Turfgrass Selection to Maximize Water Use Efficiency

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Abstract. *In arid and semi-arid climates, limited precipitation and uneven annual rainfall distribution can restrict adequate turfgrass growth and quality unless frequent irrigation is applied. Turfgrasses' water demands and irrigation requirements are measured as evapotranspiration (ET) and can vary greatly, depending on the local macro and micro-climate, turfgrass species and varieties used, quality expectations, intended use (traffic), and resulting maintenance level applied. Drought resistant turfgrasses that are adapted to the local climatic conditions and can sustain adequate quality on minimum irrigation can be used to maximize water use efficiency and to minimize irrigation requirements.*

Introduction

In arid and semi-arid regions annual precipitation amounts of 250 to 500 mm do not meet the estimated evaporative requirement of turf areas, which range from approximately 800 to 1200 mm. Consequently, 50% or more of urban domestic summer water use goes to landscape irrigation (Kjelgren et al., 2000, Devitt and Morris, 2008) to maintain turfgrass areas and lawns at desired aesthetic and functional levels.

Strategies aimed at conserving potable water use for turf irrigation include 1) replacing the potable water with recycled or other impaired water that usually does not meet standards for human consumption, 2) applying modern irrigation equipment, such as subsurface irrigation or new sprinkler and nozzle technology and/or by scheduling irrigation based on local ET or on soil sensor, and 3) the use of locally adapted, drought resistant turfgrasses that can sustain adequate quality on less irrigation than grasses currently used (Leinauer et al., 2012). However, many of the turfgrass areas have to survive and recover from significant traffic and very few plants besides turfgrasses can withstand the repeated pounding furnished by such activities as baseball, football, or soccer, and running kids and/or dogs. It is therefore no surprise that we routinely select bermudagrass, zoysiagrass, Kentucky bluegrass, perennial ryegrass, and tall fescue as grasses for our lawns, depending on the climatic conditions of the area. These grasses are the only ones that combine traffic tolerance with a dark green and uniform appearance that is aesthetically pleasing for many of us during most of the year.

Turfgrass Water Use and Drought Resistance

Several factors contribute to a turf stand's water requirement. First, water is taken up by roots and then lost to the atmosphere (transpiration) from the plants' green tissue. However, water is also lost from the soil surrounding the plants (called evaporation). The combined losses, referred to as evapotranspiration (ET), are commonly expressed in millimeters per day, and serve as a basis for a replacement requirement either from rainfall or from irrigation. Several authors have suggested that a turf plant's ET is genetically determined, and species and varieties can be ranked from high to low based on their ET rates. However, ET rates and subsequent water demands are not only influenced by the species or varieties present, but also by climate, soil type, maintenance intensity, quality expectation, and irrigation uniformity. Table 1 lists published ET values for cool and warm season grasses at different mowing heights, and in controlled or field environments at different geographical locations. Generally, water use rates are higher in dry, desert climates than in humid or temperate climates. Evapotranspiration rates are also higher when grasses are maintained at a higher rather than at lower mowing height. High fertility programs aimed at maintaining high quality and dark colored turf also influence ET rates of turfgrasses.

Evapotranspiration rates listed in Table 1 were predominately determined under well watered or non-limiting moisture conditions. The wide range of ET within each species indicates that water use rates are not only determined by genetic predisposition but also by the moisture availability in the rootzone (Leinauer et al., 2012). Consequently, in the context of water conservation, the question is not how much water do turfgrasses use, but what is the minimum amount of water they require to survive and meet desired quality expectations. All turfgrasses can maintain acceptable quality for a certain period of time when irrigation is less than 100% ET using physiological mechanisms that allow plants to adapt to drought. Irrigating below 100% ET replacement is called deficit irrigation and can be used as a practice to conserve irrigation water. Turfgrasses survive drought stress by means of drought resistance mechanisms or by successful recovery from longer term water deficits (Kneebone et al. 1992; Devitt and Morris, 2008). However, deficit irrigation is only effective if turf areas receive sufficient rainfall to occasionally recharge the soil profile (Shearman 2008). In desert areas where occasional natural precipitation is insufficient, drought periods need to be followed by periodic increased irrigation amounts for grasses to recover (Baird, et al., 2009; Devitt and Morris, 2008). The main drought resistance mechanism from a lack of sufficient irrigation may be dormancy which results in a loss in color and cover. This may not fulfill the aesthetic or the functional requirements of the area. Sevostianova et al. (2010) reported superior drought resistance in un-trafficked buffalograss compared to bermudagrass or zoysiagrass during a 3 year period of no supplemental irrigation in a desert climate. However, the decline of green cover from 100% to an average of 17% indicated that even buffalograss cannot maintain adequate turf quality on a long term basis in an arid climate without supplemental irrigation.

Conclusion

Water requirements of turfgrasses are influenced by several factors, including ET, quality expectations, traffic, water and soil quality, and irrigation efficiency. Great attention is given to low water use rates or ET when selecting turfgrasses for the purpose of conserving water. However, ET values of species and varieties can vary widely depending on climate conditions and maintenance intensities. Furthermore, some turfgrasses use dormancy as a mechanism to resist drought, but this may not be a viable option if green grass is needed throughout the year. Consequently, strategies aimed at conserving potable irrigation water cannot be based solely on selecting low water-use or drought resistant species, but need to include the use of efficient irrigation systems or switching to non-potable water sources (Leinauer et al., 2012, Leinauer and Devitt, 2013).

Table 1. Reported evapotranspiration rates for commonly used cool- and warm-season turfgrasses at different cutting heights and at different geographical locations.

Species	ET (mm day^{-1})	Cutting height (mm)	Varieties / ssp. included	Location	Reference
Festuca arundinacea	5.1 – 7.1	38	1	Texas	Kim and Beard, 1988
	5.8	n.l.	1	Colorado	Feldhake et al., 1983
	6.7 – 8	76	6	Nebraska	Kopec et al., 1988
	9.9 – 11.4	50	1	CE	Green at al., 1990
	10 – 13.5	50	20	CE	Bowman and Mcaulay, 1991
	10.6	40	1	Arizona	Kneebone and Pepper, 1982
	12.2	30	1	Israel	Biran et al., 1981
Lolium perenne	3.4 – 4.0	50	1	Rhode Island	Aronson et al., 1987
	4.9 – 10	50	12	Nebraska	Shearman, 1989
	9.1	50	1	CE	Green et al., 1990
	10.8	30	1	Israel	Biran et al., 1981
Poa pratensis	3.4 – 4.1	50	2	Rhode Island	Aronson et al., 1987
	3.9 – 6.3	50	20	Nebraska	Shearman, 1986
	4.1	63	1	Kansas	O'Neil and Carrow, 1982
	5.0 – 6.1	64	2	Colorado	Suplick-Ploense and Qian, 2005
	5.7	n.l.	1	Colorado	Feldhake et al., 1983
	5.4 – 6.8	45		CE	Ebdon et al., 1998
	11.0 – 12.4	50	3	CE	Green et al., 1990
Buchloe dactyloides	2.3	51	1	CE	Horst et al., 1997
	3.7 – 5.6	50	17	CE	Bowman et al., 1998
	4.4 – 5.3	38	1	Texas	Kim and Beard, 1988
	4.5	n.l.	1	Colorado	Feldhake et al., 1983
Cynodon dactylon	2.8 – 6.2	25	24	Texas	Beard et al., 1992
	3.0	64	1	Georgia	Carrow, 1995
	4.1 – 5.9	38	3	Texas	Kim and Beard, 1988
	4.5	n.l.	1	Colorado	Feldhake et al., 1983
	7.3 – 8.6	30	2	Israel	Biran et al., 1981
Cynodon dactylon x C. transvaalensis	3.1	64	1	Georgia	Carrow, 1995
	7.4	32	1	Arizona	Kopec et al., 2006
Paspalum vaginatum	4.7 – 6.2	38	1	Texas	Kim and Beard, 1988
	7.9	30	1	Israel	Biran et al., 1981
	8.2	32	1	Arizona	Kopec et al., 2006
Zoysia japonica	2.2	51	1	CE	Horst et al., 1997
	3.5	64	1	Georgia	Carrow, 1995
	4.7 – 6.5	38	2	Texas	Kim and Beard, 1988
	7.3	30	1	Israel	Biran et al., 1981

CE Controlled Environment
n.l. not listed

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