Water–Use Efficiency and Carbon Sequestration Influenced by Turfgrass Species and Management Practices

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Objectives:

1. *Estimate carbon balance of golf course carbon flux and soil carbon pools.*
2. *Determine associations between water use efficiency and carbon dynamics within turfgrass system.*
3. *Identify effects of reduced water and nutrient inputs.*

Our study addresses a need for improved data and understanding of turfgrass carbon dynamics, especially under reduced inputs of water, nutrients, and light. We use this approach to examine annual dynamics of seven cool–season and six warm–season turfgrass species and various cultivars of each in a field experiment, surveys of turf in common land management, regional patterns along a strong coastal to inland gradient, and high resolution sensing and modeling to describe physiological responses to drying and wetting events. Beginning in 2011 we established a varietal experiment to evaluate turfgrass sensitivity to irrigation deficit. The experimental design was similar to one we used in 2009 to study turfgrass under optimal management conditions. In combination with these direct gas exchange measurements we measured carbon dynamics through a soil inventory approach. To initiate the soil inventory we collected cores from the experimental plots and through representative sampling of turfgrass under different conditions throughout the region and at multiple depth intervals. We are preparing the samples for chemical analysis. Our project uses new field monitoring systems to describe turf ecosystem carbon fluxes, water fluxes, and water use efficiencies.

Baseline measurements of gas exchange and soil properties were collected in late spring before the hot and dry summer conditions. Irrigation ranged from 5–25% below established crop coefficients for cool season and warm season turfgrasses (deficit irrigation was based on a percentage of historical crop coefficients–Kc). Hand irrigated to maintain highest level

Figure 1. Optimal and deficit irrigation experiments designed to determine associations between water use efficiency and carbon dynamics within turfgrass system.

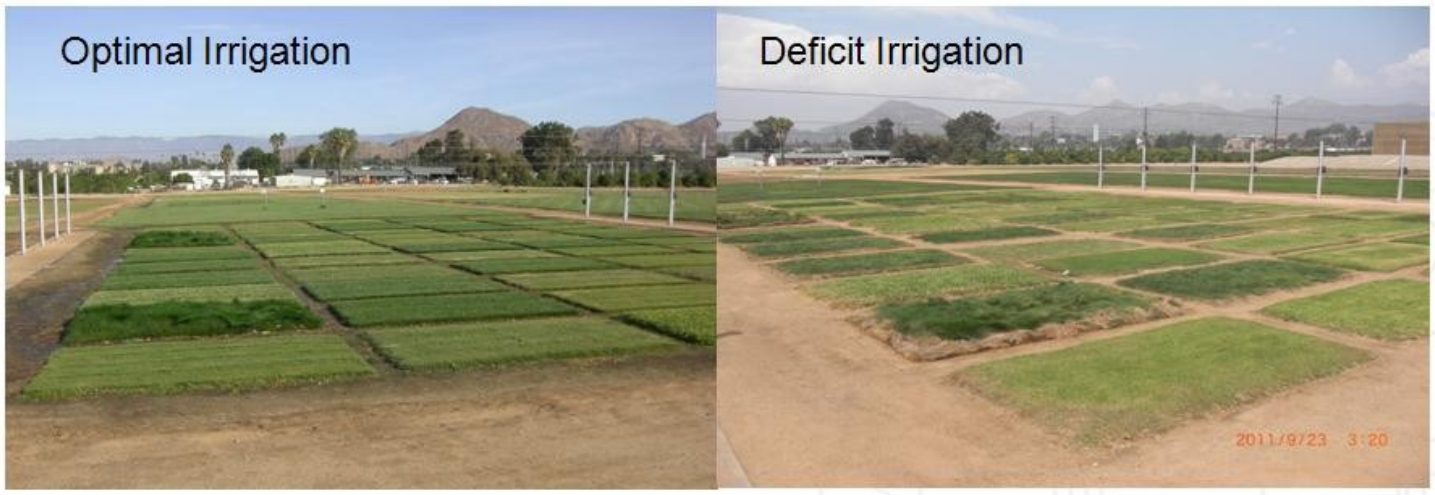

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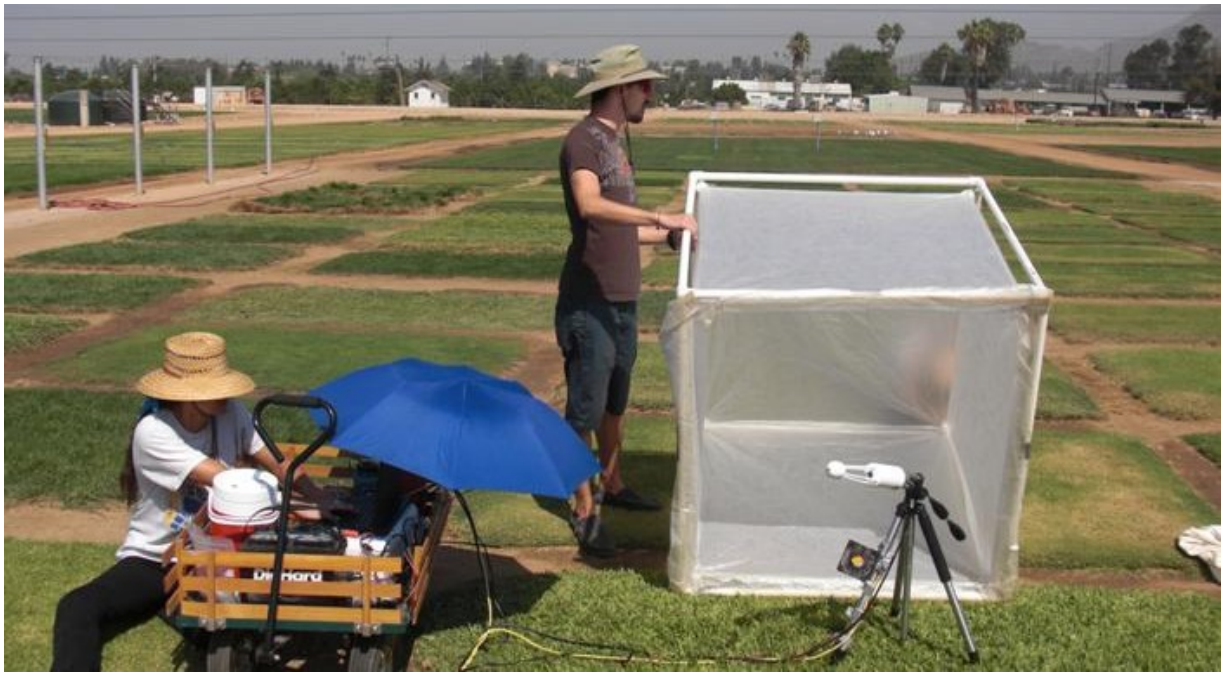
Figure 2. New field monitoring systems to describe turf ecosystem carbon fluxes, water fluxes, and water use efficiencies were deployed by Ryan Nichols and Lindy Allsman.



distribution (irrigation) uniformity (to negate uniformity issues). Our measurements were conducted shortly after watering and accurately documents plant condition in response to deficit irrigation. Measurements and data collection were completed for this portion of the study in April 2012. We now have annual carbon and water use efficiency data from optimal conditions and deficit irrigation. While still preliminary, we found significant differences in water use efficiency among many species/cultivars and for individual species/cultivars when comparing the 2 years, optimal vs. deficit irrigation (Fig. 3). Additionally we found substantial variation in carbon uptake (GEP) when comparing the 2 years for individual species/ cultivars (Fig. 4). Because of this we assume that one year of deficit irrigation is not sufficient enough to significantly change plants maximum carbon uptake ability. Currently we are further analyzing data to make connections between carbon uptake, water use efficiency, and other environmental factors such as soil temperature, and canopy temperature.

We are expanding our study to a regional sampling of turf soils from golf courses through collection across a climate gradient extending from moderate coastal to desert inland. A major aspect of this work has been identifying golf course sites and finalizing instrumentation for installation at these sites (Figure 4). We now have identified course near Westwood neighborhood of Los Angeles, CA, Riverside, CA, and Palm Springs, CA. Instrumentation at each site we are finalizing includes continuous measurements of local weather and most critically soil CO2 fluxes. These fluxes have a critical role of carbon sequestration rates and after deploying these systems we will acquire data at a 5 minute resolution across all seasons. We have performed test deployments of the complete system in a test field facility and are planning on initial deployments during winter 2013. Throughout the following year we will conduct tent–based measurements of whole ecosystem carbon and water exchanges seasonally at these sites. These manual measurements are comparable to studies at our experimental plots and will allow us to validate and extend the continual flux measurements.

Summary Points

- Deficit irrigation reduces maximum water use efficiency across all turfgrass species.
- Species varied significantly in sensitivity to deficit irrigation.
- More severe effects of deficit irrigation were observed following extended deficit irrigation.
- Water use efficiency decreased following irrigation events – such measurements may help improve irrigation frequency plans.
- New instrumentation systems are being finalized for deployment to measure soil CO2 fluxes across a network of golf courses in southern California from mild coastal to extreme inland environments.

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Figure 3. Differences in species water use efficiency (Gross Ecosystem Production / EvapoTranspiration) between optimal watering (2009) and deficit irrigation (2011). Different letters denote statistical significance.

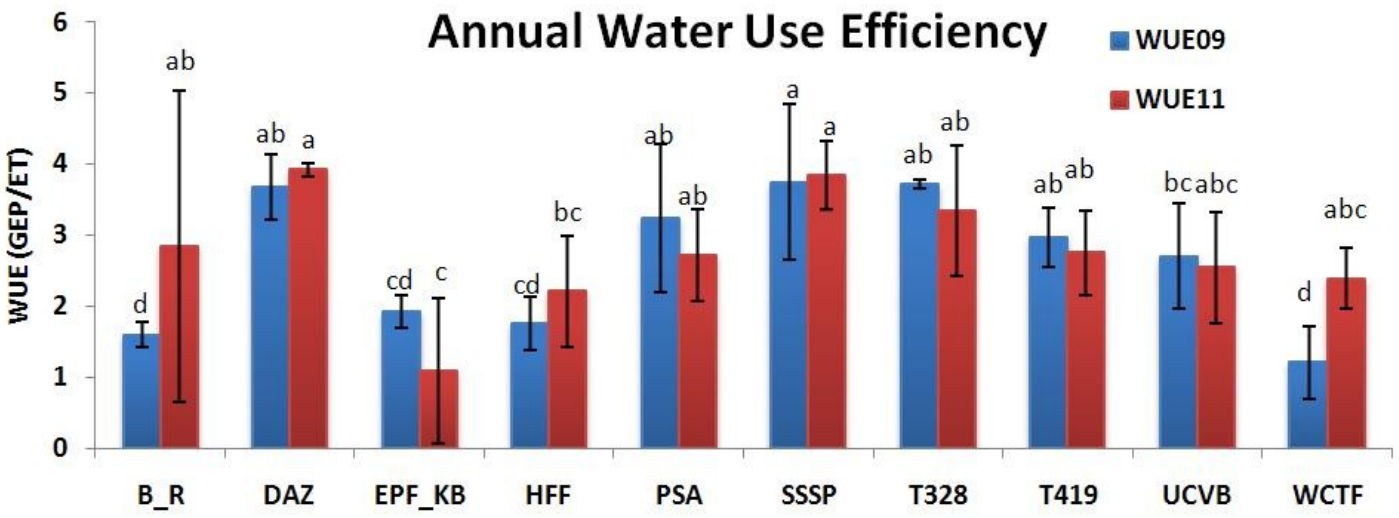
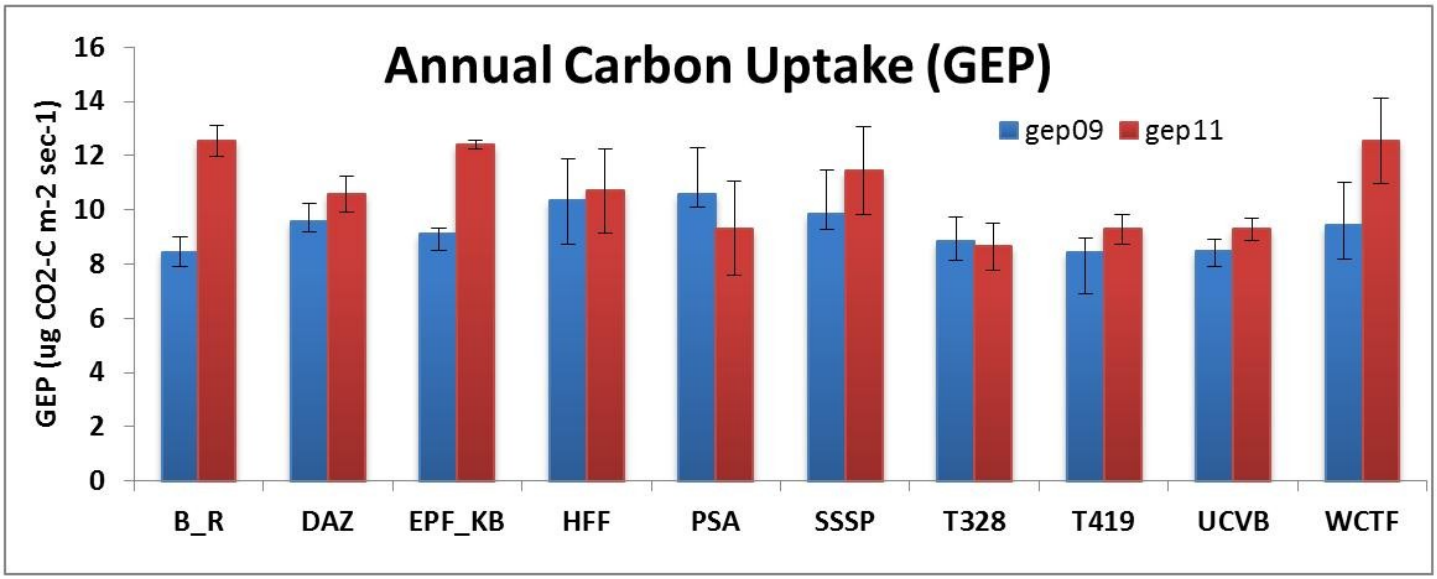


Figure 4. Differences in carbon uptake, Gross Ecosystem Production (GEP) between optimal watering (2009) and deficit irrigation (2011). No letter denote no statistical differences.



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