Turfgrass Consumptive Use Values for the Tucson Area

Introduction

Consumptive use (CU) curves that provide average rates of turfgrass evapotranspiration (ET_T) are widely used by irrigation professionals for design and management of turfgrass irrigation systems. For approximately 35 years, the bermudagrass lawn CU curve developed by the United States Department of Agriculture (Erie et al., 1965; Erie et al., 1982) has served as the lone published CU curve for turfgrass in Arizona. While the USDA CU curve has proven useful to the turf industry, turf professionals do question whether ET_T values obtained from the curve are relevant to turf systems commonly used in Arizona today. The USDA curve was developed for the summer turf season using a low-maintenance common bermudagrass mowed to a height of 3.8 cm (1.5") every four weeks, and watered every two weeks using flood irrigation (Garrot and Mancino, 1994). A relevant turf system today consists of hybrid bermudagrass maintained at a height of ~ 2 cm (0.75") and watered at frequent intervals using sprinkler irrigation. The practice of overseeding with ryegrass in the fall to maintain green cover in winter is also common today. The USDA CU curve does not address the issue of overseeding and provides no information on ET_T for the period mid-October through mid-April.

A number of research studies have been completed in recent years to quantify the water requirements of turfgrass grown in the low desert regions of Arizona (Brown et al., 1996; Brown et al., 2001). Several studies had as their primary objective the development of crop coefficients (Kcs) that convert reference evapotranspiration (ETo) data computed from meteorological data (from weather stations) into estimates of ET_T (Brown et al., 2001). In this report, we apply Kcs developed from these studies to long-term records of ETo to provide updated CU information for turfgrass grown in the Tucson metropolitan area.

Methods

Estimates of ET_T were computed on a daily basis for the period 1987 through 2000 by applying turfgrass Kcs to the historical record of reference evapotranspiration (ETo) available for Tucson from the Arizona Meteorological Network (AZMET). The mathematical procedure used to produce the ET_T estimates involved multiplying the appropriate crop coefficients (Kcs) by ETo:

$$ET_T = Kcs \times ETo$$

The Kcs used to estimate ET_T were developed for a common desert turf system consisting of Tifway

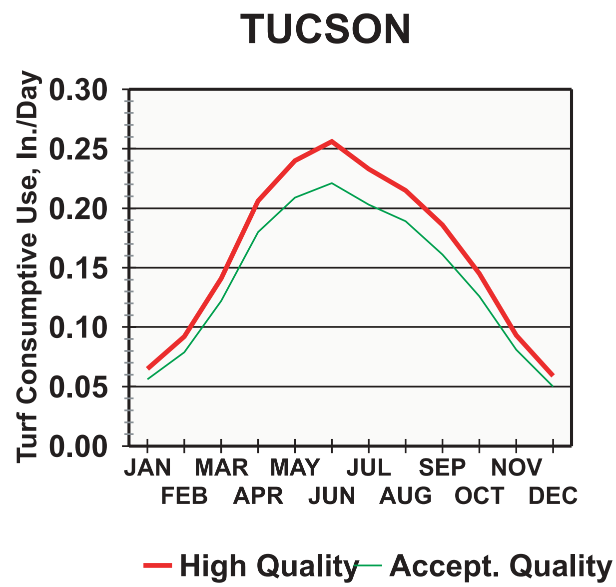

Figure 1. Consumptive use curves for high and acceptable quality turf grown in the Tucson area.

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bermudagrass in summer and overseeded ryegrass in winter. Other assumptions implicit in the use of the Kcs employed include frequent irrigation with sprinklers, mowing heights ranging from 0.625-1.0" in summer and 0.875-1.25" in winter, and two levels of turf quality defined as high and acceptable. High quality turf areas would include high profile sports turf (playing fields and golf course fairways) and areas where turf appearance is very important. These areas generally receive high levels of fertilization and maintenance. Acceptable quality turf would be suitable for lawn or park environments where traffic is low, rapid regrowth is not required and fertilization levels are relatively low.

Crop coefficients appropriate for high quality turf were based on the research results of Brown et al. (2001) and change monthly. Crop coefficients for acceptable quality turf were derived by subtracting 0.10 from the high quality Kcs (Brown et al., 1996).

The resulting 14 years of daily ET_T data were averaged by day of the year to produce an average annual ET_T data set. This daily ET_T data set was then summarized into weekly, monthly, and annual totals of ET_T. Consumptive use curves were developed for high and acceptable quality turf from the summarized data sets.

Results

Annual CU curves for high and acceptable quality turfgrass grown in Tucson area are presented in Figure 1. Turfgrass ET varies more than 4-fold over the course of the year, reflecting the annual fluctuation in atmospheric evaporative demand. The ET of high quality turf ranges from a low of ~0.06" / day in December to ~0.26" / day in June. Evapotranspiration from acceptable quality turf runs about 15% below that of high quality turf and ranges from ~0.05" / day in December to ~ 0.22" / day in June.

Weekly as opposed to daily values of ET_T may prove more useful when managing irrigation, especially if irrigation is not being applied each day. Table 1 provides weekly totals of ET_T for high and acceptable quality turfgrass grown in the Tucson area. Evapotranspiration from high quality turf ranges from 0.36"in the first week of January to 1.88" in the last week of June. The range in weekly ET_T for acceptable quality turf ranges from 0.30" in early January to 1.62" in late June.

Monthly values of ET_T are useful when planning irrigation budgets for a year. Table 2 presents monthly ET_T for high and acceptable quality turfgrass for the Tucson area. Monthly ET_T for high quality turf ranges

Table 1. Weekly consumptive use (ET_T) in inches for high and acceptable quality turf grown in the Tucson area.

Week Ending	Turf Quality		Week Ending	Turf Quality		Week Ending	Turf Quality		Week Ending	Turf Quality	
	High	Acc.		High	Acc.		High	Acc.		High	Acc.
Jan 7	0.36"	0.30"	Apr 8	1.30"	1.14"	Jul 8	1.75"	1.52"	Oct 7	1.18"	1.02"
Jan 14	0.44	0.37	Apr 15	1.46	1.27	Jul 15	1.62	1.42	Oct 14	1.16	1.01
Jan 21	0.46	0.39	Apr 22	1.48	1.29	Jul 22	1.61	1.40	Oct 21	1.00	0.86
Jan 28	0.51	0.44	Apr 29	1.54	1.34	Jul 29	1.55	1.35	Oct 28	0.85	0.74
Feb 4	0.58	0.50	May 6	1.66	1.44	Aug 5	1.56	1.37	Nov 4	0.76	0.66
Feb 11	0.63	0.54	May 13	1.66	1.44	Aug 12	1.54	1.36	Nov 11	0.72	0.62
Feb 18	0.63	0.54	May 20	1.67	1.45	Aug 19	1.52	1.34	Nov 18	0.63	0.54
Feb 25	0.70	0.60	May 27	1.69	1.47	Aug 26	1.43	1.26	Nov 25	0.60	0.52
Mar 4	0.74	0.64	Jun 3	1.77	1.53	Sep 2	1.40	1.23	Dec 2	0.54	0.47
Mar 11	0.95	0.82	Jun 10	1.75	1.51	Sep 9	1.34	1.17	Dec 9	0.44	0.38
Mar 18	0.98	0.85	Jun 17	1.79	1.54	Sep 16	1.32	1.15	Dec 16	0.44	0.38
Mar 25	1.12	0.97	Jun 24	1.81	1.56	Sep 23	1.24	1.08	Dec 23	0.37	0.32
Apr 1	1.04	0.90	Jul 1	1.88	1.62	Sep 30	1.29	1.12	Dec 31*	0.42	0.36

** Water use for the week ending December 31 represents an 8-day total for the period December 24-31.*

from 1.8" in December to 7.7" in June. For acceptable quality turf, ET_T ranges from 1.6" in December to 6.6" in June. The last column in Table 2 presents the percentage of annual ET_T occurring in each month. These monthly percentages clearly show that the bulk of the annual water use occurs during the summer months. For example, ET_T in June accounts for 13% of total annual ET_T. In contrast, total ET_T from December through February (inclusive) represents just 10.9% of annual ET_T — substantially less than ET_T for June.

Annual CU of high and acceptable quality turf is summarized at the bottom of Table 2. Consumptive use of high quality turf totals ~58.8" or 4.9' per year while the CU of acceptable quality turf approaches ~51.1" or 4.26' per year.

Table 2. Monthly and annual consumptive use (ET_T) in inches for high and acceptable quality turf grown in the Tucson area.

Month	Turf Water Use		
	Turf Quality		% of Annual Use
	High	Acc.	
January	2.0"	1.7"	3.4
February	2.6	2.2	4.4
March	4.4	3.8	7.5
April	6.2	5.4	10.5
May	7.4	6.5	12.6
June	7.7	6.6	13.1
July	7.2	6.3	12.2
August	6.7	5.9	11.4
September	5.6	4.8	9.5
October	4.5	3.9	7.6
November	2.8	2.4	4.8
December	1.8	1.6	3.1
Total	58.8"	51.1"	

Concluding Remarks

The CU data presented in this report represent long-term average rates of ET_T and should prove useful to individuals involved in the design and management of turf irrigation systems. It is important to realize that the results presented in this report represent raw ET_T data that have not been adjusted for precipitation or irrigation system performance. To use this CU information to determine the amount of water required for irrigation, one must first subtract the amount of effective precipitation (precipitation not lost to deep percolation and runoff) to determine the net water requirement for any period. Precipitation in the Tucson area averages ~12" or 1.0' per year and should reduce irrigation water requirements substantially.

The final step in determining the irrigation water requirement involves making adjustments to: 1) account for system nonuniformity and 2) ensure leaching is sufficient to maintain soil salinity at acceptable levels. Adjustments for nonuniformity and salinity management increase the amount of irrigation water required and vary dramatically with location due to differences in irrigation design, topography, local weather conditions, and water quality. A discussion of these adjustments is beyond the scope of this publication and will be discussed in a subsequent report in the Turf Irrigation Management Series.

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