Examining Turf's Carbon Footprint

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Turfgrass is a key component of urban landscapes. In southern California, recent estimates have suggested 41% of the urbanized lands are covered with turfgrass. Throughout the United States turfgrass is the predominant crop species. Ecologists are curious about how this expanse of turf affects a variety of processes. How much water is required by this vegetation? How much carbon is stored in turf? How much nutrients are leached from turf? How sensitive is turf to altered management activities? How likely are invasive species associated with turf plantings? How much greenhouse gas emissions (including CO_2, methane, and NO_x) generated by turf stands? In native regions, ecologists are often concerned with identifying the causes for why species are located where they are. This interest is also evident in urban ecological research – why do people plant turf where they do? How do they make decisions between different turf varieties and how do they select alternatives to turf? Clearly, there is a growing interest in ecological science in developing a better understanding of turfgrass both from fundamental biochemical cycling to the choices leading to turf planting.

As a means of launching a long-term research program in turfgrass ecology, commonly used cultivars of nine cool- (C3) and warm- (C4) season turfgrass species were established from sod or plugs in 2008. Beginning in March 2009, whole plot CO_2 and H_2O exchange were measured every two weeks under non-limiting conditions for irrigation, fertility, and mowing height. These data will serve as a baseline for future experiments.

2009 Objectives

1. Determine association between water use efficiency and carbon dynamics among different turfgrass species and cultivars under non-limiting cultural practices.
2. Expand knowledge base about ecological role of turf in the landscape.

Location: UCR Turf Facility

Soil: Hanford fine Sandy loam

Mowing Heights: 12.5'' for cool-season grasses except fine fescues (no mow), 2.0'' warm-season grasses, except St. Augustinegrass and buffalograss (3'')

Experimental Design: Randomized complete block with 3 replications

Plot Size: 6' by 10'

Establishment: Treatments 1-12 were established on 7/17/2008, 13-16 on 7/25/08, 17-19 on 8/1/08, and 20 on 8/5/08

Fertility: 1 lb N/1000 ft^2 at planting; 0.5 lb N/1000 ft^2/wk during establishment and approximately once/month thereafter;

Irrigation Regimes: Once it was established, turfgrasses were subjected to warm-season irrigation regimes (approximately 60% Et_o/DU). Supplemental irrigation is applied to the coolseason turf as necessary by hand watering.

Data Collection: Turf quality, color, density, leaf firing/wilting, rooting, gas exchange, and leaf C and N content will be evaluated periodically throughout the study. Physiological measurements to include carbohydrate content, photosynthesis, chlorophyll fluorescence, soil respiration.

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North

4	12	3	14	7
17	2	9	5	16
19	8	20	18	15
10	1	13	11	6
10	20	8	12	5
19	3	17	1	14
9	15	11	16	6
18	2	4	7	13
20	19	18	17	16
15	14	13	12	11
10	9	8	7	6
5	4	3	2	1

Treatments:

1. Tifsport Bermudagrass	**11. West Coaster Tall Fescue**
2. Bull's Eye Bermudagrass	**12. UC Verde Buffalograss**
3. Palmetto St. Augustinegrass	**13. El Toro Zoysiagrass**
4. Tifway II Bermudagrass	**14. Experimental Tall Fescue I**
5. Sea Spray Seashore Paspalum	**15. St. Augustinegrass**
6. Tifway 419 Bermudagrass	**16. Experimental Tall Fescue II**
7. De Anza Zoysiagrass	**17. Excalibre Seashore Paspalum**
8. Tifgreen 328 Bermudagrass	**18. Medallion Tall Fescue**
9. Bayside Blend K. Bluegrass/P. Ryegrass	**19. GN-1 Bermudagrass**
10. Hillside Fine Fescue	**20. Elite Plus T. Fescue/K. Bluegrass**

Preliminary Results:

We determined leaf carbon (C) and nitrogen (N) content of different C3 and C4 turfgrass cultivars (Table 1). Leaf C content for C3 cultivars ranged between 36 to 43 percent, whereas, C4 cultivars contained 36 percent to 48 percent C. The isotopic analyses of δC^{13} showed a significant variation between C3 and C4 cultivars. C4 cultivars were enriched in C and depleted in the case of C3 cultivars. δC^{13}values for C3 grasses were in between -28 to -29‰ and -13 to -16‰ for the C4 grasses. There was no major difference in leaf N or δC^{15} N values between C3 and C4 cultivars.

Table 1. Leaf carbon and nitrogencontent (%) and respective isotopic analyses of different turfgrass cultivars grown in California.

Cultivars	C%	δC^{13}‰	N%	δN^{15}‰
C3 cultivars				
Bayside blend K. Bluegrass/P. Ryegrass	41.09	-	2.63	2.86
Hillside Fine Fescue	38.56	-29.24	3.01	1.37
West Coaster Tall Fescue	36.53	-29.43	2.06	1.76
Experimental Tall Fescue I	42.49	-	2.20	4.74
Medallion Tall Fescue	36.43	-28.67	1.87	3.22
Elite Plus T. Fescue/K. Bluegrass	43.22	-	2.46	2.69
C4 cultivars				
Tifsport Bermudagrass	42.18	-14.79	2.29	2.66
Palmetto St. Augustinegrass	39.90	-13.89	2.13	5.53
Tifway II Bermudagrass	37.92	-15.85	3.07	5.41
Sea Spray Seashore Paspalum	39.28	-15.05	2.81	2.40
Tifway 419 Bermudagrass	45.94	-14.63	2.67	4.70
De Anza Zoysiagrass	48.87	-15.11	2.87	1.38
UC Verde Buffalograss	36.21	-	2.35	2.64
El Toro Zoysiagrass	39.26	-13.75	2.25	4.28
St. Augustinegrass	43.03	-16.32	2.87	2.19
Excalibre Seashore Paspalum	42.72	-16.33	2.3	4.02
GN-1 Bermudagrass	43.26	-15.67	2.31	4.63

Changes in gross primary productivity (GPP) or the amount of carbon fixed during photosynthesis over time (µmole CO_2 m^{-2} sec^{-1}) varied between C3 and C4 cultivars. Most of the C3 cultivars showed a decrease in GPP from March to August 2009 whereas the GPP of the C4 cultivars increased during the same period of time (Figure 1).

Figure 1. Changes in gross primary productivity (GPP; µmole CO_2 m^{-2} sec^{-1}) over time for representative C3 and C4 turfgrass cultivars grown in California.