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Water Use of Turfgrass Mohave County, Arizona

Introduction

The amount of water required to irrigate turfgrass is a growing concern for the River Cities (Lake Havasu and Bullhead City) and Kingman areas of Mohave County as population growth places increasing demands on limited water supplies. Understanding the water requirements or consumptive use (CU) of turfgrass is essential to improve irrigation management and plan for future urban growth. Consumptive use curves that provide average rates of turfgrass water use (evapotranspiration; ET_T) provide this much needed information. This report provides turfgrass CU curves and other information pertinent to turfgrass irrigation for the River Cities and Kingman areas of Mohave County.

Turfgrass CU Methodology

Turfgrass CU (ET_T) was estimated by multiplying crop coefficients (Kc) appropriate for acceptable (parks and lawns) and high quality (golf course) turf to average values of reference evapotranspiration (ETos; Brown and Kopec, 2000):

$$ET_T = Kc * ETos$$

Reference evapotranspiration is a measure of environmental evaporative demand computed from meteorological data (Brown, 2000; Brown, 2005). Data used in the ETos computation include air and dew point temperature, wind speed and solar radiation, and were obtained from the Arizona Meteorological Network (AZMET) for the River Cities area and the National Oceanic and Atmospheric Administration (NOAA; WRCC, 2006) and Solar Energy Research Institute (Knapp et al., 1980) for Kingman.

Crop coefficients developed by Brown and Kopec (2000) for Tucson and Phoenix, Arizona were used for warm season turf systems after making adjustments for differences in growing season length and winter temperatures. Crop coefficients for high quality turfgrass (e.g., golf course fairways, sports fields) were set equal to 0.80 during the summer (bermudagrass) and 0.83 during the winter turf (overseeded perennial ryegrass) seasons. Crop coefficients for overseeded acceptable quality turf were set equal to 0.70 and 0.73 for the summer and winter seasons, respectively while Kc's for acceptable quality non-overseeded bermudagrass were set equal 0.70 during summer, 0.50 during the months when the grass is transitioning to and from dormancy and 0.30 when dormant. Crop coefficients in the Kingman area were reduced by 0.04 from November through February to account for chill stress (Brown et al., 2001). The summer turf season extended from May through September in the River Cities and June through September in Kingman. The fall transition months for non-overseeded bermudagrass were defined as October for Kingman and November for the River Cities. Spring transition months were defined as May for Kingman and April for the River Cities. Overseeding was assumed to occur in October at both locations.

Crop coefficients developed by the Northern Colorado Water Conservation District (NCWCD, 2003) and Brown and Albrect (2005) were used for cool season turf systems located in the Kingman area. Crop coefficients for high and acceptable quality turf were set to 0.95 and 0.80 for the period 1 March through 31 October, then reduced to 0.79 (high) and 0.69 (acceptable) during the colder months (November through February) to account for the effects of chill stress and partial dormancy.

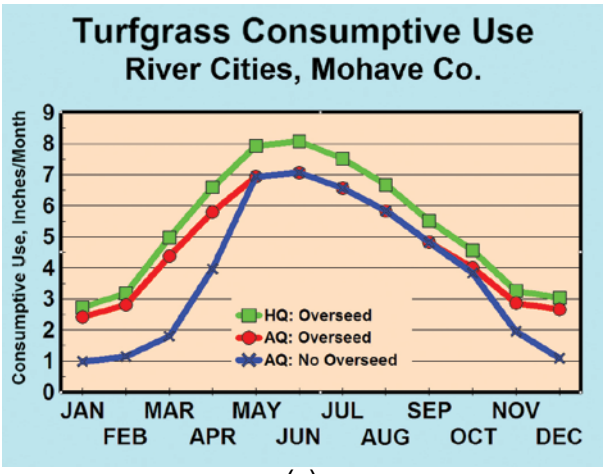
Turfgrass Consumptive Use: River Cities

Turfgrass CU ranges from ~46.0"/year for non-overseeded, acceptable quality bermudagrass to ~64.0"/year for high quality bermudagrass that is overseeded in winter (Table 1). June represents the peak month for turfgrass CU and ranges from ~7.1"/month for acceptable quality turf to ~8.1"/month for high quality turf (Table 1 and Fig.1a). Consumptive use typically reaches a minimum in January and ranges from ~1.0"/month for non-overseeded bermudagrass to ~2.7"/month for high quality overseeded turf. Note that when CU is summarized on a daily basis (Table 1 and Fig.1b), values for high quality turf in summer are approximately three times greater than in winter.

Monthly precipitation totals for the River Cities are also provided in Table 1. The River Cities area is extremely dry and precipitation is rather rare and sporadic. However, precipitation can on average provide as much as 30-40% of CU for overseeded turfs and 85-100% of CU for non-overseeded turfs during the months of January and February and thus can reduce the amount of water required from irrigation.

Turfgrass Consumptive Use: Kingman

Turfgrass CU values for warm season turf in Kingman were surprisingly similar to those estimated for the River Cities because ETos (Tables 1 & 2) did not vary significantly among the two areas. One would expect lower ETos in Kingman due



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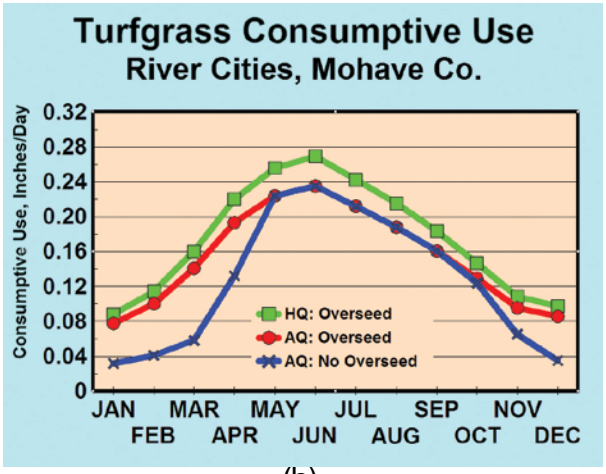

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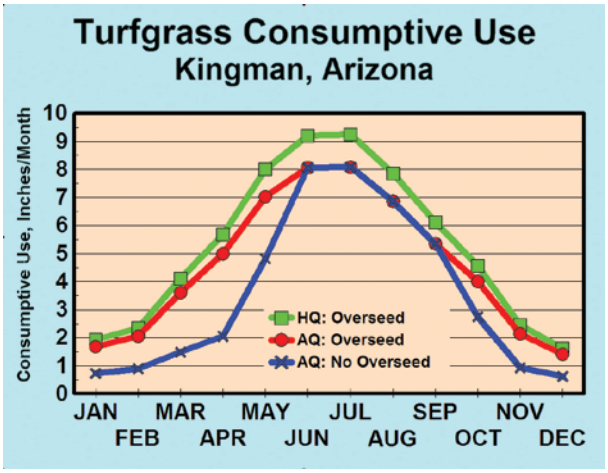
Figure 1. Turfgrass consumptive use (CU) in inches per month (a) and inches per day (b) for high quality (HQ) and acceptable quality (AQ) bermudagrass turf in the River Cities area of Mohave County, AZ. Consumptive use is provided for both overseeded and non-overseeded acceptable quality turf. The River Cities area includes Lake Havasu and Bullhead City.



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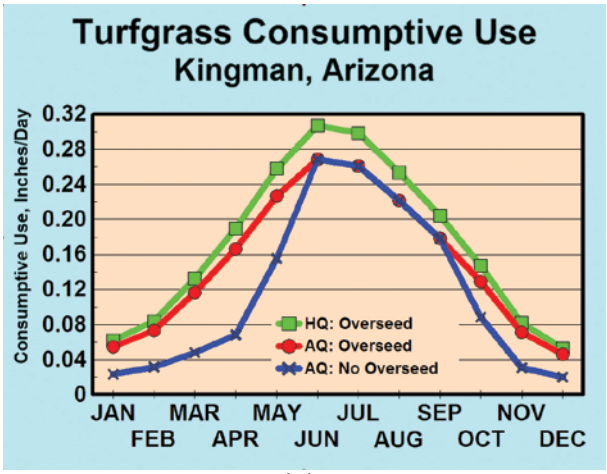

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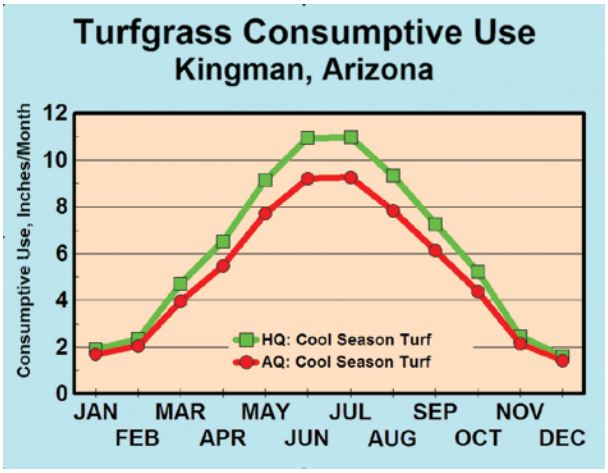
Figure 2. Turfgrass consumptive use (CU) in inches per month (a) and inches per day (b) for high quality (HQ) and acceptable quality (AQ) bermudagrass turf in the Kingman area of Mohave County, AZ. Consumptive use is provided for both overseeded and non-overseeded acceptable quality turf.



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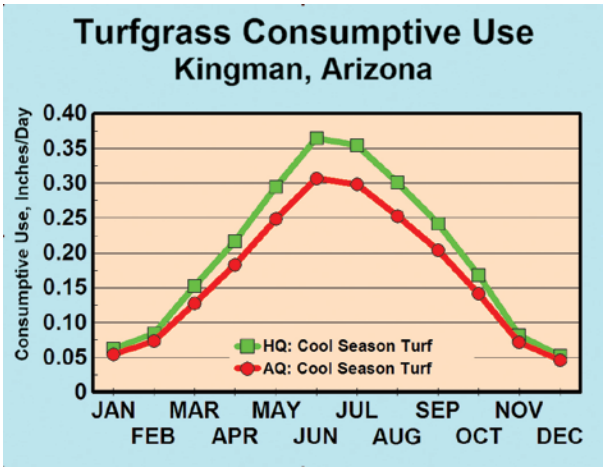

(b)

Figure 3. Turfgrass consumptive use (CU) in inches per month (a) and inches per day (b) for high quality (HQ) and acceptable quality (AQ) cool season turf in the Kingman area of Mohave County, AZ.

Table 1. Turfgrass consumptive use (CU) values for high and acceptable quality warm season turf in the River Cities area of Mohave County, AZ. Consumptive use values are presented for each month in units of inches per month and inches per day. ETos and PPT data for the River Cities area are presented in the final three columns.

Month	Warm Season Turf CU						ETos		PPT
	High Quality Winter: Overseeded		High Quality Winter: Overseeded		Acceptable Quality Winter: Dormant				
	″/Month	″/Day	″/Month	″/Day	″/Month	″/Day	″/Month	″/Day	″/Month
JAN	2.74	0.09	2.41	0.08	0.99	0.03	3.30	0.11	0.85
FEB	3.19	0.11	2.81	0.10	1.15	0.04	3.84	0.14	1.23
MAR	4.97	0.16	4.37	0.14	1.80	0.06	5.99	0.19	0.69
APR	6.59	0.22	5.80	0.19	3.97	0.13	7.94	0.26	0.19
MAY	7.93	0.26	6.94	0.22	6.94	0.22	9.91	0.32	0.01
JUN	8.07	0.27	7.06	0.24	7.06	0.24	10.09	0.34	0.02
JUL	7.51	0.24	6.57	0.21	6.57	0.21	9.39	0.30	0.10
AUG	6.67	0.22	5.83	0.19	5.83	0.19	8.34	0.27	0.35
SEP	5.51	0.18	4.82	0.16	4.82	0.16	6.88	0.23	0.23
OCT	4.56	0.15	4.01	0.13	3.84	0.12	5.49	0.18	0.43
NOV	3.25	0.11	2.86	0.10	1.96	0.07	3.92	0.13	0.25
DEC	3.03	0.10	2.66	0.09	1.09	0.04	3.65	0.12	0.33
TOTAL	64.02″		56.15″		46.04″		78.75″		4.68″

Table 2. Turfgrass consumptive use (CU) values for high and acceptable quality warm season turf in the Kingman area of Mohave County, AZ. Consumptive use values are presented for each month in units of inches per month and inches per day. ETos and PPT data for the Kingman area are presented in the final three columns.

Month	Warm Season Turf CU						ETos		PPT
	High Quality Winter: Overseeded		High Quality Winter: Overseeded		Acceptable Quality Winter: Dormant				
	″/Month	″/Day	″/Month	″/Day	″/Month	″/Day	″/Month	″/Day	″/Month
JAN	1.93	0.06	1.69	0.05	0.73	0.02	2.44	0.08	1.34
FEB	2.35	0.08	2.05	0.07	0.89	0.03	2.98	0.11	1.20
MAR	4.11	0.13	3.62	0.12	1.49	0.05	4.96	0.16	1.25
APR	5.68	0.19	5.00	0.17	2.05	0.07	6.85	0.23	0.56
MAY	8.00	0.26	7.03	0.23	4.82	0.16	9.64	0.31	0.37
JUN	9.21	0.31	8.06	0.27	8.06	0.27	11.52	0.38	0.29
JUL	9.25	0.30	8.09	0.26	8.09	0.26	11.56	0.37	1.04
AUG	7.85	0.25	6.87	0.22	6.87	0.22	9.81	0.32	1.40
SEP	6.12	0.20	5.35	0.18	5.35	0.18	7.65	0.25	0.76
OCT	4.56	0.15	4.01	0.13	2.75	0.09	5.49	0.18	0.76
NOV	2.46	0.08	2.15	0.07	0.93	0.03	3.11	0.10	0.83
DEC	1.63	0.05	1.42	0.05	0.62	0.02	2.06	0.07	1.00
TOTAL	63.15″		55.35″		42.65″		78.06″		10.80″

to its higher elevation and cooler temperatures. However, meteorological data clearly indicates Kingman has higher average wind speed and lower humidity than the River Cities area. This trend is particularly evident in the middle of the year and explains why ETos in Kingman exceeds ETos in the River Cities in the summer months.

Turfgrass CU ranges from ~42.7″/year for non-overseeded, acceptable quality bermudagrass to ~63.2″/year for high quality bermudagrass that is overseeded in winter (Table 2). The peak CU months in Kingman are June and July with CU ranging from ~8.1″/month for acceptable quality turfgrass to ~9.2″/month for high quality turfgrass (Table 2 and Fig. 2a). December is the month with the lowest CU in most years with CU ranging from ~0.6″/month for non-overseeded bermudagrass to ~1.6″/month for high quality overseeded turf. The increased windiness and lower humidity in summer causes CU of high quality turfgrass to differ by a factor of six between summer and winter in

Table 3. Turfgrass consumptive use (CU) values for high and acceptable quality cool season turf in the Kingman area of Mohave County, AZ. Consumptive use values are presented for each month in units of inches per month and inches per day. ETos and PPT data for the Kingman area are presented in the final three columns.

Month	Cool Season Turf CU				ETos		PPT
	High Quality		Acceptable Quality				
	″/Month	″/Day	″/Month	″/Day	″/Month	″/Day	″/Month
JAN	1.93	0.06	1.69	0.05	2.45	0.08	1.34
FEB	2.35	0.08	2.05	0.07	2.98	0.11	1.20
MAR	4.71	0.15	3.96	0.13	4.96	0.16	1.25
APR	6.51	0.22	5.48	0.18	6.85	0.23	0.56
MAY	9.15	0.30	7.71	0.25	9.64	0.31	0.37
JUN	10.94	0.36	9.21	0.31	11.52	0.38	0.29
JUL	10.98	0.35	9.25	0.30	11.56	0.37	1.04
AUG	9.32	0.30	7.85	0.25	9.81	0.32	1.40
SEP	7.27	0.24	6.12	0.20	7.65	0.25	0.76
OCT	5.22	0.17	4.39	0.14	5.49	0.18	0.76
NOV	2.46	0.08	2.15	0.07	3.11	0.10	0.83
DEC	1.63	0.05	1.42	0.05	2.06	0.07	1.00
TOTAL	72.46″		61.28″		78.06″		10.80″

Kingman (Fig. 2b). Cool season turf requires significantly more water than warm season turf in Kingman (Table 3 and Fig. 3). Consumptive use ranges from ~61.3″/year for acceptable quality turf to ~72.5″/year for high quality turf. Consumptive use reaches a maximum in June and July, and ranges from ~9.2″/month for acceptable quality turf to nearly 11.0″/month for high quality turf. Consumptive use typically reaches a minimum in December and totals ~1.4″/month and 1.6″/month for acceptable and high quality turf, respectively.

Precipitation in Kingman averages 10.8″/year (Tables 2 & 3) and can be used to offset irrigation demand, especially in winter. Average values of precipitation can provide 50-90% of CU for overseeded bermudagrass and cool season turfs and 100% of CU for non-overseeded turfs during the months of December through February. Monsoon precipitation is less reliable and more spatially variable, but still provides 10-20% of CU during July and August (Tables 2 & 3).

How To Use Consumptive Use Information

Information on CU can be used to help schedule irrigations on turfgrass provided the precipitation rate of the irrigation system is known. The best way to determine the precipitation rate is to conduct a sprinkler precipitation test. This involves setting out catch cans on a turf surface, running the system for a set time period (e.g., 15 minutes) and then measuring the depth of water collected in the cans. Dividing the average depth of water in the catch cans by the irrigation run time provides the precipitation rate in inches/minute. For example, if the average depth of water in the catch cans is 0.30″ and the system ran for 15 minutes, the precipitation rate would be 0.30″ divided by 15 minutes or 0.02″/minute. To determine the number of minutes to run the irrigation system, simply divide the daily CU value from Tables 1-3 by the precipitation rate. The irrigation run time for acceptable quality turfgrass in the River Cities area for May would be:

Irrigation Run Time = CU ÷ Precipitation Rate
= 0.22″/day ÷ 0.02″/minute
= 11 minutes/day

where 0.22″/day represents the CU for acceptable quality turf in May (Table 1).

The precipitation test described above is often completed as part of a formal irrigation audit. Additional aspects of an irrigation audit include an evaluation of system pressure and an assessment of the function and spacing of irrigation heads. Often, the auditing procedures will assess irrigation uniformity and recommend the use of "run time multipliers" which increase run times to prevent the development of dry spots caused by non-uniform irrigation. Run time multipliers are coming under increased scrutiny by conservation personnel because they over irrigate all but the driest areas of turf, leading to excessive water use. New irrigation designs that employ valve-in-head and block irrigation systems eliminate the need to run the entire irrigation system to wet selected dry spots. Run time multipliers should be used sparingly, if at all. A preferred means of dealing with dry spots is to extend the run time of selected heads or hand water using hoses.

A simpler and less accurate means of estimating the precipitation rate is to use the published specifications provided by the manufacturer of the irrigation heads. These specifications, when combined with information on head spacing and the system operating pressure, can be inserted into formulas that estimate the precipitation rate. Precipitation estimates obtained in this manner generally over estimate the true precipitation rate since they do not account for real world factors such as malfunctioning irrigation heads and spray losses due to evaporation and/or wind drift. The suppliers of irrigation equipment may be able to provide information on how to adjust computed precipitation rates for local conditions.

Irrigations should be eliminated any time precipitation exceeds CU for a day or more, provided the costs associated shutting down a system are not prohibitively expensive. The "shut down" process should be relatively easy for small systems and systems that employ central control. A rain gauge should be placed at the turf facility to help guide such decisions. The number of days a system can be shut down will be a function of the amount and intensity of the rain event as well as the topography of the site. The CU values in Tables 1-3 can assist with this decision. For example, a 0.72" rain event in July in the River Cities area is equivalent to three days of CU for high quality turf. One could therefore shut an irrigation system down for three days where the turf is growing in a level area (e.g., sports field) and perhaps two days on a golf course where complex terrain could lead to runoff. Likewise, a 0.40" rain in Kingman in February is sufficient to offset five days of CU for high quality turf. The irrigation system could be shut down for four to five days after such an event.

Rainfall is often adequate to meet the limited water requirements of dormant bermudagrass in the winter (see Tables 1 & 2). Irrigation should be applied every 10-14 days during dry winters to prevent desiccation of the roots, stolons and rhizomes near the soil surface. The amount of irrigation water required during these infrequent winter irrigations is ~0.30".

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This information has been reviewed by university faculty.
cals.arizona.edu/pubs/water/az1447.pdf