Evaluation of Turfgrasses and a Ground Cover Under Drought and Extreme Deficit Irrigation

Nineteen turfgrass species/cultivars and one ground cover received on 40% ETo during the summer of 2012. Which ones survived?

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The Bottom Line: Under extreme deficit irrigation (40% ETo) and minimal natural precipitation during 2012 in Riverside, the ground cover Kurapia and warm-season turfgrass species Kikuyugrass and buffalograss performed the best in terms of color and quality. The cool-season turfgrass species were most severely impacted by water stress, resulting in significant turf loss and/or dormancy. Perennial ryegrass appeared to survive the best among the cool-season turfgrasses under the conditions of our study. Overall, these results demonstrate the benefits of using alternative species such as ground covers or warm-season turfgrasses in warm, inland climates like Riverside or when water use is severely restricted.

Introduction:

Turfgrass is a key component of urban landscapes. In Southern California, recent estimates have suggested 41% of urbanized lands are covered with turfgrass. Throughout the United States, turfgrass is the predominant irrigated crop species. Climate change resulting in increasing temperature and drought coupled with diminishing water resources offer the greatest potential for severely impacting turfgrass and landscape use. Hopefully landscape water restrictions in California will never become as severe as in this study; however, we wanted to evaluate how the major cool- and warm-season turfgrasses species are affected by drought and extreme deficit irrigation. Furthermore, we compared turfgrass performance to a low-growing ground cover 'Kurapia' (*Lippia nodiflora* L.) that was selected and developed in Japan for drought tolerance among other characteristics.

Location:	UCR Turfgrass Research Facility, Riverside, CA
Soil:	Hanford fine sandy loam
Experimental Design:	Randomized complete block with 3 replications
Plot Size:	6 ft by 10 ft
Establishment:	Turf was established by sod or plugs (buffalograss) were in July and August 2008; A-4 bentgrass, Chaparral perennial ryegrass, Tifdwarf bermudagrass, and Whittet zoysiagrass were sodded in spring of 2010; Kurapia established from plugs in spring 2011
Fertility:	2 to 4 lbs N/1000 ft^2/yr prior to June 2012; no fertilizer applied thereafter
Irrigation:	Prior to June 2012, all turfgrasses and ground cover were subjected to deficit irrigation (water stress) based on a percentage of the previous week's reference evapotranspiration (60% ET_o). Hand watering was used to maintain uniform and accurate irrigation distribution. Automatic irrigation treatment began on June 1, 2012 with 40% Eto scheduled using daily ETo estimates calculated by an on-site California Irrigation Management Information System (CIMIS) automated weather station. Rainfall of 0.1 inches or more per day was subtracted from ETo. When the accumulated ETo equaled 2.5 inches, irrigation of 1.0 inch was applied to the entire area.
Data Collected:	Monthly color and quality ratings (1 to 9, 9 = best; 6 = minimally acceptable)

Commercial Variety/Species	**Variety/Composition**	**Origin/Producer**	**Mowing Height**
Hillside Fine Fescue	'Florentine GT' Strong Creeping Red Fescue, 'Seabreeze GT' Slender Creeping Red Fescue, and 'Tiffany' Chewings Fescue.	Sod from West Coast Turf	Mow once/yr
Chaparral Perennial Ryegrass	Unstated varietal blend	Sod from West Coast Turf	2.5" rotary
Creeping Bentgrass	A-4	Sod from West Coast Turf	0.75" reel
Bayside Blend Kentucky Bluegrass and Perennial Ryegrass	Unstated varietal mixture; 80% KB/20% PR	Sod from West Coast Turf	2.5" rotary
West Coaster Tall Fescue	Unstated varietal blend	Sod from West Coast Turf	2.5" rotary
Medallion Tall Fescue	Unstated varietal blend	Sod from Pacific Sod	2.5" rotary
Elite Plus Tall Fescue and Kentucky Bluegrass	Unstated varietal mixture	Sod from A-G Sod	2.5" rotary
Tifway 419 Hybrid Bermuda	Tifway 419	Sod from West Coast Turf	1.25" reel
Tifsport Hybrid Bermuda	Tifsport	Sod from West Coast Turf	1.25" reel
Tifdwarf Hybrid Bermuda	Tifdwarf	Sod from West Coast Turf	0.75" reel
Tifgreen 328 Hybrid Bermuda	Tifgreen 328	Sod from A-G Sod	0.75" reel
El Toro Zoysiagrass	El Toro	Sod from Southland Sod	1.25" reel
De Anza Zoysiagrass	De Anza	Sod from West Coast Turf	1.25" reel
Palmetto St. Augustinegrass	Palmetto	Sod from West Coast Turf	2.5" rotary
Common St. Augustinegrass	Variety unknown	Sod from Southland Sod	2.5" rotary
UC Verde Buffalograss	UC Verde	Plugs from Florasource	2.5" rotary
Excalibre Seashore Paspalum	Excalibre	Sod from Pacific Sod	1.25" reel
Sea Spray Seashore Paspalum	Sea Spray	Sod from West Coast Turf	1.25" reel
Kurapia	*Lippia nodiflora* L.	Kurapia Inc. www.kurapia.com	No mowing
Kikuyugrass	Whittet	Sod from Emerald Sod	1.25" reel

Table 1. CIMIS data collected during the deficit irrigation experiment. Riverside, CA.
Source: www.cimis.water.ca.gov/

California Irrigation Management Information System
Department of Water Resources
Office of Water Use Efficiency
Rendered in ENGLISH units
May 1, 2012 - November 30, 2012
Printed on December 1, 2012

Los Angeles Basin - U.C. Riverside - 44

Date	Tot ETo (in)	Tot Precip (in)	Avg Sol Rad (Ly/Day)	Avg Vap Pres (mBars)	Avg Max Air Tmp (F)	Avg Min Air Tmp (F)	Avg Air Tmp (F)	Avg Max Rel Hum (%)	Avg Min Rel Hum (%)	Avg Rel Hum (%)	Avg Dew Point (F)	Avg Wind Speed (mph)	Avg Soil Temp (F)
May 2012	7.00 K	0.04 K	636	11.7 K	80.7	54.8	66.4 K	78 K	32 K	54	48.6	4.3 K	68.5 K
Jun 2012	7.62	0.00	717	12.5 K	84.8	57.0	69.2	76	29	52 K	50.2 K	4.6 K	72.0
Jul 2012	7.93	0.07	670	13.7	89.7	61.6 K	74.4	73	27	48	52.7	4.3 K	74.5
Aug 2012	7.83	0.18	604	15.0	95.2	68.0 K	80.3	65	26	43	55.2	4.1 K	77.3
Sep 2012	6.44 K	0.01 K	522 K	12.7	93.6	63.8 K	78.2	63	22	39	50.2	3.9 K	75.3
Oct 2012	4.38	0.17	407 K	10.9	82.0 K	56.7 K	68.2 K	68 K	29 K	48	45.3	3.7 K	66.5
Nov 2012	2.72	0.38 K	296 K	8.9 K	73.7 K	49.6 K	60.2 K	71 K	31 K	51 K	39.7 K	3.3 K	58.7 K
Totals	43.92	0.85	550	12.2	85.7	58.8	71.0	71	28	48	48.8	4.0	70.4

Flag Legend

M - All Daily Values Missing	K - One or More Daily Values Flagged
J - One or More Daily Values Missing	L - Missing and Flagged Daily Values

Table 2. Mean monthly color ratings (1 to 9, 9 = darkest green; 6 = minimally acceptable; 1 = brown) of turfgrasses and ground cover following reduction in irrigation from 60 to 40%[1] ETo on June 1 for the remainder of the 2012 season. Riverside, CA.

Name	**5/31/12**	**6/29/12**	**7/31/12**	**8/31/12**	**9/28/12**	**10/31/12**
'Tifsport' Bermudagrass	6.7 bcd[2]	5.3 ab	2.7 d-g	3.3 def	2.7 cde	3.7 b
'Chaparral' Perennial Ryegrass	7.0 abc	2.7 cde	1.7 fg	2.7 e-h	3.7 abc	5.0 a
'Palmetto' St. Augustine	6.3 bcd	6.0 a	3.0 c-f	2.3 fgh	3.3 bcd	3.3 bc
'Whittet' Kikuyugrass	6.0 cd	4.3 abc	4.7 ab	5.0 ab	4.7 a	4.0 ab
'Sea Spray' Seashore Paspalum	6.3 bcd	4.0 bc	2.3 efg	4.0 bcd	3.3 bcd	3.7 b
'Tifway 419' Bermudagrass	6.7 bcd	6.0 a	2.3 efg	3.0 d-g	2.0 ef	3.3 bc
'De Anza' Zoysiagrass	6.3 bcd	4.0 bc	2.3 efg	3.7 cde	2.3 de	3.3 bc
'Tifgreen 328' Bermudagrass	6.0 cd	3.7 bcd	1.7 fg	2.3 fgh	2.0 ef	2.0 de
'Bayside Blend' Kentucky Bluegrass/Perennial Ryegrass	6.7 bcd	2.0 de	1.3 g	1.7 hi	2.0 ef	2.3 cde
'Hillside' Fine Fescue	8.0 a	5.3 ab	3.3 b-e	2.0 ghi	2.3 de	3.3 bc
'West Coaster' Tall Fescue	7.3 ab	1.3 e	1.7 fg	2.0 ghi	2.3 de	4.0 ab
'UC Verde' Buffalograss	6.0 cd	6.0 a	4.3 abc	2.7 e-h	4.7 a	3.0 bcd
'El Toro' Zoysiagrass	6.0 cd	5.3 ab	4.0 bcd	4.7 abc	2.7 cde	4.0 ab
'A-4' Creeping Bentgrass	3.7 e	1.0 e	1.7 fg	1.0 i	1.0 f	1.7 e
Common St. Augustinegrass	6.3 bcd	4.0 bc	3.3 b-e	2.0 ghi	4.0 ab	4.0 ab
'Tifdwarf' Bermudagrass	6.0 cd	3.3 cd	1.7 fg	2.7 e-h	2.0 ef	2.0 de
'Excalibre' Seashore Paspalum	6.7 bcd	3.3 cd	2.0 efg	3.3 def	3.0 b-e	3.7 b
'Medallion' Tall Fescue	6.3 bcd	1.3 e	2.0 efg	2.0 ghi	3.3 bcd	4.0 ab
Kurapia (*Lippia nodiflora* L.)	5.7 d	6.0 a	5.7 a	5.3 a	4.0 ab	3.7 b
'Elite Plus' Tall Fescue/ Kentucky Bluegrass	6.0 cd	1.0 e	1.7 fg	2.0 ghi	3.0 b-e	3.3 bc
LSD (P= 0.05)[3]	**1.0**	**1.7**	**1.4**	**1.0**	**1.2**	**1.2**

[1]One inch of irrigation was scheduled when cumulative ETo reached 2.5 inches.
[2]Means followed by the same letter in a column are not significantly different.
[3]Least Significant Difference. If the difference between any two means in a column is > LSD, then there is a 95% probability that the difference is related to differences in turfgrass species/cultivar or ground cover.

Table 3. Mean monthly quality ratings (1 to 9, 9 = best; 6 = minimally acceptable; 1 =dead or dormant) of turfgrasses and ground cover following reduction in irrigation from 60 to 40%[1] ETo on June 1 for the remainder of the 2012 season. Riverside, CA.

Name	**5/31/12**	**6/29/12**	**7/31/12**	**8/31/12**	**9/28/12**	**10/31/12**
'Tifsport' Bermudagrass	7.0 a[2]	5.7 ab	3.7 bcd	2.7 de	2.0 c-f	3.0 cd
'Chaparral' Perennial Ryegrass	7.0 a	3.0 de	1.3 fg	2.0 efg	2.3 cde	3.3 bc
'Palmetto' St. Augustine	6.0 b	6.0 a	3.3 cde	2.0 efg	3.0 bc	3.3 bc
'Whittet' Kikuyugrass	6.0 b	5.0 abc	5.0 ab	4.3 ab	4.3 a	4.7 a
'Sea Spray' Seashore Paspalum	6.7 ab	5.0 abc	2.7 def	3.3 cd	2.7 cd	3.3 bc
'Tifway 419' Bermudagrass	7.0 a	6.0 a	2.7 def	2.3 ef	2.3 cde	3.0 cd
'De Anza' Zoysiagrass	6.3 ab	4.7 abc	2.7 def	2.7 de	2.3 cde	2.7 cde
'Tifgreen 328' Bermudagrass	6.7 ab	4.0 cd	2.0 efg	1.7 fgh	1.3 ef	1.7 ef
'Bayside Blend' Kentucky Bluegrass/Perennial Ryegrass	6.7 ab	2.0 e	1.0 g	1.0 h	1.0 f	1.3 f
'Hillside' Fine Fescue	7.0 a	5.0 abc	2.7 def	1.7 fgh	1.7 def	2.0 def
'West Coaster' Tall Fescue	6.3 ab	2.0 e	1.0 g	1.0 h	1.7 def	3.0 cd
'UC Verde' Buffalograss	6.0 b	6.0 a	4.3 abc	3.3 cd	4.7 a	4.7 a
'El Toro' Zoysiagrass	7.0 a	5.7 ab	4.3 abc	3.7 cd	2.3 cde	3.7 abc
'A-4' Creeping Bentgrass	4.3 c	2.0 e	1.0 g	1.0 h	1.0 f	1.0 f
Common St. Augustinegrass	6.0 b	4.3 bcd	3.3 cde	2.3 ef	3.0 bc	3.7 abc
'Tifdwarf' Bermudagrass	7.0 a	4.3 bcd	2.0 efg	2.0 efg	1.7 def	1.3 f
'Excalibre' Seashore Paspalum	7.0 a	4.3 bcd	1.7 fg	2.7 de	2.3 cde	3.7 abc
'Medallion' Tall Fescue	6.3 ab	2.0 e	1.0 g	1.3 gh	2.0 c-f	3.0 cd
Kurapia (*Lippia nodiflora* L.)	6.0 b	5.7 ab	5.3 a	5.0 a	4.0 ab	4.3 ab
'Elite Plus' Tall Fescue/ Kentucky Bluegrass	6.0 b	2.0	1.0 g	1.0 h	1.7 def	2.0 def
LSD (P= 0.05)[3]	**0.9**	**1.6**	**1.4**	**0.82**	**1.1**	**1.2**

[1]One inch of irrigation was scheduled when cumulative ETo reached 2.5 inches.
[2]Means followed by the same letter in a column are not significantly different.
[3]Least Significant Difference. If the difference between any two means in a column is > LSD, then there is a 95% probability that the difference is related to differences in turfgrass species/cultivar or ground cover.

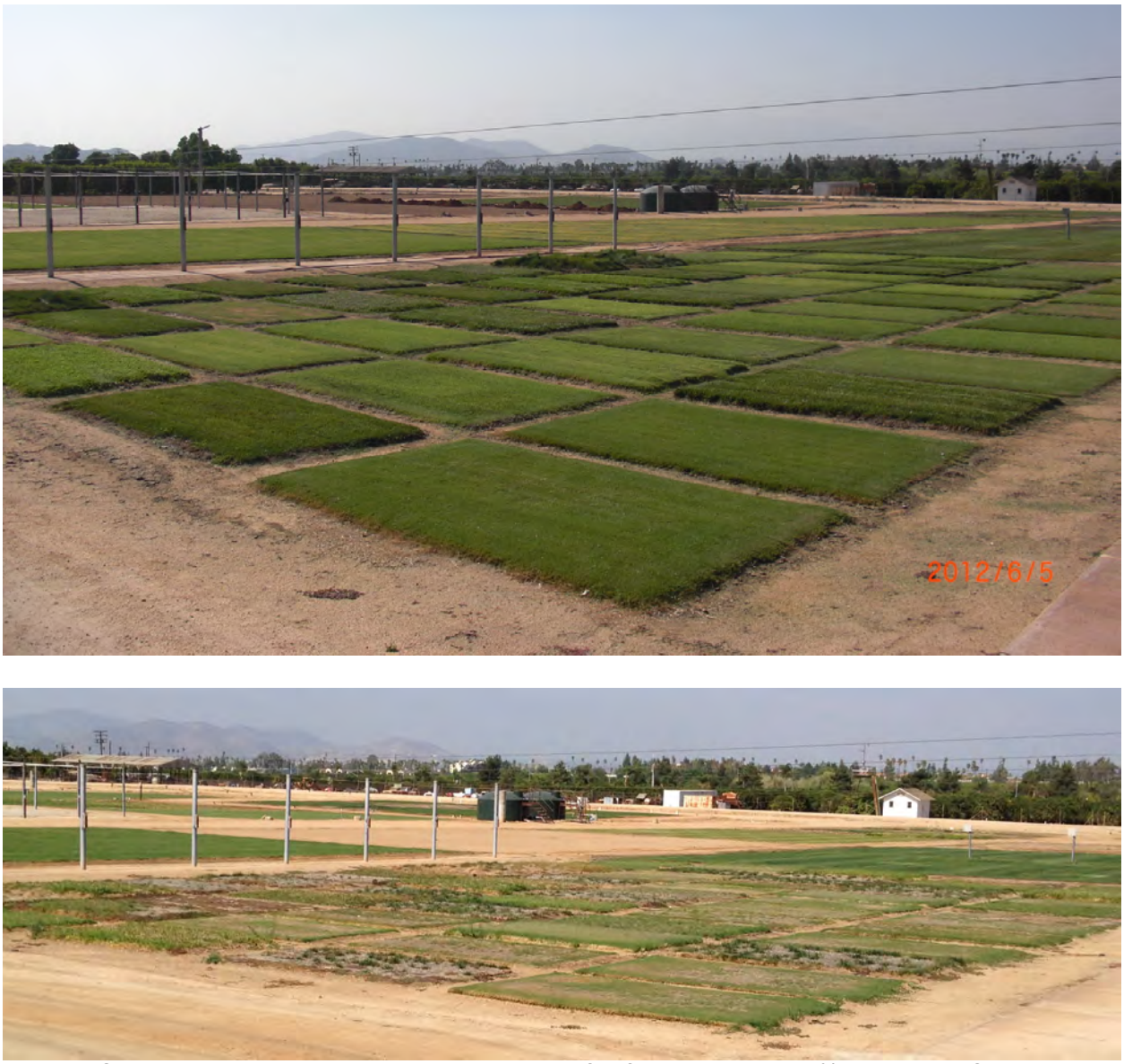

Figure 1. Study area in June 2012 (above) at the start of deficit irrigation at 40% ETo and in October 2012 (below) five months later. Riverside, CA.

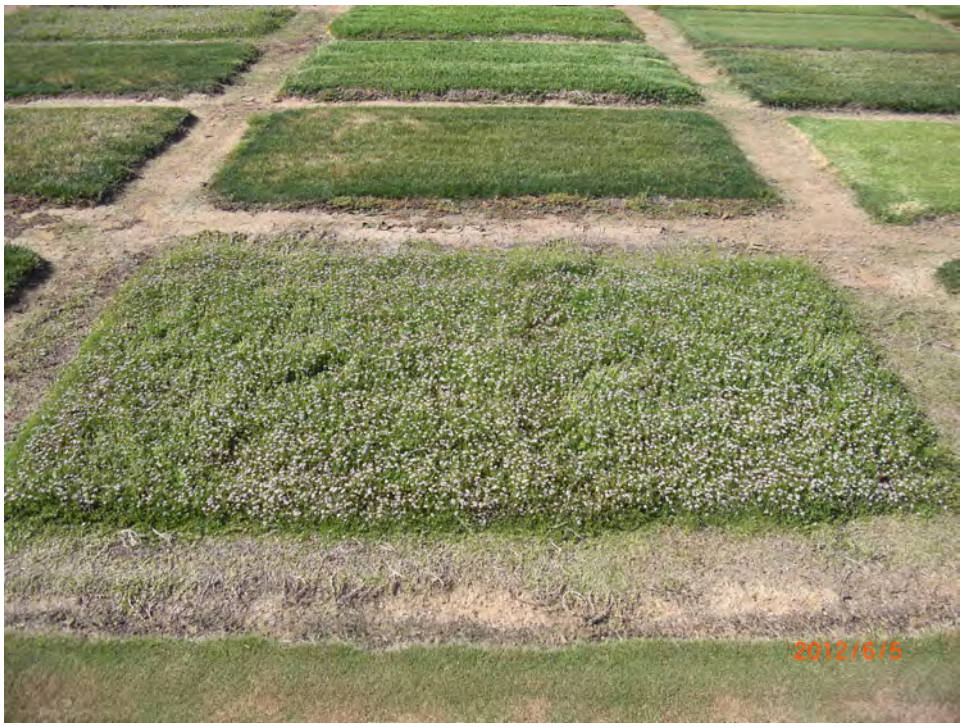

Figure 2. Close-up of study area in June 2012 (above) at the start of deficit irrigation at 40% ETo and in October 2012 (below) five months later. Riverside, CA. From bottom center plot to top: Kurapia, Chaparral perennial ryegrass, common St. Augustinegrass.