Executive Summary, Fall 1995

Characterization of Water Use Requirements and Gas Exchange of Buffalograss Turf

Submitted by: Daniel C. Bowman

Since irrigation accounts for nearly half of urban water use, considerable savings could be realized by planting turfgrasses with low water requirements. Buffalograss may be the ideal species for both water savings and aesthetics, but water use data are scarce and one can only speculate on water requirements. This study is generating crop coefficients for buffalograss and identifies intraspecific water use differences among a diverse selection of genotypes.

A field project was installed at the UNR Valley Road Field Station to determine water use requirements of seventeen buffalograss genotypes representing a diverse genetic background. This project utilizes a line source water gradient in which buffalograss varieties are planted in strips down the gradient. Turf performance can be measured at any given irrigation amount, and minimum irrigation requirements are indicated by that point in the gradient beyond which the turf goes dormant or cannot survive.

Mini-lysimeters (15 cm diameter, 30 cm depth and each with a drain hole and removable plug to stop drainage) were planted, four per genotype, and established in the greenhouse. Cores for the lysimeters were drilled in each plot 2 meters from the main irrigation line. These are used to determine ET gravimetrically under non-limiting conditions.

The line source gradient was established in June, 1995, with irrigation scheduled based on ET (modified Penman) as determined with weather station data. Data on ET under non-limiting conditions, turf quality, canopy temperature, soil moisture, minimum water requirements, and plant water status were collected during 1995. The data demonstrate significant differences between genotypes for water use (crop coefficients ranged from 0.60 to 0.92) and turf quality. Canopy temperatures were relatively unaffected by drought during the first five weeks of the experiment, and subsequently increased only at the outer edge of the plots. Over the course of this experiment (70 days), the point demarcating the minimum irrigation required to prevent total dormancy corresponded to approximately 40% ET. It is apparent from this and the previous year's
data that some genotypes of buffalograss can produce an acceptable turf with deficit irrigation of 50-60% ET.

Progress Report, November, 1995

Characterization of Water Use Requirements and Gas Exchange of Buffalograss Turf

Submitted by: Daniel C. Bowman

This project is designed to determine water use requirements of seventeen buffalograss genotypes representing a diverse genetic background. A line source water gradient provides a continuous range of irrigation volumes from a value set at potential ET to essentially zero. By planting the buffalograss varieties in strips down the gradient (perpendicular to the irrigation line), turf performance can be measured at any given irrigation amount.

This report summarizes data from the second year of data collection. The data are essentially the same as those collected during 1994, except that 1) the line source was used from June 20 through September 8, 2) plots of Washoe and Highlight 912 were equipped with TDR probes, and 3) TDR probes were sited at 80%, 60% and 40% of ET. By comparison to 1994, 1995 was relatively cool and moist, with significant rain recorded as late as June 15. There was considerable precipitation during the winter, and the soil was near field capacity at the start of the experimental period. TDR probes 60 cm in length were installed at the start of this season, with the intent to measure moisture withdrawal from deeper in the soil profile. However, these proved problematic. Very poor signals, possibly due to the probes being inserted in deeper gravel lenses, were commonly observed with several of the probes, and functional probes generally did not detect moisture drawdown. Since these longer probes were all tested in water before installation in the field, it is unclear why they functioned unacceptably.

Again, irrigation was scheduled twice each week to apply 100% ET at the irrigation line as determined from weather station and the modified Penman equation. Minilysimeters positioned close to the irrigation line in each plot were used to determine ET gravimetrically under non-limiting conditions. Lysimeters were covered with fitted caps during irrigation of the plots to exclude water and reduce variability. Each was irrigated manually to a volumetric water content of 30% and the weight recorded to an accuracy of 1 gram. Water loss was determined by weighing the pots three or four days later, corresponding to the next scheduled irrigation. Actual amount and distribution of each irrigation was determined with catch cans spaced at 1 m intervals across the gradient (Fig. 1). Each subsequent irrigation event was adjusted to correct for previous excess or deficit irrigation. The plots were mowed weekly with clippings removed.

Turfgrass canopy temperatures were measured weekly at 1 m intervals along each plot using a hand-held infrared thermometer. Soil moisture was measured by Time Domain Reflectrometry (TDR) using 30 cm triple wire probes. Probes were installed in replicate plots of Washoe and Highlight 912 at locations in the gradient corresponding to 80%, 60% and 40% of maximum irrigation. Turf quality was rated visually for all plots on August 17 at points in the gradient representing 80% and 40% of potential ET. Finally, each plot was visually evaluated to determine the transition point between dormant and non-dormant turf, and the distance to the transition line was measured and converted to %ET. This transition was assumed to represent the minimum amount of irrigation required for growth in the short term, and survival in the long term. Data were analyzed by ANOVA and means separated by LSD when significant differences existed.

Results

Evapotranspiration was determined for turf under non-limiting soil moisture, using in-ground lysimeters. Particular care was taken to keep the turf canopy clipped at a line parallel to the vertical edge of the lysimeters so that ET could be expressed on a soil area basis. Actual irrigation very closely matched reference ET values (Fig. 2). Data were collected every three to four days, and significant differences in ET between genotypes were found for each measurement. For brevity, however, only data for July ET, August ET, and total ET for July 1 through September 8 are presented (Table 1). Total ET for the ten week period ranged from 30 to 46 cm, corresponding to crop coefficients (Kc's) of 0.60 to 0.92. These are somewhat lower than those from 1994. Rankings were generally similar between dates, especially for the several genotypes at the low and high ends of the range (Fig. 3). Plains, Guymon 6 and Prairie were consistently among the highest water users, while Tetraploids 2-2, 2-5, and Topgun were among the lowest water users. Curiously, Diploid 3-5, which ranked high during 1994, was the lowest water user in 1995. As in 1994, the genotypes ranking lowest for total water use were either diploids or tetraploids, with the exception of Topgun.

There was a significant difference in the distance along the gradient at which the genotypes entered dormancy/stress, with an average distance equivalent to 38% of ET (Table 2). This compares to 10-20% ET in 1994, but the gradient was operated for several weeks longer in 1995. Over the experimental period, 38% represents the minimum to maintain growth, but not necessarily quality turf (see below). Total water use during July was positively correlated with distance to dormancy/stress ($P=0.014$).

Turfgrass quality was rated at the end of the experiment (Table 2). Several genotypes produced a turf of near-acceptable quality (Neb. 315, Neb. 609, Tetraploid 2-2, 2-5 and Washoe) while others, were of low quality (Plains, Topgun, Diploids 2-7 and 3-5). These rankings are very similar to data for 1994. Of those with nearly acceptable quality, Tetraploids 2-2, 2-5 and Washoe were also among the lowest water users, again consistent with 1994. Turf quality was significantly reduced ($P < 0.001$) at 40% ET, with quality at 100% and 40% ET highly correlated ($P = 0.002$). Turf quality was not evaluated at 60% ET because it was visually apparent that even slight reductions in quality due to drought stress were much further out on the gradient. Total water use was negatively correlated with turf quality at 40% ET ($P=0.042$) but not with quality at 100% ET ($P=0.11$).

Canopy temperature was measured at 1300 hr once each week on a bright, sunny day at 1 meter intervals for all plots. Air temperature averaged 30-34^{o} C and relative humidity was typically 8-25%. For simplicity, only data for two genotypes, Washoe and Highlight 912, are presented. There was little or no apparent increase in canopy temperature with decreasing irrigation after 18 days (July 9) for either genotype (Fig. 4), with an average canopy temperature being nearly the same as air temperature. By August 3, canopy temperature increased relatively sharply approximately 11 meters from the irrigation line, indicative of drought stress and corresponding to roughly 15-20% ET. The same pattern was observed on September 6, nearly 10 weeks into the gradient irrigation treatment.

Changes in soil moisture were monitored by time domain reflectrometry in the Washoe and Highlight 912 plots (Fig. 5 and 6). These plots were chosen based on the data from 1994 as representative of high and low water using genotypes. However, as noted in table 1, Washoe and Highlight 912 were not significantly different in total water use. Soil moisture was very similar both between genotypes, and also between the 80% and 60% ET positions, where it averaged approximately 30% during the 64 day period. At the 40% ET position, soil moisture declined steadily to an average of 20%. Oscillations in the curves are due to irrigation events. These data are useful in interpreting both the canopy temperature and turf quality data. It is apparent that deficit irrigation at 60% ET was not severe enough, at least over the ten week period, to impose drought stress on the turf. By comparison, 40% ET resulted in considerable soil moisture depletion and drought stress, based on quality ratings. In most cases, turf was still growing, albeit at a reduced rate, at 40% ET.

Collectively, these data and those from 1994 define water requirements for buffalograss both at the species and genotype levels. It is apparent that, although capable of using as much water as a cool season grass when supplied with unlimited resources, buffalograss can thrive with irrigation set at 50% of ET, at least over a period of approximately three months.

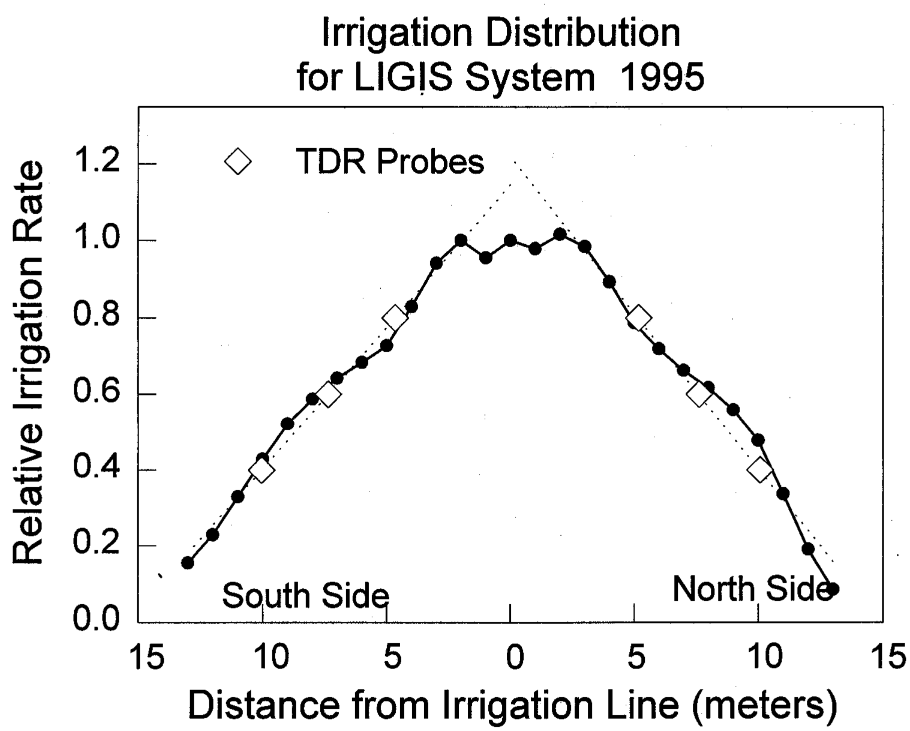

Figure 1. Relative irrigation distribution as a function of distance from center irrigation line. Solid line is measured irrigation, dotted line is linear regressions of each side used to position TDR probes.

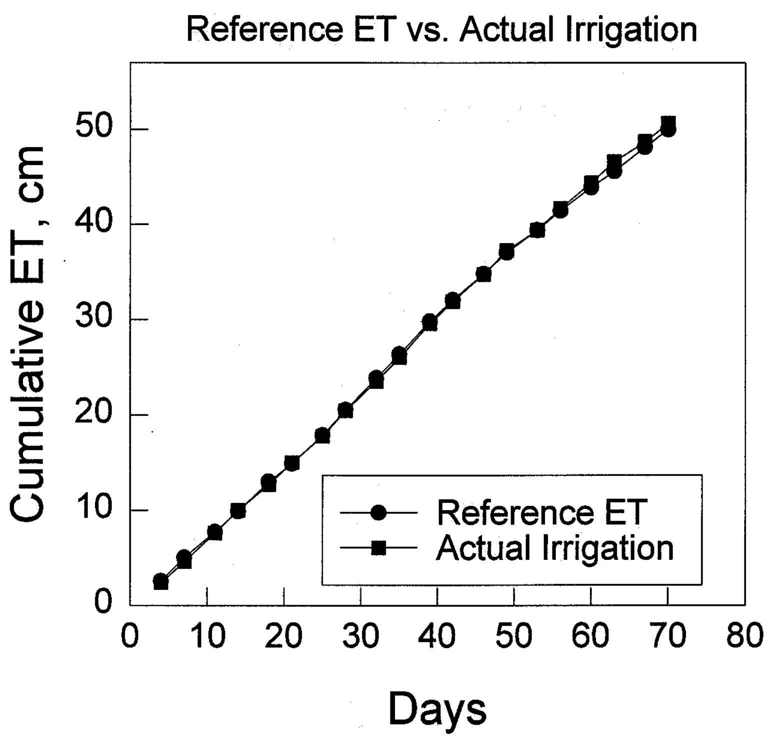

Figure 2. Actual cumulative irrigation compared to reference ET, calculated from the Penman equation, for the period July 1-Sept. 8, 1995.

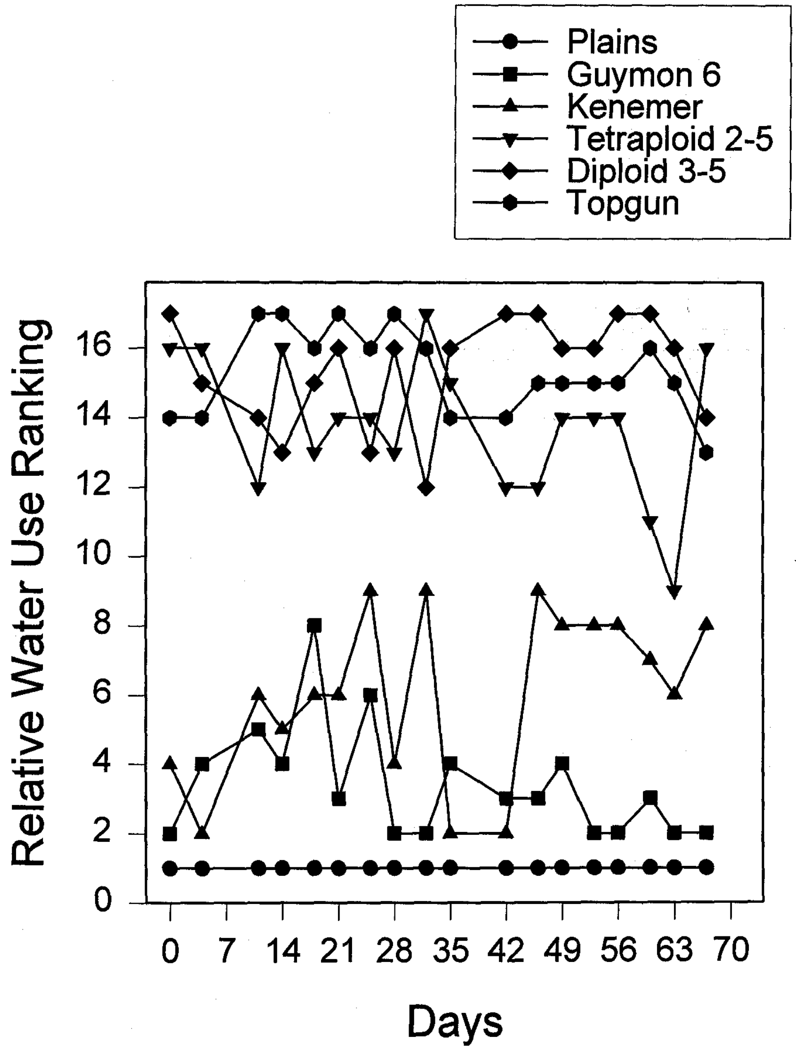

Figure 3.Relative rankings for water use over time for three high water using and three low water using genotypes of buffalograss.

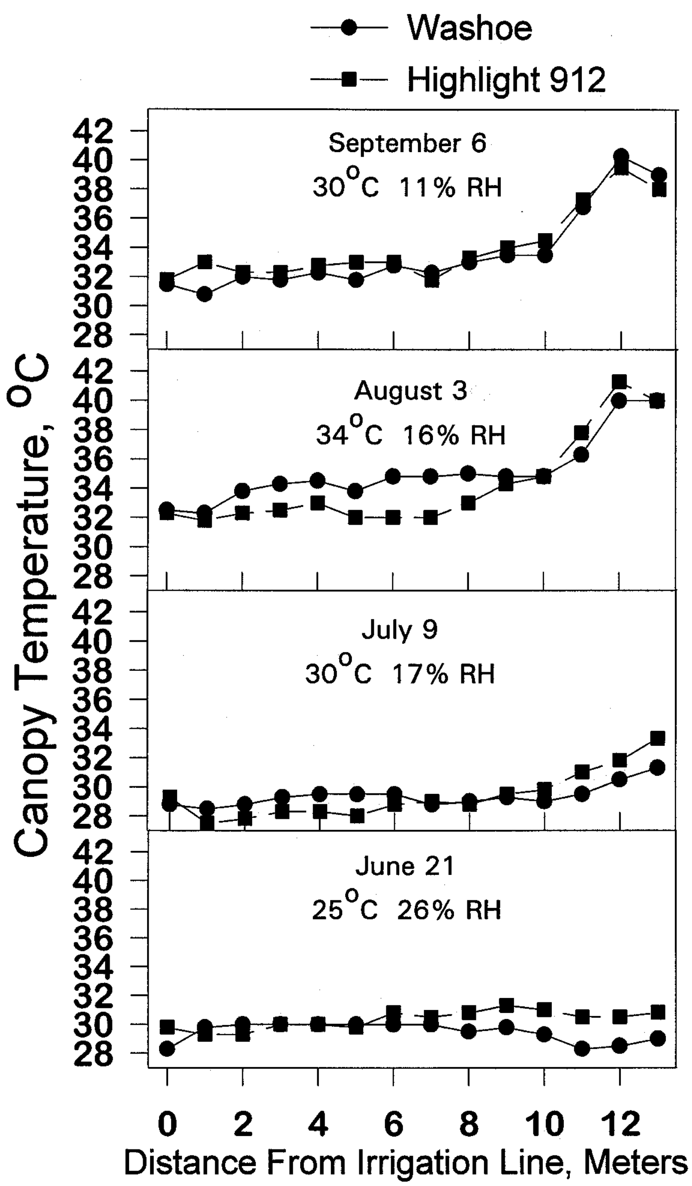

Figure 4. Canopy temperatures across the irrigation gradient for two buffalograss genotypes on four dates during 1995.

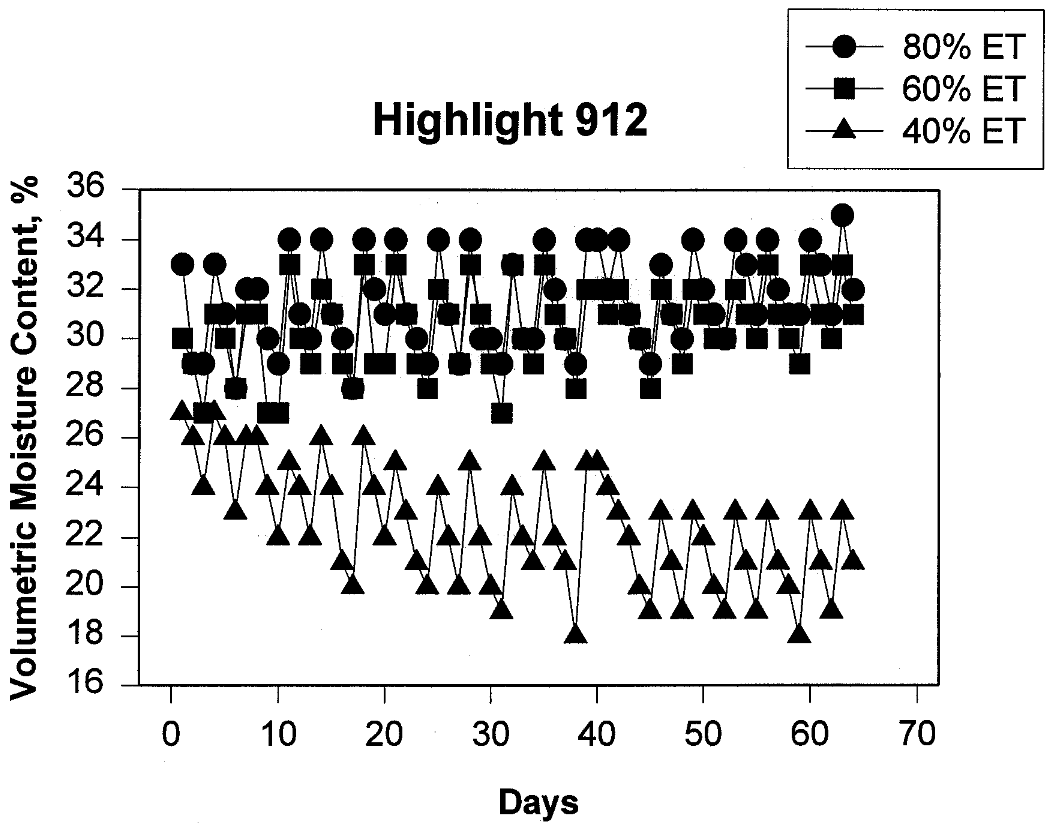

Figure 5. Volumetric soil moisture measured by TDR at 80%, 60% and 40% of ET for Highlight 912.

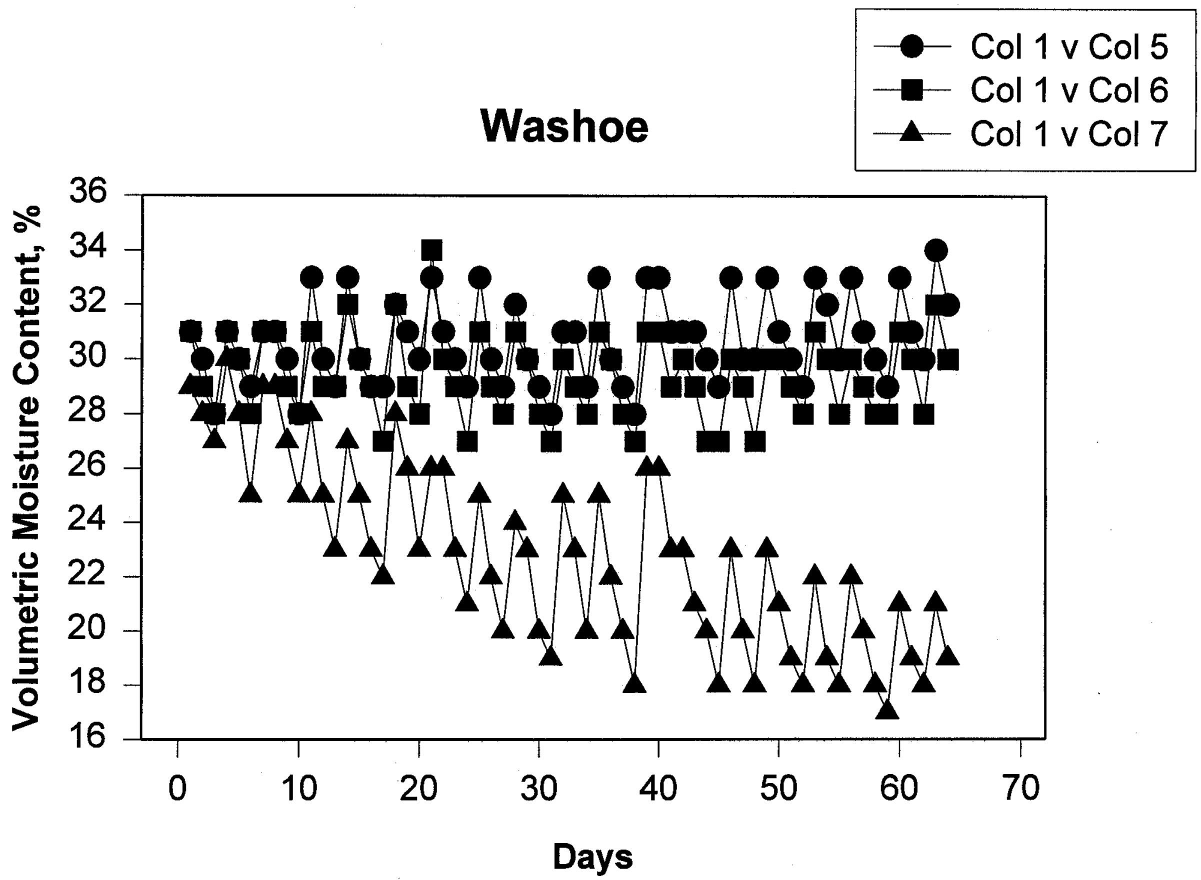

Figure 6. Volumetric soil moisture measured by TDR at 80%, 60% and 40% of ET for Washoe buffalograss.

Table 1. Evapotranspiration for July, August, and July1-September 8, 1995, and asociated crop coefficients for seventeen buffalograss genotypes. Values are means of four replicates. Values in a column followed by the same letter are not significantly different.

	July ET		July Kc	Aug. ET		Aug. Kc	Total ET		Total Kc
Plains	21.2	a	0.94	20.7	a	0.86	46.5	a	0.92
Guymon 6	18.6	b	0.83	16.8	b	0.70	39.2	b	0.77
Prairie	17.5	bc	0.78	16.3	bc	0.68	37.5	bc	0.74
Kenemer	18.3	b	0.81	15.5	b-d	0.64	37.1	b-d	0.73
Hilight 15	16.8	b-e	0.75	16.2	bc	0.67	36.6	b-d	0.72
Nebraska315	17.5	b-d	0.78	15.5	b-e	0.64	36.5	b-d	0.72
Hilight 912	17.4	b-d	0.77	15.6	b-d	0.65	36.3	b-e	0.72
Guymon 1	18.3	b	0.81	14.9	b-e	0.62	36.2	b-e	0.71
Nebraska609	18.2	b	0.81	14.5	b-f	0.60	35.6	b-e	0.70
Diploid 2-7	17.1	b-d	0.76	15.2	b-e	0.63	35.5	b-e	0.70
Guymon 2	17.5	b-d	0.78	14.3	b-f	0.59	34.9	b-f	0.69
Washoe	17.0	b-d	0.75	14.3	b-f	0.59	34.4	c-f	0.68
Tetraploid 1-14	16.3	c-e	0.72	14.6	b-f	0.61	34.0	c-f	0.67
Tetraploid 2-5	15.8	c-e	0.70	13.6	c-f	0.57	32.5	d-f	0.64
Tetraploid 2-2	16.1	c-e	0.72	12.7	ef	0.53	31.6	ef	0.62
Topgun	14.9	e	0.66	12.9	d-f	0.54	30.7	f	0.61
Diploid 3-5	15.6	de	0.69	12.1	f	0.50	30.5	f	0.60

Table 2. Quality ratings at 80% and 40% ET, and %ET associated with dormancy/stress for seventeen buffalograss genotypes. Values are means of four replicates. Values in a column followed by the same letter are not significantly different.

	Turf Quality 80% ET		Turf Quality 40% ET		Dormancy at %ET	
Tetraploid 2-5	5.25	a	3.50	b-d	0.32	ef
Tetraploid 2-2	5.25	a	3.75	a-c	0.37	c-f
Washoe	5.00	ab	4.50	a	0.34	d-f
Nebraska 609	5.00	ab	3.50	b-d	0.34	d-f
Nebraska 315	4.75	a-c	2.50	ef	0.43	a-d
Kenemer	4.75	a-c	3.50	b-d	0.38	c-f
Guymon 6	4.50	a-d	2.25	ef	0.49	ab
Prairie	4.50	a-d	2.75	d-f	0.32	ef
Hilight 15	4.50	a-d	4.00	ab	0.28	f
Guymon 1	4.00	b-e	2.25	ef	0.46	a-c
Tetraploid 1-14	3.75	c-e	2.75	d-f	0.39	b-e
Guymon 2	3.50	de	3.50	b-d	0.30	ef
Diploid 2-7	3.50	de	3.00	c-e	0.38	c-f
Topgun	3.25	e	2.50	ef	0.40	a-e
Plains	3.25	e	2.00	f	0.38	c-f
Diploid 3-5	3.00	e	2.50	ef	0.35	d-f
Hilight 912	3.00	e	3.00	c-e	0.50	a