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Urban Lawn Microclimates Affect Reference Evapotranspiration

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Urban Lawn Microclimates Affect Reference Evapotranspiration

Abstract

Grass reference evapotranspiration (ET_o) obtained from weather stations in open locations is often used to estimate irrigation requirements of turfgrass in local or regional urban lawns. However, the environments of urban lawns are often altered by surrounding buildings, trees, etc., to form various microclimates that may alter evapotranspiration (ET). Our research, which placed weather stations in urban lawns and nearby open swards of turfgrass, revealed ET_o was 41% lower in residential lawn microclimates than in nearby open turfgrass swards. Less ET within urban lawns than in nearby open swards suggests using standard historical weather data to estimate irrigation amounts in urban lawns (based on ET_o) is problematic, because historical weather data is typically obtained from open areas such as local airports (Ley et al., 1996; Romero and Dukes, 2013). Consequently, the use of weather stations located onsite, or at least in an urban lawn within the same region, may improve estimates of lawn irrigation requirements.

Keywords

evapotranspiration, water, turfgrass, landscape irrigation

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Summary

Grass reference evapotranspiration (ET_o) obtained from weather stations in open locations is often used to estimate irrigation requirements of turfgrass in local or regional urban lawns. However, the environments of urban lawns are often altered by surrounding buildings, trees, etc., to form various microclimates that may alter evapotranspiration (ET). Our research, which placed weather stations in urban lawns and nearby open swards of turfgrass, revealed ET_o was 41% lower in residential lawn microclimates than in nearby open turfgrass swards. Less ET within urban lawns than in nearby open swards suggests using standard historical weather data to estimate irrigation amounts in urban lawns (based on ET_o) is problematic, because historical weather data are typically obtained from open areas such as local airports (Ley et al., 1996; Romero and Dukes, 2013). Consequently, the use of weather stations located onsite, or at least in an urban lawn within the same region, may improve estimates of lawn irrigation requirements.

Rationale

Reference evapotranspiration (ET_o) is typically estimated from data obtained from weather stations located in open areas such as local airports (Ley et al., 1996; Romero and Dukes, 2013). Such values of ET_o may then be used to estimate irrigation requirements of turfgrass in urban microclimates such as lawns and landscapes where the local climate is modified by surrounding trees, buildings, etc. Therefore, ET_o obtained from weather data in open areas may not represent ET of turfgrass in urban areas.

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Objective

Compare ET_o estimates between open turfgrass swards and nearby urban lawn microclimates using data obtained from weather stations located in both locations.

Study Description

The study was initiated in June 2010 at Manhattan, KS and was continued in 2011 at sites in Manhattan and Wichita, KS (Table 1). Portable weather stations were positioned concurrently at multiple urban home sites and in an open sward of turfgrass near each city. These weather stations recorded meteorological variables necessary to calculate grass ET_o including air temperature, relative humidity, wind speed, and net radiation. Reference ET was calculated using the FAO56-PM (Penman-Monteith) empirical model (Allen et al., 1998). Additional details about the study can be found in Peterson et al. (2015).

Results

Grass reference ET (ET_o) averaged 41% lower in urban microclimates (mean = 0.127 inches per day) than in the open swards (mean= 0.216 inches per day). This was caused primarily by reduced wind speeds (blockage from surrounding trees, buildings, etc.) and lower net radiation (from shade) in urban microclimates compared with open areas (Table 2). For example, wind speed averaged 63% less at the urban sites than at open swards. Interestingly, the maximum wind speed (30-min average) within urban lawns (11.7 mph) during the entire study was only about half of the maximum wind speed at the open sward (22.6 mph). Net radiation also averaged 39% less at the microclimate sites than at the open swards.

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Table 1. Evapotranspiration measurement days for microclimate study locations at Manhattan, KS, in 2010–2011 and Wichita, KS, in 2011

Lawn	Location	Number of microclimate observation days†
1	Manhattan	46
2	Manhattan	52
3	Manhattan	33
4	Manhattan	26
5	Manhattan	24
6	Manhattan	11
7	Wichita	15
8	Wichita	26
9	Wichita	24
10	Wichita	12

†N = 269.

Table 2. Daily (24 hr) means for grass reference evapotranspiration (ET_o) and environmental variables from the open sward and urban microclimate locations, and the percentage difference between urban microclimates and nearby open swards

Location	n†	Penman-Monteith ET_o	Wind speed	Net radiation	Air temperature
		inch	mph	$MJ\ m^{-2}\ d^{-1}$	°C
Open sward	132	0.216	6.7	12.2	76.6
Microclimates	269	0.127	2.5	7.5	77.2
Difference‡		-41%	-63%	-39%	+0.8%

†Daily (24 hr) evapotranspiration measurements.
‡[(microclimate – open sward)/open sward] × 100 = percent difference

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Figure 1. Weather stations were located at open swards of turfgrass (top) and in urban lawn microclimates (bottom).

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