POTENTIAL EVAPOTRANSPIRATION FOR IRRIGATION WATER MANAGEMENT IN URBAN LANDSCAPES - THE SAN ANTONIO EXPERIENCE

C.N. Pope and G. Fipps[1]

ABSTRACT

In 1997 and 1998, an experiment was conducted in San Antonio to determine the water savings potential and acceptance by home owners of lawn irrigation based on PET (potential evapotranspiration), a standard crop coefficient, and stress factors of 100%, 70% and 50%.. Sixty-seven homeowners participated in the study and rated the quality of their lawns on a weekly basis. The project was carried out by the Bexar County Extension Office with technical support provided by the Department of Agricultural Engineering at Texas A&M University. The home owners quickly acquired an understanding of PET- based irrigation scheduling concepts and procedures. The results showed that a water savings of at least 1/3 inch per week was achieved while maintaining good lawn quality.

INTRODUCTION

San Antonio, Texas, is one of the fastest growing cites in the U.S. and is the largest city in the county that depends exclusively on groundwater. The city shares the Edwards Aquifer with many other users, including agriculture and environmental interests. Under a recent state law, all users must now obtain a permit and must reduce pumping from the aquifer by 20% by the year 2007. Thus, the city is exploring various options to reduce water consumption and find alternative sources of water.

In recent years, Texas, like many other states, has implemented PET (potential evapotranspiration, also denoted as ET_o) networks for determining and reporting daily PET and ET (evapotranspiration) information for irrigation scheduling. One such network, the TexasET Network and Web Site (http://texaset.tamu.edu), includes ET reporting services specifically for homeowners and other irrigators of urban landscapes.

This paper presents the results of a study conducted in San Antonio to determine the feasibility and potential water savings of PET-based lawn irrigation. The study was conducted by the Bexar County Extension Office through their Master Gardener Program with funding from the San Antonio Water System. Technical support was provided by the Agricultural Engineering Department of Texas A&M University.

METHODS AND MATERIALS

The project was conducted from May to November during 1997 and 1998. The purposes of the first year activities were to determine home owner acceptance and procedures using PET for making lawn irrigation decisions; the 1998 study assessed lawn response and water savings.

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[1]Extension Assistant and Professor, respectively, Dept. of Agricultural Engineering, Texas A&M University, College Station, TX 77843-2117.

The city was divided into 4 quadrants with an equal number of lawns from each. Lawns were selected based on the following criteria:

- full exposure to sunlight
- a minimum of 4 inches of soil, and
- homeowner willingness to actively participate in program

A total of 67 lawns were selected for monitoring, consisting of 13 Bermuda, 21 Buffalo, 29 St. Augustine, and 4 Zoysia grass lawns. Homeowners attended one of two training sessions where they were instructed on how to determine sprinkler precipitation rate, methods for obtaining weekly ET, rating criteria for lawn quality, and symptoms of turf disease and stress.

PET values were determined with weather data from an automated weather station located within the city using the modified Penman-Montieth equation. Turf ET was calculated using the following equation:

$$ET_{turf} = PET \times Kc \tag{1}$$

where ET_{turf} is the daily turf water requirement (inches) and Kc is a turf coefficient. A Kc of 0.6 (warm season turf grass) was used for all turf types. Homeowners irrigated their lawns based on the amount of water depleted during the previous week. This amount of “replacement” water was calculated weekly by

$$TIR = ET_{def} \times AF \tag{2}$$

$$ET_{def} = ET_{turf} - RF \tag{3}$$

where TIR is turf irrigation requirement (inches), ET_{def} is the water deficit, AF is an adjustment factor equal to 1.00, 0.70, or 0.50, and RF is total weekly rainfall (inches). An adjustment factor of 1.00 represents an irrigation replacing 100% of ET_{def}. All TIR values were rounded to the nearest 1/4 of one inch. Irrigation durations were determined by

$$DUR = TIR \times 60 / PR \tag{4}$$

where DUR is irrigation duration (minutes) and PR is the sprinkler precipitation rate (inches / hour). A conversion factor of 60 was included to convert duration from hours to minutes.

Homeowners obtained ET_{turf} values by using a calculator on the Texas ET Website (http://texaset.tamu.edu) or by calling the Bexar County Extension Office to access recorded messages of weekly ET_{turf} and TIR values. Watering recommendations were adjusted based on the soil water holding capacity of each lawn (Table 1). Homeowners also rated the quality of their lawns on Sundays before 10:00 am. The rating was based on the following scale: (1) excellent, (2) good, (3) fair, and (4) poor. Turf rating criteria are shown in Table 2.

RESULTS

Before the project started, most homeowners participating in the study followed the standard recommendation of applying 1 inch per week. In comparison, the amount of water use for the

100% TIR treatments averaged about 2/3 inches, a 33% savings from the commonly used amount of 1" per week.

Figure 1 shows the quality rating for St. Augustine for all three watering treatments: replacing 100%, 70%, and 50% of TIR. The quality ratings in all three treatments fell during the summer months as expected. The quality ratings for St. Augustine at 100% TIR showed a lower summer decline and quicker autumn recovery to higher ratings than at the beginning of the season. At all levels of irrigation, St. Augustine eventually returned to at least its original rating.

Buffalo grass at both the 50% and 0% TIR treatments (Fig. 2) showed summer plunges in quality ratings, but ended the year with an improved rating, with the 0% TIR treatment taking slightly longer to recover. Buffalo at the 70% TIR treatment declined more slowly in quality rating, but ended the year with a lower quality rating than initially.

The quality ratings for Bermuda lawns irrigated at 100% TIR (Fig. 3) declined to a lesser degree later in the summer and recovered more quickly than the other watering treatments. All Bermuda yards recovered quickly in the fall.

The number of Zoysia samples in the experiment were too few (4) to draw conclusions from. It should be noted that extreme weather conditions occurred during 1998 in San Antonio. Record heat and drought were accompanied by record rainfall. The location of the lawn in the city did not have any significant effect.

The relationship between quality ratings, soil depth and bulk density were also analyzed, with the results varying among lawn type and watering levels. Soil depth only accounted for about 10% of lawn quality performance. Soil depth were more important for Bermuda grass, and to a lesser extent buffalo grass, than for St. Augustine grass. The measured soil bulk density was not related to quality ratings except for buffalo grass at 50% of ET, with better quality ratings occurring in lighter soils.

SUMMARY AND CONCLUSION

Results from the 1998 San Antonio ET Pilot Study reveal that homeowners can have a significant impact on water savings through proper management of landscape irrigation. In a city where water conservation not only is needed but required, techniques such as the one described here could provide substantial water savings if enacted by the majority of homeowners.

Table 1. Irrigation Schedules Adjusted For Rainfall.

Week	Date	Rain	Irrigation Recommendation As A Percent Of TIR		
			100%	70%	50%
1	5/4	None	0.75"	0.5"	Wait
2	5/11	None	0.75"	0.5"	0.5"
3	5/18	None	0.5"	0.25"	Wait
4	5/28	None	0.75"	0.5"	0.5"
5	6/1	None	1.0"	0.75"	0.5"
6	6/8	None	1.0"	0.75"	0.5"
7	6/15	0.5"	0.5"	Wait	Wait
8	6/22	None	1.0"	0.75"	0.5"
9	6/29	0.5"	0.75"	0.5"	Wait
10	7/6	0.2"	0.5"	Wait	Wait
11	7/13	None	1.0"	0.75"	0.5"
12	7/20	None	1.0"	0.75"	0.5"
13	7/27	None	1.0"	0.75"	0.5"
14	8/3	None	1.0"	0.75"	0.5"
15	8/10	None	0.5"	Wait	Wait
16	8/17	None	1.0"	0.75"	0.5"
17	8/24	3.1"	Wait	Wait	Wait
18	8/31	None	Wait	Wait	Wait
19	9/7	None	1.0"	0.5"	0.5"
20	9/14	1"	Wait	Wait	Wait
21	9/21	0.3"	0.5"	Wait	Wait
22	9/28	None	0.75"	0.75"	0.5"
23	10/5	0.3"	0.75"	0.5"	Wait
24	10/12	1.6"	0.5"	Wait	Wait
25	10/19	14.1"	Wait	Wait	Wait
26	10/26	0.1"	Wait	Wait	Wait
27	11/2	0.9"	Wait	Wait	Wait
28	11/9	None	Wait	Wait	Wait
29	11/16	None	Wait	Wait	Wait
Number of Irrigations			21	16	12
Total Water			16.5"	10"	6.0"

Table 2. Turf Rating Criteria.

(1) Excellent	Turf is very dense with no ground visible when looking from above. The color is a uniform green with no yellowing. No weeds or bare spots are evident.
(2) Good	No ground is visible when looking from above. The color is uniform green nearly throughout. There may be a few areas with color variation. Very few weeds are evident and there are no completely bare spots.
(3) Fair	There are areas in the lawn where the grass is thin enough to see soil through the stems, but mos is dense enough to cover the lawn. Variations of green color and some browning are evident. Some weeds may be evident in the thin areas.
(4) Poor	The lawn is not dense enough to cover the soil. There are brown patches and bare spots. Weeds have invaded the lawn and are obvious.

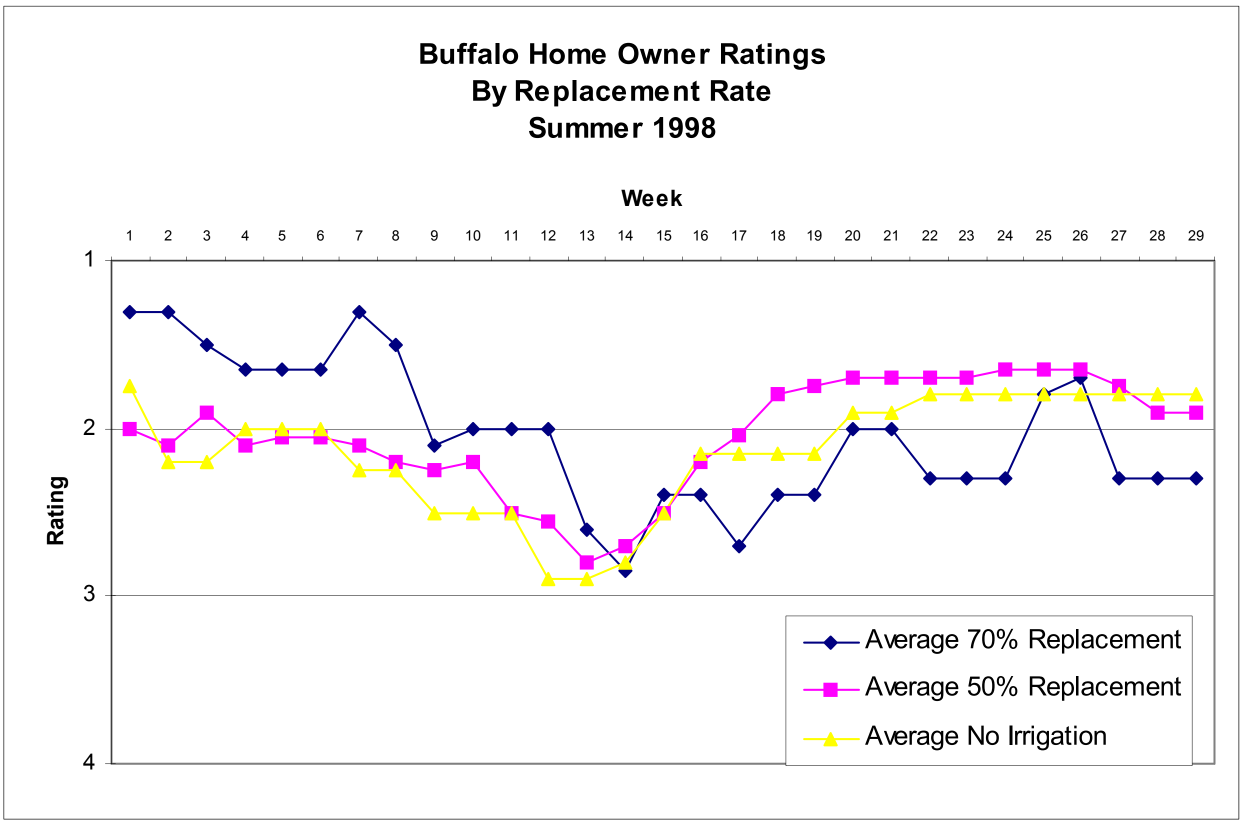


Figure 1. Average Buffalo homeowner quality ratings for each treatment as a percentage of ET.

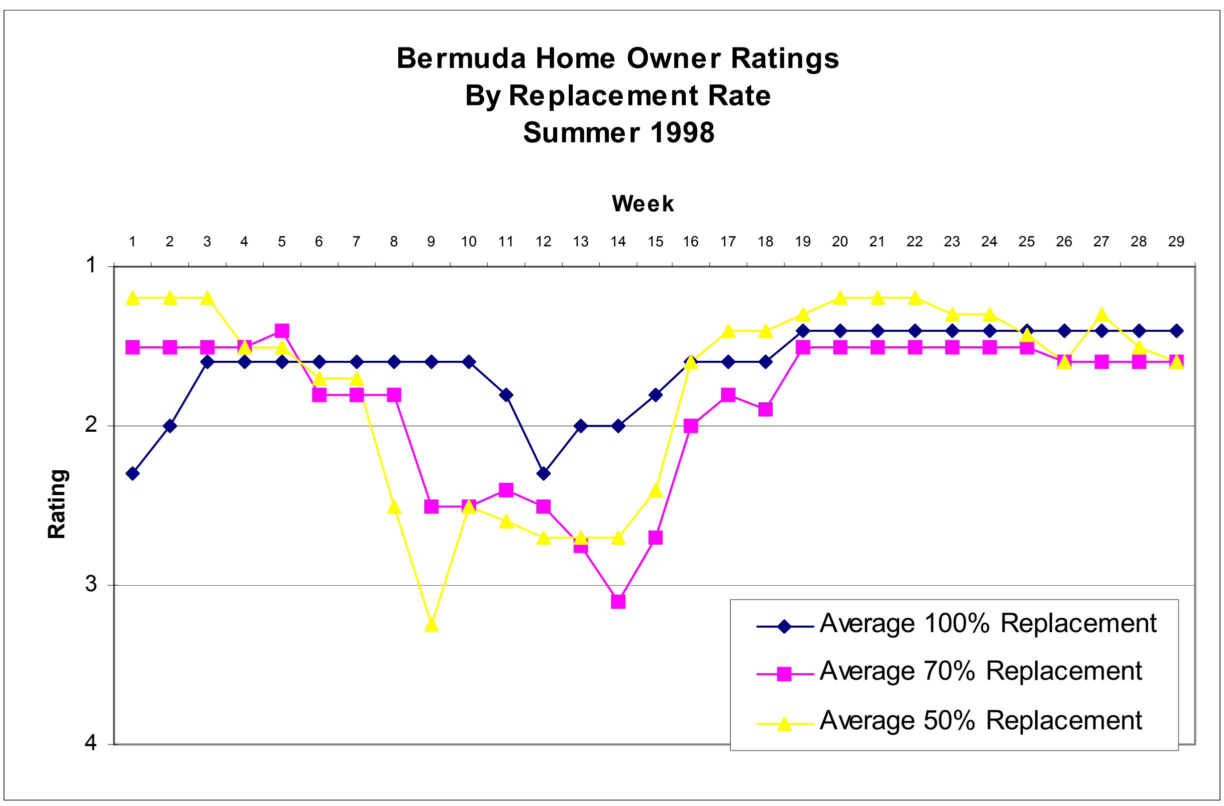
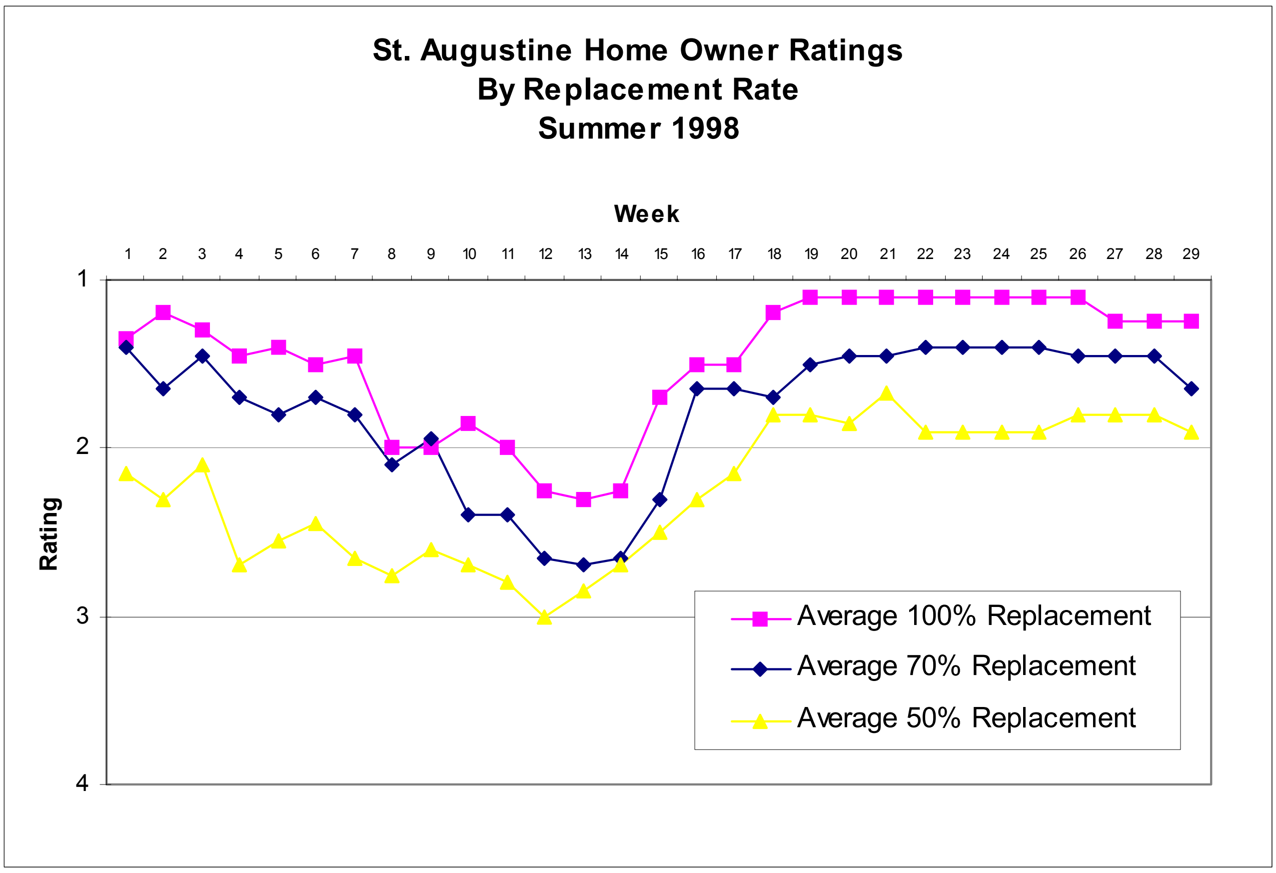


Figure 2. Average Bermuda homeowner quality ratings for each treatment as of percentage of ET.


St. Augustine Home Owner Ratings
By Replacement Rate
Summer 1998
Week
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
Rating
1
2
3
4
Average 100% Replacement
Average 70% Replacement
Average 50% Replacement