Turfgrass water consumption on green and fairway as a function of turfgrass species and day number after irrigation to field capacity

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Key words: *Agrostis* sp., *Festuca rubra*, *Lolium perenne*, *Poa pratensis*, evapotranspiration

Introduction

Worldwide, lack of irrigation water is a serious threat to the turfgrass sector. The objective of this research was to determine crop coefficients (K_c), i.e. the ratio between actual and reference evapotranspiration, for cool season turfgrasses on greens and fairways.

Materials and methods

Actual evapotranspiration (ET_a) was determined using mini lysimeters (MLs; intact cores with turf and soil, 10 cm in diameter and 30 cm deep, 1 mm x 1 mm mesh in bottom and surrounded by metal sleeves) that had been installed on plots with various turfgrass species on a one year old USGA green (plant available water capacity (3 – 1500 kPa) 10.5 % (v/v)) and on a four year old fairway (silt loam soil, plant available water capacity 19.0 % (v/v)) at the Bioforsk Turfgrass Research Centre, Landvik, Norway. The green, including MLs, was mowed three times per week at 5 mm for *Festuca* and 3 mm for *Agrostis*. All species on the fairway were mowed twice per week at 15 mm. During four periods in 2009 and 2010, each period 5-12 days without rainfall, six MLs per species were pulled out and weighed on a daily basis. After weighing, three MLs (replicates) were hand-irrigated gently and repeatedly for about 30 minutes to field capacity and left to drain for about one hour until no more droplets came from the bottom of the MLs before new weighting and reinstallation into the green or fairway. The remaining three MLs were not irrigated during the dry-down periods. On reinstallation into the green or fairway, the bottoms of the MLs were always sealed with plastic bags to avoid hydraulic contact with the underlying gravel layer in the green or with the underlying soil on the fairway. Reference ET (ET_0) values were calculated from the Bioforsk weather station (200 m from the experimental green and fairway) using the FAO 56 version of the Penman Monteith equation (WaSim software, Cranfield University, UK). Results were analyzed using the SAS procedure ANOVA.

Results

Fig. 1 shows typical patterns for turfgrass water use during one of the four registration periods. Both on green and fairway, ET_a from MLs that received daily irrigation to field capacity was two to three times higher than ET_0. By contrast, turfgrasses that were not irrigated usually showed a dramatic fall in ET_a from the first to the second day of the dry-down period. Among species used for green, the only exception to this general pattern was *Agrostis canina* which used significantly less water than other species in the treatment with daily irrigation to field capacity (Fig 1c, Table 1). Among species used for fairway, *F.rubra* ssp. *litoralis* and *L.perenne* used significantly more water than *Poa pratensis* and

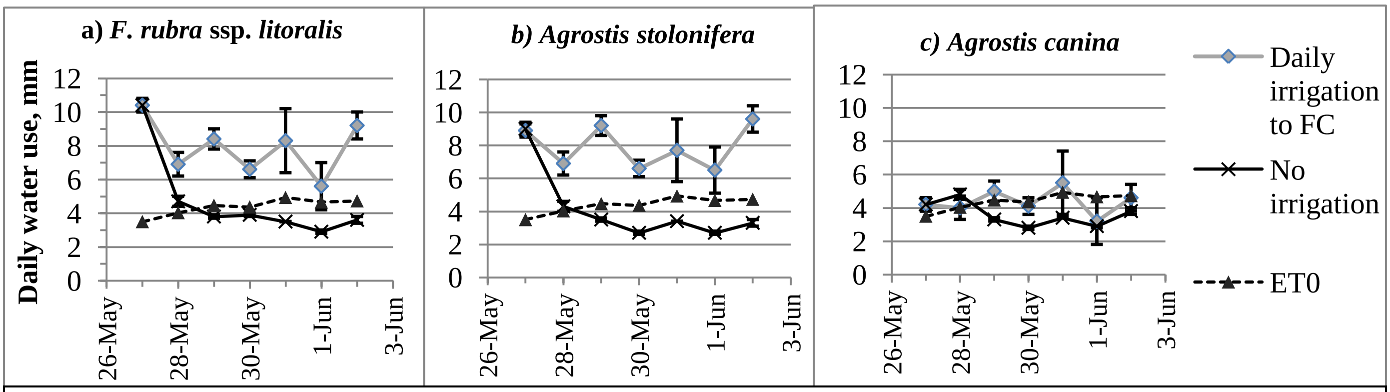

Fig. 1. Effect of daily irrigation to field capacity vs. no irrigation on daily water consumption of three turfgrass species on a USGA green from 27 May to 2 June 2009. Reference ET_0 is also indicated.

Table 1. Crop coefficients (K_c) on day no 1 and mean values for day no 2-6 after irrigation to field capacity of turfgrasses growing on green and fairway. Mean of four registration periods in 2009 and 2010.

Green			Fairway		
Turfgrass species / variety	Days after irrigation to field capacity		Turfgrass species / variety	Days after irrigation to field capacity	
	Day no 1	Mean of day no 2-6		Day no 1	Mean of day no 2-6
FRC 'Center'	2.54	0.92	*FRC* 'Center'	2.24	0.89
FRL 'Cezanne'	2.65	0.77	*FRL* 'Barcrown'	3.29	0.82
ACAP 'Barking'	2.83	0.84	*FRR* 'Celianna'	2.86	0.91
AS 'Independence'	2.39	0.79	*PP* 'Limousine'	2.49	0.90
ACAN 'Legendary'	1.71	0.83	*LP* 'Bargold'	3.12	0.96
P-value	<0.01	0.12	*P*-value	<0.001	>0.15
LSD 5%	0.39	-	LSD 5%	0.36	-

F.rubra ssp. *commutata* on the first day after irrigation to field capacity, after which differences were not significant.

Discussion

Gravimetric determination of turfgrass water consumption depends on ML type and on the protocol used for weighing and replenishment of water (Bremner et al. 2003). In this study we used intact cores with a sealed bottom that prevented drainage; hence, the surprisingly high weight losses of MLs receiving daily irrigation to field capacity must have been due to high ETa-values. ET_a from irrigated MLs during the period 27 May – 2 June, on average 9.1 mm for all species on fairway and 8.1 mm for all species except *A.canina* on green, were only slight lower than the maximum possible value of 10.8 mm that can be calculated from the average daily global radiation (26.4 MJ/m^2) recorded during the same period at the Bioforsk weather station. For a later registration period in August 2009, ET_a was in fact 25% higher than theoretically maximum value calculated from irradiance. In other words, there must have been an additional factor contributing to the high ET_a-rates, and this factor might have been latent heat that was stored in the soil and released as ET upon irrigation (J. Knox & H. Riley, pers. comm, June 2011). In any case, our results shows that turfgrass ET_a is a function of irrigation management and that frequent irrigation to field capacity will result in excessive water use.

The differences in ET_a among *Agrostis* sp. that were irrigated to field capacity on the experimental green are consistent with those previously reported under fairway conditions by DaCosta & Huang (2006). Common characteristics for *A.canina* putting greens are a thick an often spongy thatch layer and a very dense and fine-textured canopy. Both factors may result in a thick boundary layer with a high relative humidity that limits transpiration from *A.canina* putting greens. As for *F.rubra* spp. *commutata*, it is noteworthy that cv.' Center' had a lower ET_a than the other species after irrigation to field capacity on the fairway but on the green it tended to uphold the highest water consumption as the soil dried out. Part of the explanation for the latter may be that *F. rubra* spp. *commutata*, had more roots below 10 cm depth than any other species in the green trial (data not shown), but also that the upright leaves on the sandy green with *F. rubra* mowed at 5 mm was more exposed to wind and possibly had higher surface temperatures than denser canopies of *Agrostis* sp. mowed at 3 mm.

Acknowledgement

This research was funded by the Scandinavian Turfgrass and Environment Research Foundation (STERF) and grant no 192272/110 from the Research Council of Norway.

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