘Thermal Blue’, a hybrid between KBG and Texas bluegrass (*Poa arachnifera* Torr.)

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INTRODUCTION:

High temperature and drought stresses are significant problems in cool-season turfgrasses during summer months in the U.S. transition zone. High temperature and drought stresses often occur simultaneously during summer months and may limit growth and cause a severe decline in the visual quality of cool-season turfgrasses. Recent increases in competition for water have resulted in restrictions in water use for irrigation of turfgrasses, which further exacerbates the problem of drought stress in cool-season turfgrasses. Predictions of higher temperatures from global warming also suggest that heat stress in cool-season turfgrasses may become more common in some regions, including the transition zone.

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. However, little information is available about the effects of both high temperature and drought on hybrid bluegrasses.

MATERIALS AND METHODS:

Turfgrasses were exposed for 48 days to supra-optimal (high temperature; 35/25°C, 14-h day/10-h night) and optimal (control; 22/15°C, 14-h day/10-h night) temperatures under well-watered (100% evapotranspiration [ET] replacement) and deficit (60% ET replacement) irrigation

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 every 6 d by the same individual during the entire study. Photosynthesis was measured every 6 d at about 8 h into the daily light cycle, with a LI-6400 portable gas exchange system. Leaf electrolyte leakage (EL) was measured at 0, 3, 15, 27, 39, and 45 days of heat and drought treatments.

Turfgrasses were mowed every 3 d, and all clippings were collected. Clippings were dried in a forced-air oven for 48 h at 70°C and then weighed. Cumulative dry matter production for each treatment was determined by summing the dry weights of all clippings during the 48 d study. Daily dry matter production was calculated as the clipping weight at each mowing divided by the number of days since the previous mowing.

Soil surface temperature was measured with soil-encapsulated thermocouples. To evaluate potential cumulative heat effects among treatments during the most stressful periods, heat units (degree-hours) were calculated as the sum of soil surface temperatures during the final 8 h of each daily light cycle. Our data indicated that this was the period of maximum soil surface temperatures, which may have had important physiological impacts on the turfgrasses (e.g., on meristematic activity in the crowns).

At the end of each 48 d replication, aboveground biomass was harvested from each lysimeter and separated into living and dead components. Green leaves were separated from green shoots and the area of the leaves was measured with an area meter (LI-3100, LI-COR, Lincoln, NE). All green and dead tissue was then dried in a forced-air oven for 48 h at 70°C and weighed separately. Green LAI was calculated as the ratio of the green leaf area to ground surface, and total aboveground biomass for each treatment was calculated as the sum of the dry weights of all living and dead tissue.

After aboveground biomass was harvested, lysimeters were laid horizontally and cut into three sections (0 to 15, 15 to 35, and 35 to 57.5 cm). The soil was washed from the roots in each section and roots were dried in a forced-air oven for 48 h at 70°C and then weighed. Root mass density of each section was calculated as dry root mass divided by the volume of soil inside each respective section of lysimeter.

RESULTS:

Heat resistance was greater in the hybrid bluegrass, which was illustrated by its greater visual quality than Kentucky bluegrass and tall fescue under high temperature (Fig. 1). The hybrid bluegrass also exhibited greater photosynthesis, ET, and dry matter production (Table 1), and lower electrolyte leakage and soil-surface temperatures than Kentucky bluegrass and tall fescue under high temperature (data not shown). Cumulative photosynthesis during the study was 16% and 24% greater in the hybrid than in Kentucky bluegrass and tall fescue, respectively, in the high temperature treatment. Green leaf area index (LAI) in the hybrid bluegrass was not affected by high temperature, but LAI was reduced by 29 % in Kentucky bluegrass and 38% in tall fescue. Differences in drought resistance were negligible among species. The combination of high temperature and drought caused rapid declines in visual quality and dry matter production (Table 1), but the hybrid bluegrass generally performed better; cumulative photosynthesis decreased by 50% to 60% among all species compared with the control, but photosynthesis was higher in the hybrid than in tall fescue. Results indicated greater heat resistance, but not drought resistance, in the hybrid bluegrass than in Kentucky bluegrass or in tall fescue.

Note: More information on this study is available in Crop Science (in press).

Figure 1. Effects on visual quality rated on a scale of 1 to 9 (1=poorest and 9=highest) of: high temperature (A), drought (B), high temperature and drought (C), and control (D) in Kentucky bluegrass (KBG), hybrid bluegrass (HBG), and tall fescue (TF). Symbols along the abscissa of each graph indicate significant differences (P<0.05) between: HBG and KBG (*); HBG and TF (+); and KBG and TF (+); on a given day after treatment initiation (Days of treatment).

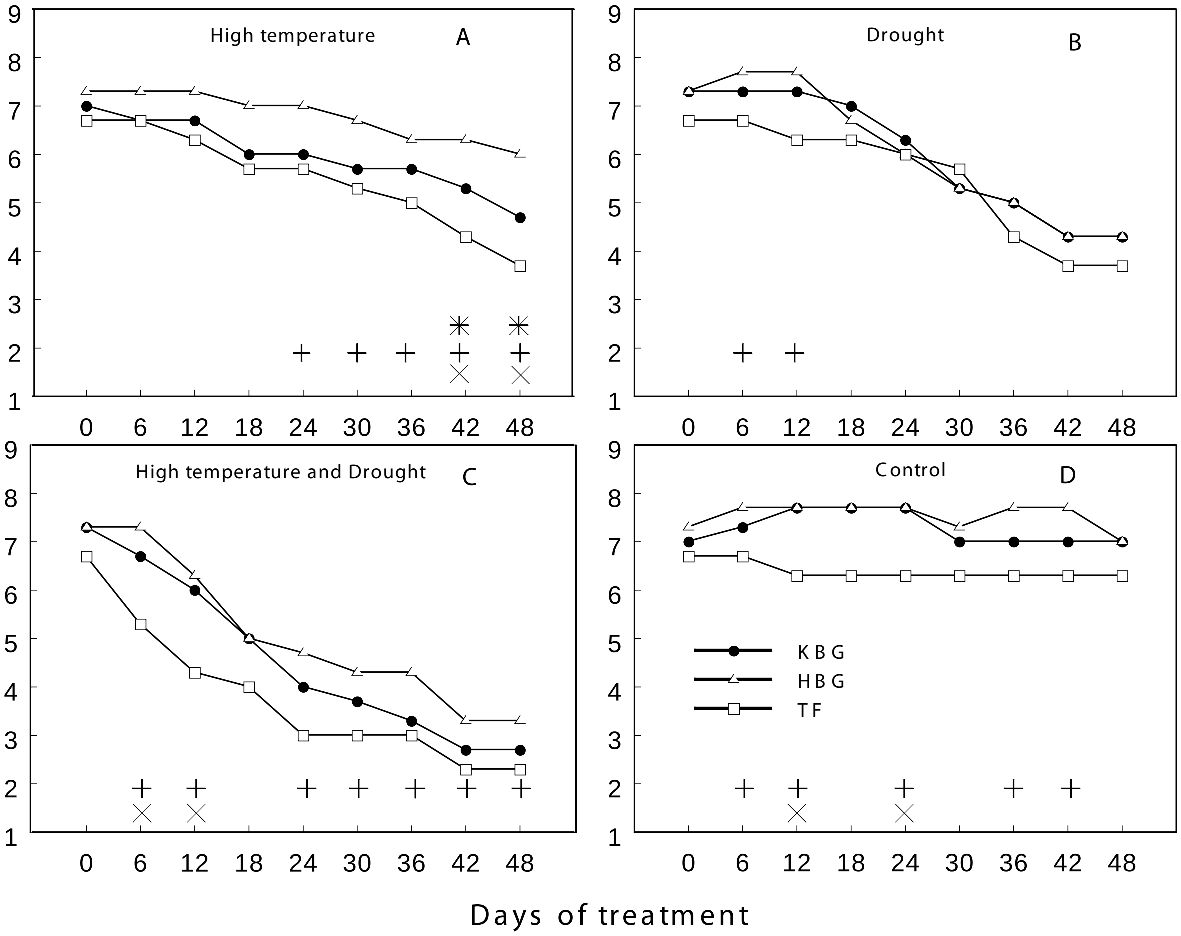

Table 1. Effects on dry aboveground biomass of high temperature, drought, high temperature and drought, and control in Kentucky bluegrass (KBG), hybrid bluegrass (HBG), and tall fescue (TF).

Treatments	*Species*	*Aboveground biomass(g m^{-2})*			*Percentage of living biomass in total (%)*
		Total	Dead	Living	
High temperature	KBG	1411.8 ef[†]	776.4 de	635.4 bcdef	45 abcd
	HBG	1430.6 def	606.5 de	824.2 abc	58 a
	TF	1706.7 bcd	1092.6 abc	614.1 cdef	36 cde
Drought	KBG	1596.4 cde	869.5 bcde	726.9 abcd	46 abcd
	HBG	1338.7 ef	687.2 de	651.5 bcde	49 abc
	TF	1932.6 ab	1153.6 ab	779.0 abc	40 bcde
High temperature and drought	KBG	1266.4 f	903.1 abcd	363.3 f	29 de
	HBG	1179.7 f	718.0 de	461.7 def	39 bcde
	TF	1581.3 cde	1205.0 a	376.3 ef	24 e
Control	KBG	1717.6 bc	802.2 cde	915.5 ab	53 ab
	HBG	1444.8 cdef	571.4 e	873.4 abc	60 a
	TF	2151.1 a	1207.4 a	943.6 a	44 abcd

[†] Means followed by the same letter within a column were not significantly different (P<0.05).