Evaluation of Cool-season Turfgrasses under Deficit Irrigation

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Irrigating turfgrasses below the optimal irrigation water requirement, or deficit irrigation, is one method to conserve irrigation water. The optimal irrigation water requirement is the optimal turfgrass water requirement adjusted for irrigation application uniformity and sometimes application efficiency. An irrigation amount of 80% below the optimal for cool-season turfgrasses would be considered a good start in most situations. Developing new cool-season turfgrasses with increased drought tolerance would also reduce the irrigation water requirement. Hybrids of perennial ryegrass with meadow fescue (*Festulolium*) are being developed and tested at UCR. They have shown an extraordinary capacity to survive during periods of drought.

Objective The objective of this study was to evaluate relative drought tolerance among *Festulolium* and tall fescue experimental lines, tall fescue commercial varieties, and commercial seed mixtures in the field when subjected to deficit irrigation during the warm season.

Materials and Methods This study was conducted at the UCR Turf facility on a specially-constructed irrigation plot. The native soil texture is a Hanford fine sandy loam, though the upper 4-inch root zone is a loam. The plot included 12 independently-controlled irrigation cells, each 20.0 x 20.0 ft. Each irrigation cell had a pop-up sprinkler at each of the four corners (Toro 300 Stream Rotor Series). The plot was controlled with a Hunter ICC controller. On July 11, 2008, *Festulolium* and tall fescue experimental lines, tall fescue commercial varieties, and commercial seed mixtures were seeded as shown on the plot plan. *Festulolium* was seeded at 4.4 lb/1000 ft^2 and all other treatments were seeded at 7.0 lb/1000 ft^2. Commercial seed mixtures were grown in 10.0- x 10.0-ft plots (4 plots per cell) while all other treatments were grown in 5.0- x 5.0-ft plots (16 plots per cell). Plots of all treatments were well established, representative, and well watered to the 9- to 12-inch soil depth before deficit irrigation was initiated on May 10, 2009. For 13 weeks, May 10 to August 7, all cells were irrigated at 80% ETcrop for cool-season turfgrass (80% CS turf), except for three cells (1,6,10) which were irrigated at 100% ETcrop for cool-season turfgrass (100% CS turf). Weekly irrigation amount was calculated by using the previous 7-day CIMIS ETo, monthly cool-season turfgrass crop coefficients, and a factor of 0.8 for 80% CS turf and a factor of 1.0 for 100% CS turf. Total weekly irrigation run time for each cell was calculated by using the irrigation precipitation rate (PR) for each cell. This was equally divided into four irrigation days per week and four irrigation cycles per irrigation day (16 start times per week). No adjustments were made for irrigation distribution uniformity (DU). Irrigation catch can tests were conducted on each cell on April 30. Average DU was 77% and average PR was 0.66 inch/hour. Irrigation heads were checked and adjusted once every 4 weeks. During the 13-week study, total CIMIS ETo was 14.24 inch, average total irrigation for the nine cells irrigated at 80% CS turf was 19.25 inch (74% CIMIS ETo), and the same for the three cells irrigated at 100% CS turf was 19.25 inch (91% CIMIS ETo). Rainfall during this period was 0.02 inch. Between January 1 and August 7, 2009, the plot was fertilized with a 15-5-8 fertilizer on the following dates and N rates (lb/1000 ft^2): March 2 (1.0); April 8 (0.4); May 7 (0.3); June 8 (0.3), and July 8 (0.3). Beginning in the second week of April, the plot was mowed two times per week at a 2.5-inch mowing height with a walk-behind rotary mower; clippings were collected. During July and August, the mowing frequency was reduced to not less than one mowing per week. Once every 3 weeks, visual turfgrass quality ratings were taken on a 1 to 9 scale with 1 = brown turf, 5 = minimally acceptable, and 9 = best tall fescue/cool-season turf. Many home lawn owners would be satisfied with a quality rating of 6. Percent brown leaf coverage ratings (0% to 100%) were taken once every 2 weeks. These ratings started on July 6 when there was sufficient expression of this trait. Cells with 5.0- x 5.0-ft plots had relatively large areas of brown leaf coverage from mid-July to the premature end of the study (August 7) due to irrigation patterns. This issue was more evident on cells being irrigated at 80% CS turf than 100% CS turf. As expected, these large brown areas confounded the data and made it difficult to ascertain actual plant treatment performance. To

overcome this, we increased the number of replications to six by considering only treatments 1-12 in cells being irrigated at 80% CS turf (see plot plan, cells 3,4,8,9,11, and 12). Additionally, outliers were judiciously removed from the data set which was then statistically analyzed according to a randomized complete block design. Treatment means, shown under Study I in Tables 1 and 2, are fairly representative of actual performance without excessive influence from irrigation patterns. Cells containing 10.0- x 10.0-ft plots of commercial seed mixtures did not have excessive irrigation patterns. These data were statistically analyzed according to a randomized complete block design and treatment means are shown under Study II in Tables 1 and 2.

Results

1. Turfgrass quality substantially declined in July and August, following a mild June. In terms of **overall visual turfgrass quality**, all plant treatments, except Fawn tall fescue, produced at least a minimally acceptable turfgrass quality in both Study I and II (Table 1). In Study I, tall fescues had significantly higher overall quality than *Festulolium* (exception was Fawn tall fescue). In Study II, differences among commercial seed mixtures for overall quality were not significantly different, though differences were significant for the first three rating dates.

2. Percent brown leaf coverage was generally lower on August 1 than on July 18 for plant treatments other than tall fescue. Tall fescues exhibited significantly less **overall percent brown leaf coverage** than *Festulolium* in Study I. Similarly, there was a biological trend that tall fescue commercial seed mixtures in Study II (Scotts Landscapers' Mix and Pennington tall fescue) exhibited lower overall percent brown leaf coverage than commercial seed mixtures containing perennial ryegrass or Kentucky bluegrass or fine fescues (Pennington Sun/Shade and Scotts Traffic Mix).

3. *Festulolium* and commercial seed mixtures containing perennial ryegrass or Kentucky bluegrass or fine fescues exhibited nitrogen deficiency symptoms which resulted in slow shoot growth and recovery, less green leaf color, and increased brown leaf coverage. This negatively affected both visual turfgrass quality and percent brown leaf coverage ratings.

4. Since this is only one study, caution should be exercised when interpreting results. Due to limitations of this study, a second study with a revised protocol was initiated on September 5, 2009. It involves the same plot and subjecting representative, well-watered plant treatments to no irrigation for 14 to 21 days. On the theme of change, it also should be noted that new and improved experimental lines of *Festulolium* are continually being developed.

Practicum

Based on **current** information, irrigating tall fescue and other cool-season turfgrasses at the equivalent of 74% CIMIS ETo is not sufficient irrigation for the inland summer conditions of Riverside. Justification for this point includes 1) overall turfgrass quality of the current study would have been lower if the study would have continued to the end of the summer instead of August 7, 2) past studies concluded that 80% CIMIS ETo was not sufficient irrigation to maintain satisfactory tall fescue during the summer in Riverside, and 3) the combination of irrigating at the equivalent of 74% CIMIS ETo, typical DUs, and variable soil conditions result in irrigation patterns with areas of brown turf.

NORTH

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

Cell 9				Cell 8				Cell 7	
3	6	5	12	20	5	8	1	**d**	**a**
9	10	19	11	10	6	7	9		
2	4	8	7	12	18	2	3	**c**	**b**
18	20	17	1	17	4	11	19		

Cell 6				Cell 5		Cell 4			
20	6	9	12	**a**	**b**	19	11	8	17
1	3	11	7			3	20	1	7
4	18	10	5	**d**	**c**	12	4	6	5
19	8	2	17			9	2	18	10

Cell 3				Cell 2		Cell 1			
3	7	9	12	**d**	**c**	8	18	7	19
13	8	11	5			11	17	4	5
15	14	16	4	**b**	**a**	2	20	6	3
6	10	2	1			10	1	9	12

Treatments in 5 x 5 ft plots
Cells 3,11,12 contain 1-12 plus 13-16
Cells 1,4,6,8,9,10 contain 1-12 plus 17-20

Festulolium
1. B7.1143
2. B7.1142

Tall fescue
3. 6.1657
4. 6.0891
5. 6.1534
6. 5.0541
7. 6.0726
8. 7.0536
9. 7.0537
10. 7.0535
11. 7.0534
12. Fawn
13. 7.0543
14. 8.0151
15. 7.0542
16. 7.1359
17. Avenger
18. Firenza
19. Bonsai 3000
20. 2nd Millenium

Treatments in 10 x 10 ft plots
Cells 2,5,7

a. Pennington Turf Type Tall Fescue (39% Forte, 29%Duranna, and 29% Signia tall fescue)
b. Pennington Sun and Shade Mix (49% Integra perennial ryegrass; 10% Blue Bonnet and 10% Kenblue Kentucky bluegrass; 15% Flyer creeping red fescue; 15% Shadow II chewings fescue)
c. Scotts Select Turf Landscapers' Mix (44% Adobe and 44% Chinook tall fescue; 10% Gulf annual ryegrass)
d. Scotts Pure Premium High Traffic Mix (30% Roadrunner, 25% Inspire, and 19% Showtime perennial ryegrass; 25% Abbey Kentucky bluegrass)

Table 1. Visual turfgrass quality[1] of cool-season turfgrasses when irrigated at 74% CIMIS reference evapotranspiration (ETo) from May 10 to August 7, 2009 in Riverside, Calif.

Treatment	May 9	May 30	June 20	July 11	Aug. 3	Overall
			Study I[2]			
Festulolium						
B7.1143	5.7 c[3]	5.4 d	5.3 e	4.7 b	4.8 bc	5.3 c
B7.1142	5.7 c	5.5 d	5.6 d	4.2 c	4.2 d	5.2 c
Tall fescue						
6.0891	6.6 ab	6.6 a	6.3 ab	5.6 a	5.3 a	6.1 ab
7.0534	6.7 a	6.6 a	6.4 a	5.5 a	5.3 a	6.2 a
7.0536	6.5 b	6.5 abc	6.3 ab	5.6 a	5.3 a	6.1 ab
6.1534	6.6 ab	6.3 c	6.3 ab	5.7 a	5.4 a	6.1 ab
5.0541	6.6 ab	6.5 abc	6.3 ab	5.7 a	5.4 a	6.2 a
6.1657	6.5 b	6.4 bc	6.1 c	5.5 a	5.1 ab	6.0 b
7.0537	6.5 b	6.5 abc	6.2 bc	5.7 a	5.2 ab	6.2 a
7.0535	6.5 b	6.4 bc	6.2 bc	5.7 a	5.2 ab	6.1 ab
6.0726	6.4 b	6.5 abc	6.3 ab	5.7 a	5.0 ab	6.1 ab
Fawn	4.0 d	4.0 e	4.0 f	4.0 c	4.4 dc	4.1 d
			Study II[4]			
Scotts Landscapers' Mix[5]	4.8 b	5.0 c	5.2 c	5.0 a	5.2 a	5.0 a
Pennington tall fescue	6.2 a	6.0 a	6.0 a	5.4 a	4.2 a	5.7 a
Pennington Sun/Shade[6]	5.7 a	5.3 bc	5.6 b	4.8 a	4.9 a	5.3 a
Scotts Traffic Mix[7]	5.5 ab	5.4 b	5.5 b	5.0 a	4.6 a	5.2 a

[1] Visual turfgrass quality ratings were on a 1 to 9 scale where 1= brown turf, 9= best tall fescue/cool-season turf, and 5= minimal acceptance.
[2] Each of the 12 turfgrass treatments were grown in six replicate, 5.0- x 5.0- ft plots (cells 3, 4, 8, 9, 11, 12; see plot plan).
[3] Means within the same study and column followed by the same letter are not significantly different, Fisher's protected LSD test, *P*=0.05.
[4] Each of the four turfgrass treatments were grown in three replicate, 10.0- x 10.0- ft plots (cells 2, 5, 7; see plot plan).
[5] Seed mixture was 88% tall fescue and 10% annual ryegrass (see plot plan for more details).
[6] Seed mixture was 49 perennial ryegrass, 20% Kentucky bluegrass, 15% creeping red fescue, and 15% chewings fescue (see plot plan for more details).
[7] Seed mixture was 74% perennial ryegrass and 25% Kentucky bluegrass (see plot plan for more detail).

Table 2. Percent brown leaf coverage of cool-season turfgrasses when irrigated at 74% CIMIS reference evapotranspiration (ETo) from May 10 to August 7, 2009 in Riverside, Calif.

Treatment	July 6	July 18	Aug. 1	Overall
		Study I[1]		
Festulolium				
B7.1143	42 a[2]	46 b	29 ab	39 b
B7.1142	46 a	60 a	35 a	47 a
Tall fescue				
6.0891	14 b	18 cd	16 c	16 c
7.0534	17 b	14 d	16 c	16 c
7.0536	14 b	19 cd	18 c	17 c
6.1534	14 b	21 cd	17 c	17 c
5.0541	16 b	19 cd	17 c	18 c
6.1657	19 b	20 cd	19 c	19 c
7.0537	15 b	24 cd	20 c	20 c
7.0535	22 b	20 cd	18 c	20 c
6.0726	18 b	22 cd	23 bc	21 c
Fawn	18 b	27 c	22 bc	22 c
		Study II[3]		
Scotts Landscapers' Mix[4]	18 b	25 a	18 a	20 c
Pennington tall fescue	22 b	26 a	26 a	24 bc
Pennington Sun/Shade[5]	42 a	43 a	28 a	38 ab
Scotts Traffic Mix[6]	50 a	45 a	33 a	43 a

Each of the 12 turfgrass treatments were grown in six replicate, 5.0- x 5.0- ft plots (cells 3, 4, 8, 9, 11, 12; see plot plan).

[2] Means within the same study and column followed by the same letter are not significantly different, Fisher's protected LSD test, *P*=0.05.

[3] Each of the four turfgrass treatments were grown in three replicate, 10.0- x 10.0- ft. plots (cells 2, 5, 7; see plot plan).

[4] Seed mixture was 88% tall fescue and 10% annual ryegrass (see plot plan for more detail).

[5] Seed mixture was 49% perennial ryegrass, 20% Kentucky bluegrass, 15% creeping red fescue, and 15% chewings fescue (see plot plan for more detail).

[6] Seed mixture was 74% perennial ryegrass and 25% Kentucky bluegrass (see plot plan for more detail).