Welcome to Field Day!

On behalf of the entire UCR Turfgrass and Landscape Team, I'd like to welcome you to the 2008 UCR Turfgrass and Landscape Research Field Day. Although it has been five years since our last event, you should be pleased to know that future Field Day programs will take place annually on the first Thursday after Labor Day. Although there are many excellent opportunities for Continuing Education throughout the State, we hope that UCR Field Day will become an annual ritual for you, your staff, and colleagues.

By the end of the day, I think you will agree that our programs are headed in the right direction in terms of striving to meet both the short- and long-term challenges facing the turfgrass and landscape industries. I am most proud of the teamwork and trans-disciplinary approach to Turfgrass and Landscape Management exhibited by UCR faculty, staff, and students. Scientists who are leaders in their respective fields are coming together to lend their expertise toward the advancement of scientific knowledge in our arenas.

As we come together as a Green Industry to see and hear about the latest research, let's be mindful of the importance of strengthening and consolidating industry resources for continued support at the University of California. With your help, the best is yet to come!

As you enjoy today's tours, please take a moment to thank those folks wearing the green shirts with our new Turfgrass Science logo. They have worked tirelessly to make this event possible and are deserved of your appreciation.

Enjoy the day, the sharing of experiences and information, and the *Growing* of turf and landscape plants California!

James H. Baird, Ph.D.
Assistant Specialist in Cooperative Extension and Turfgrass Science

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- California Golf Course Superintendents Association
- California Sod Producers Association
- Coachella Valley Association of Governments
- Coachella Valley Water District
- Golf Course Superintendents Association of Southern California
- Hi-Lo Desert Golf Course Superintendents Association
- San Diego Golf Course Superintendents Association
- South Coast Air Quality Management District
- Southern California Golf Association
- Southern California Section, Professional Golfers' Association of America
- Southern California Turfgrass Council
- Southern California Turfgrass Foundation
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- University of California, Riverside Extension – Natural Resources
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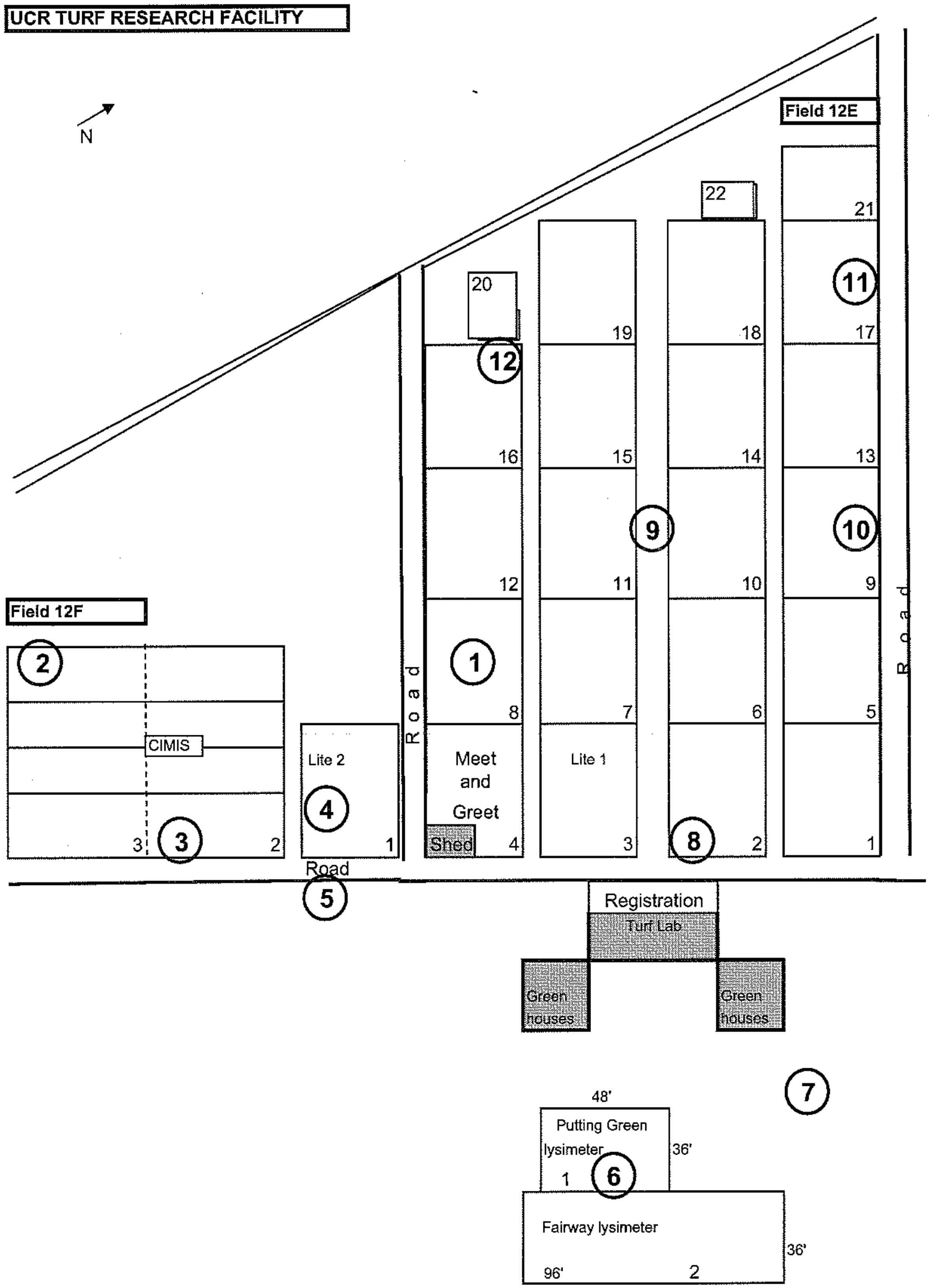

UCR TURF RESEARCH FACILITY
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Meet and Greet
Shed
Registration
Turf Lab
Green houses
Green houses
48'
Putting Green lysimeter
36'
Fairway lysimeter
36'
96'

Turfgrass and Landscape Research Field Day

FIELD DAY SCHEDULE AND TABLE OF CONTENTS

An Evaluation of Grasses Under Low-Input, Reduced Maintenance Conditions, for Potential Turfgrass Use in California

Victor A. Gibeault, Emeritus, Botany and Plant Sciences Department; Stephen T. Cockerham, Superintendent, UC Riverside Agricultural Operations; Steven B. Ries, Staff Research Associate, Agricultural Operations; and Richard Autio, retired, Botany and Plant Sciences Department.

A low maintenance turfgrass study was established on May 28-29, 2003, at the University of California, Riverside, Turfgrass Research Facility. It was the objective of the study to evaluate the relative turfgrass performance of grasses under low water- and low nutritional inputs. The 24 grasses included traditional low maintenance warm- and cool-season turfgrasses; experimental traditional turfgrasses; and warm and cool-season plains states native grasses. The 24 grasses examined are listed on the attached study plot plan.

The grasses were allowed to "grow-in" during 2003. Deficit irrigation (irrigation below water needed for optimum performance) for warm-season turfgrasses was initiated in 2004 and continued through the end of 2006. The irrigation level was approximately 50% of the California Irrigation Management Information System (CIMIS) reference evapotranspiration (ETo). Fertilization was restricted to fall applications that normally totaled 1.0 pound of N per 1000 sq.ft per year. The plots were mowed weekly at a three inch height until September, 2005, when the plots were split to a high cut (3.0") and low cut (1.25").

On December 31, 2006, the formal study concluded, but the low maintenance regimes of the study were continued to the present time. Because of drought and high temperature conditions in 2007/2008 additional separation of relative grass performance was noted. Grass cover and turfgrass quality ratings were made October, 2007, and again in June, 2008. A 1-10 rating scale was used, with 10 representing best cover or quality. Tables 1-4, attached, are of a preliminary nature, for information only at this 2008 UC Riverside Turfgrass Field Day, and are not intended for further publication at this time.

The grasses that should be noted for higher performance results under low input maintenance practices and presented in Tables 1-4 include: Buffalograsss (all cultivars and experimental grasses), *Zoysia tenuifolia*, Saltgrasses (A 138, DT 18), Sporobolis (DT12), Blue Grama (Hatchita), and Bermudagrass (Princess). Other grasses gave various lower levels of performance and some of the grasses could not survive the severe maintenance regime for the duration of the study.

Table 1. Grass Quality (range 1-10 with 10 being best) for the "whole study". Average of High and Low cut; high mowing height; and low mowing height. October, 2007.

Note: Preliminary (Not for reproduction)

Grass	**Whole Study (Average of High & Low)**	**High Mowing Height**	**Low Mowing Height**
Hybrid Texas bluegrass (HB342)	2.000 CDEF	2.333 BCDEF	1.667 CD
Zoysia tenuifolia	3.667 AB	3.667 AB	3.667 AB
Hard Fescue	1.000 F	1.000 F	1.000 D
Canada bluegrass	1.000 F	1.000 F	1.000 D
Seashore Paspalum	1.333 DEF	1.333 EF	1.333 CD
Crested hairgrass (Barkoel)	1.667 CDEF	1.333 EF	2.000 CD
Russian wildrye (Bozoisky)	1.500 DEF	1.667 DEF	1.333 CD
Blue grama (Alma)	1.000 F	1.000 F	1.000 D
Blue grama (Hatchita)	2.833 BC	3.333 ABC	2.333 BCD
Buffalograss (SWI 2000)	1.667 CDEF	1.667 DEF	1.667 CD
Sideoats grama	1.500 DEF	1.667 DEF	1.333 CD
Bermudagrass (Sahara)	2.167 DEF	2.000 CDEF	2.333 BCD
Bermudagrass (Princess)	2.500 CD	2.667 BCDE	2.333 BCD
Saltgrass (A 137)	1.167 EF	1.333 EF	1.000 D
Saltgrass (A 138)	1.833 CDEF	2.000 CDEF	1.667 CD
Buffalograss (UC Verde)	4.833 A	4.667 A	5.000 A
Buffalograss (Legacy)	2.333 CDE	2.333 BCDEF	2.333 BCD
Buffalograss (Cody)	1.500 DEF	1.333 EF	1.667 CD
Zoysiagrass (De Anza)	1.000 F	1.000 F	1.000 D
Zoysiagrass (Zenith)	1.333 DEF	1.333 EF	1.333 CD
Spike Muhly	1.667 CDEF	1.667 DEF	1.667 CD
Saltgrass (DT18)	2.000 CDEF	1.667 DEF	2.333 BCD
Sporobolis (DT12)	2.833 BC	3.000 BCD	2.667 BC
Saltgrass (DT16)	1.833 CDEF	2.333 BCDEF	1.333 CD

Note: Data followed by the same letter(s) not significantly different.

Table 2. Grass Cover (range 1-10 with 10 best) for the "whole study" which is Average of High and Low cut; high mowing height; and low mowing height. October, 2007.

Note: Preliminary (Not for reproduction)

Grass	Whole Study (Average of High & Low)	High Mowing Height	Low Mowing Height
Hybrid Texas bluegrass (HB342)	3.667 CDEFG	4.333 BCDEF	3.000 CDE
Zoysia tenuifolia	6.667 AB	6.667 AB	6.667 AB
Hard Fescue	2.000 DEFG	2.333 EFG	1.667 DE
Canada bluegrass	1.833 EFG	2.000 EFG	1.667 DE
Seashore Paspalum	2.167 DEFG	2.000 EFG	2.333 CDE
Crested hairgrass (Barkoel)	2.667 DEFG	2.667 DEFG	2.667 CDE
Russian wildrye (Bozoisky)	2.333 DEFG	3.000 CDEFG	1.667 DE
Blue grama (Alma)	1.500 G	2.000 EFG	1.000 E
Blue grama (Hatchita)	5.500 BC	6.000 ABC	5.000 BC
Buffalograss (SWI 2000)	3.167 CDEFG	2.333 EFG	4.000 BCDE
Sideoats grama	2.667 DEFG	3.000 CDEFG	2.333 CDE
Bermudagrass (Sahara)	4.167 BCDEF	4.333 BCDEF	4.000 BCDE
Bermudagrass (Princess)	4.333 BCDE	5.667 ABCD	3.000 CDE
Saltgrass (A 137)	2.167 DEFG	2.667 DEFG	1.667 DE
Saltgrass (A 138)	2.833 CDEFG	3.333 CDEFG	2.333 CDE
Buffalograss (UC Verde)	8.833 A	8.667 A	9.000 A
Buffalograss (Legacy)	4.167 BCDEF	4.667 BCDEF	3.667 BCDE
Buffalograss (Cody)	2.833 CDEFG	2.667 DEFG	3.000 CDE
Zoysiagrass (De Anza)	1.000 G	1.000 G	1.000 E
Zoysiagrass (Zenith)	1.667 EFG	1.667 FG	1.667 DE
Spike Muhly	2.667 DEFG	3.333 CDEFG	2.333 CDE
Saltgrass (DT18)	3.000 CDEFG	2.667 DEFG	3.333 CDE
Sporobolis (DT12)	4.667 BCD	5.000 BCDE	4.333 BCD
Saltgrass (DT16)	3.000 CDEFG	3.333 CDEFG	2.667 CDE

Note: Data followed by the same letter(s) not significantly different.

Table 3. Grass Quality (range 1-10 with 10 best) for the "whole study" which is Average of High and Low cut; high mowing height; high mowing height and low mowing height. June, 2008.

Note: Preliminary (Not for reproduction)

Grass	Whole Study (Average of High & Low)	High Mowing Height	Low Mowing Height
Hybrid Texas bluegrass (HB342)	2.000 DEFGH	2.333 CDEF	1.667 CDE
Zoysia tenuifolia	4.500 AB	4.667 AB	4.333 AB
Hard Fescue	1.833 EFGH	2.333 CDEF	1.333D
Canada bluegrass	1.600 FGH	1.000 F	2.000 CDE
Seashore Paspalum	1.500 FGH	1.000 F	1.667 CDE
Crested hairgrass (Barkoel)	2.667 CDEF	2.000 DEF	3.333 ABCD
Russian wildrye (Bozoisky)	2.333 CDEFGH	2.333 CDEF	2.333 BCDE
Blue grama (Alma)	1.500 FGH	2.000 DEF	1.000 E
Blue grama (Hatchita)	3.333 BCD	3.667 ABC	3.000 ABCDE
Buffalograss (SWI 2000)	3.333 BCD	3.333 BCD	3.333 ABCD
Sideoats grama	2.833 CDEF	3.000 CD	2.667 BCDE
Bermudagrass (Sahara)	2.333 CDEFGH	2.333 CDEF	2.333 BCDE
Bermudagrass (Princess)	3.167 BCDE	3.667 ABC	2.667 BCDE
Saltgrass (A 137)	2.333 CDEFGH	2.333 CDEF	2.333 BCDE
Saltgrass (A 138)	3.167 BCDE	3.333 BCD	3.000 ABCDE
Buffalograss (UC Verde)	5.000 A	5.000 A	5.000 A
Buffalograss (Legacy)	3.667 ABC	3.667 ABC	3.667 ABC
Buffalograss (Cody)	3.167 BCDE	3.667 ABC	2.667 BCDE
Zoysiagrass (De Anza)	1.333 GH	1.000 F	1.000 E
Zoysiagrass (Zenith)	1.000 H	1.333 EF	1.333 DE
Spike Muhly	2.000 DEFGH	2.333 CDEF	1.667 CDE
Saltgrass (DT18)	2.833 CDEF	2.667 CDE	3.000 ABCDE
Sporobolis (DT12)	3.333 BCD	3.333 BCD	3.333 ABCD
Saltgrass (DT16)	2.500 CDEFG	3.000 BC	2.000 CDE

Note: Data followed by the same letter(s) not significantly different.

Table 4. Grass Cover (range 1-10 with 10 best) for the "whole study" which is Average of High and Low cut; high mowing height; and low mowing height. June, 2008.

Note: Preliminary (Not for reproduction)

Grass	Whole Study (Average of High & Low)	High Mowing Height	Low Mowing Height
Hybrid Texas bluegrass (HB342)	3.167 EFG	3.333 FGHIJ	3.000 CDEF
Zoysia tenuifolia	6.000 ABCDE	8.000 ABC	4.000 BCDEF
Hard Fescue	2.833 FG	4.000 EFGHIJ	1.667 EF
Canada bluegrass	2.600 FG	1.000 J	3.667 CDEF
Seashore Paspalum	1.500 FG	1.000 J	1.667 EF
Crested hairgrass (Barkoel)	4.333 CDEF	2.667 HIJ	6.000 ABC
Russian wildrye (Bozoisky)	3.167 EFG	3.667 EFGHIJ	2.667 CDEF
Blue grama (Alma)	2.000 FG	3.000 GHIJ	1.000 F
Blue grama (Hatchita)	6.000 ABCDE	6.333 ABCDEF	5.667 ABCD
Buffalograss (SWI 2000)	7.000 ABC	6.333 ABCDEF	7.667 AB
Sideoats grama	5.833 BCDE	6.000 ABCDEFG	5.667 ABCD
Bermudagrass (Sahara)	3.833 DEFG	5.000 CDEFGHI	2.667 CDEF
Bermudagrass (Princess)	6.833 ABC	8.333 AB	5.333 ABCDE
Saltgrass (A 137)	3.667 DEFG	4.000 EFGHIJ	3.333 CDEF
Saltgrass (A 138)	6.167 ABCD	6.667 ABCDE	5.667 ABCD
Buffalograss (UC Verde)	8.833 A	9.000 A	8.667 A
Buffalograss (Legacy)	8.000 AB	8.000 ABC	8.000 A
Buffalograss (Cody)	6.333 ABCD	7.333 ABCD	5.333 ABCDE
Zoysiagrass (De Anza)	1.000 G	1.000 J	1.000 F
Zoysiagrass (Zenith)	2.000 FG	2.000 IJ	2.000 DEF
Spike Muhly	3.833 DEFG	4.667 DEFGHI	3.000 CDEF
Saltgrass (DT18)	6.000 ABCDE	5.667 BCDEFG	6.333 ABC
Sporobolis (DT12)	6.833 ABC	8.000 ABC	5.667 ABCD
Saltgrass (DT16)	4.167 CDEF	5.000 CDEFGHI	3.333 CDEF

Note: Data followed by the same letter(s) not significantly different.

Control of *Rhizoctonia* Diseases on Turfgrass

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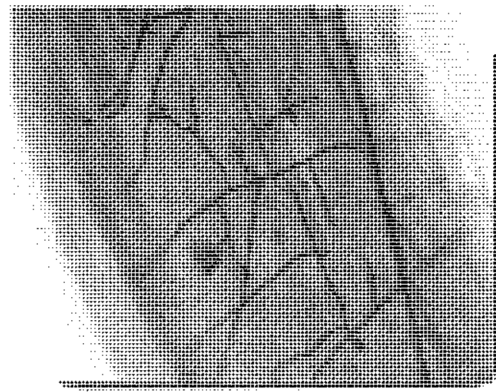
www.turfpathology.ucr.edu



Rhizoctonia diseases are collectively the largest group affecting sports and landscape turf worldwide. *Rhizoctonia* fungi have mycelia with 90° branching angles without spores but can be divided up into different species based on their rarely found sexual, sporulating state. Different species of *Rhizoctonia* cause different diseases depending on host and environmental conditions.

Disease	**Teleomorph Name (Sexual State)**	**Anamorph name (Asexual State)**	**Optimal Temp. Range***	**Typical hosts**
Yellow Patch	*Ceratobasidium cereale*	*Rhizoctonia cerealis*	50-65°F	Annual Bluegrass, Creeping Bentgrass, Bermudagrass, Kentucky Bluegrass, Tall Fescue, Perennial Ryegrass, Zoysiagrass
Brown Patch of Cool Season Turf	*Thanatephorus cucumeris*	*Rhizoctonia solani*	77-90°F	All cool season species
Brown Patch of Warm Season Turf (Large Patch)	*Thanatephorus cucumeris*	*Rhizoctonia solani*	60-77°F	All warm season species
Sheath and Leaf Spot	*Waitea circinata* var *oryzae*	*Rhizoctonia oryzae*	83-97°F	Annual Bluegrass, Creeping Bentgrass, Bermudagrass, Centipedegrass, Kentucky Bluegrass, Tall Fescue, Perennial Ryegrass, St. Augustine, Zoysiagrass
	Waitea circinata var *zeae*	*Rhizoctonia zeae*	83-97°F	
Brown Ring Patch, Waitea Patch	*Waitea circinata* var *circinata*	none	77-86°F	Annual Bluegrass, Creeping Bentgrass, Rough Bluegrass

* typical max. daytime temp. disease is most active at

Fungicides Under Evaluation on 2008 Trials

Fungicide	Class	Ingredient(s)
Clearys 3336 4F	benzimidazole	thiophanate-methyl
Humabalance	biological	Bacillus spp.
Rhapsody 0.1AS	biological	Bacillus spp.
Prostar 70WG	carboximide	flutolanil
Daconil Ultrex 82.5WG	multi-site	chlorothalonil
Chipco 26 GT 2SC	dicarboximide	iprodione
Banner MAXX 1.3ME	DMI	propiconazole
Tourney 50WG	DMI	metconazole
Trinity 1.69SC	DMI	triticonazole
Triton Flo 3.1SC	DMI	triticonazole
26/36 3.8SC	mixture	iprodione + thiophanate-methyl
Concert 4.3SE	mixture	propiconazole + chlorothalonil
Headway 1.39EC	mixture	azoxystrobin + propiconazle
Instrata 3.61SE	mixture	fludioxonil+propiconazole + chlorothalonil
Renown 5.16SC	mixture	azoxystrobin + chlorothalonil
Tartan 2.4SC	mixture	trifloxystrobin + triadimefon
Medallion 50WP	phenylpyrrole	fludioxonil
Endorse 2.5WP	polyoxin	polyoxin-D
Disarm 480SC	Qoi	fluoxastrobin
Heritage 50WG	Qoi	azoxystrobin
Heritage TL 0.8ME	Qoi	azoxystrobin

USDA-ARS U.S. Salinity Laboratory Turf Research

D.L. Suarez, C.M. Grieve, P.J. Shouse, D.L. Corwin and S.M. Lesch
USDA-ARS U.S. Salinity Laboratory
Riverside, CA

The Salinity Laboratory is a national research laboratory of the Agricultural Research Service located on the University of California Riverside campus. The mission of the laboratory is to conduct research dedicated to the solution of problems of crop production of lands, water reuse for irrigation and of degradation of associated surface and ground water resources with salts, pesticides or pathogens. The Water Reuse Unit has as its objective to develop management practices and technologies to sustain irrigation with saline and recycled waters. The following two programs relate to turfgrass:

1) Determination of plant response to salinity including ,salt tolerance, physiological response (growth and biochemical indicators). Current research includes examination of the salt tolerance of six cultivars of Kentucky bluegrass (*Poa pratensis L*), selections previously screened for drought tolerance at Rutgers University. Based on both absolute biomass production and relative production as related to salinity (indicative of overall plant health) the salt tolerance ranking was Baron>Brilliant>Eagleton>Cabernet=Midnight>A01-856, a reversal of the established drought tolerance. Shown in Figure 1 is plant response when irrigated with EC=14 dS/m water in our sand tank facility. Additional research has been conducted on ion relations, nutrient ion concentrations, and remote sensing (hyperspectral scanning).

2) Development of salinity sensing technology and management practices for irrigation with saline and recycled water. The Salinity Laboratory has developed remote sensing instrumentation technology currently used by large irrigation districts (Imperial Irrigation District, Coachella Water District, Yuma etc.) for rapid field scale mapping of salinity. Shown in Figure 2 is one of our remote sensing units, consisting of two electromagnetic sensors (enabling collection of depth as well as spatial information, coupled with an on board computer, GPS unit, soil drilling unit all mounted on a modified spray tractor.

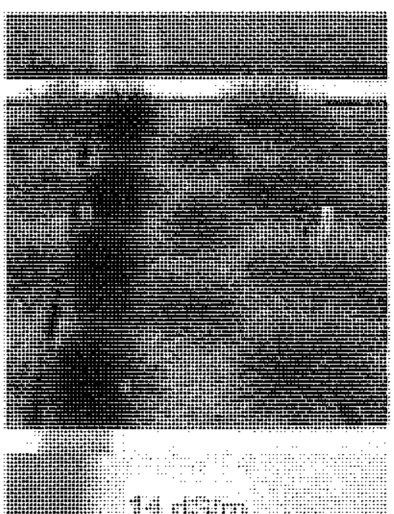


Figure 1. Kentucky bluegrass (Brilliant) irrigated with EC=14 dS/m.

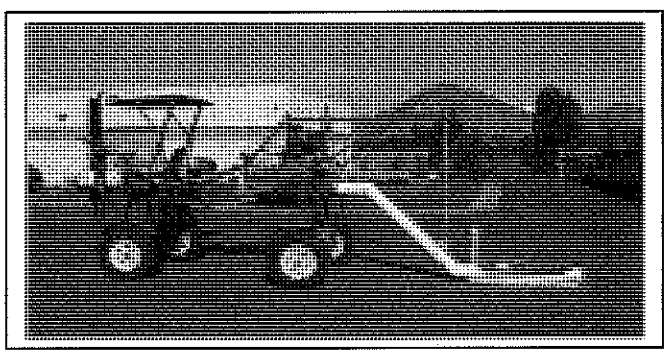
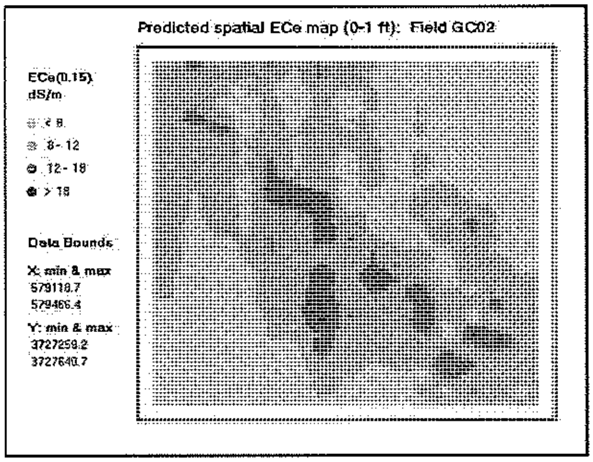
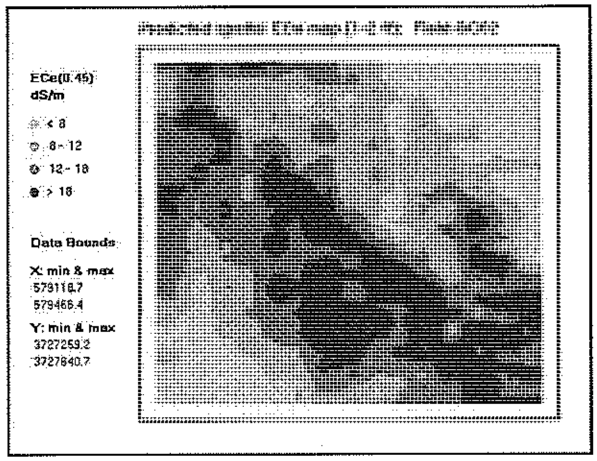
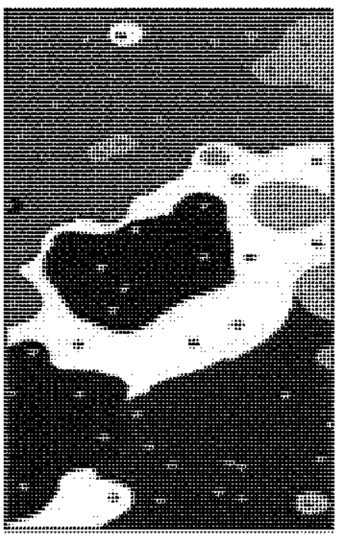


Figure 2. Salinity Laboratory remote sensing salinity unit.





Generated salinity maps (Figure 3 and 4) provide depth information diagnosis of the cause of the salinity problem (e.g. under irrigation, poor drainage etc.). Using the salinity (electrical conductivity) maps with developed software (ESAP- available on our website) enables optimal sampling and site specific management recommendations, as shown in Figure 5.



- EC_a-directed soil sample locations
- Leaching fraction: reduce LF to < 0.4
- Salinity: reduce ECe to < 7.17 dS/m
- Coarse texture requires more frequent irrigation
- pH: reduce pH to < 7.9

Figure 5. Management recommendations for site site-specific management units.

Turfgrass Case study:

In cooperation with UCR turfgrass specialists and industry consultants, we are mapping salinity distributions (electrical conductivity), and water infiltration rates of golf fairways (course in Orange County) irrigated with treated municipal wastewaters of moderate salinity (EC > 2 dS/m) and moderately elevated SAR (sodium absorption ratio- a measure of sodium hazard). Root zone salinity buildup and poor infiltration of shallow subsoil material results in insufficient water intake and plant water stress. In this case salinity and sodicity levels are not sufficiently elevated to account for the turf condition/appearance. The cost effective remediation is selected deep ripping and reseeding, however this may not be acceptable due to playing demands thus alternative remediation may be undertaken by gradual surface application of sand/loam.

Physiological Ecology of Turfgrass: Response to Light and Other Factors

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The Growing Importance of Turfgrass in Ecological Research

Urbanization is one of the most rapid land-cover changes occurring worldwide. For the first time in human history more people live in cities than in rural environments. Ecologists are now focusing their attention on understanding the vegetation, animals, and biogeochemical cycles occurring in these urban environments. Studies from urban systems provide novel locations to test ecological theories but more importantly provide opportunities to provide information relevant to the most common location of human-ecological interactions.

A key component of urban landscapes is turfgrass. 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 fields? 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.

Ecologists have also become interested in identifying sustainable solutions in achieving societal needs. Recent research activities have addressed methods for quantitatively assessing the production of ecosystem services and the cost of this production. A growing sub-discipline of ecology addresses these problems by estimating the economic and non-economic role different ecosystems have for different segments of society. How can the balancing benefits between aesthetics and recreation with the large costs associated with the high water demand of turfgrass be best evaluated? Certainly the "correct" balance will differ between various stakeholders. How can improved ecological knowledge help achieve sustainable solutions that work for the diversity of views?

Our research will address many of these questions while at the same time studying turfgrass responses and adaptation to sunlight and shade.

Shade Tolerance and Performance of Commonly Used Turfgrass Species for Lawns and Golf Course Rough in Southern California

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University of California, Riverside

Objectives:

1. Determine relative water use, shade tolerance, and overall performance among nine turfgrass species in southern California.
2. Expand knowledge base about the ecological role of turf in the landscape.

Location: UCR Turf Facility

Soil: Hanford fine sandy loam

Mowing Heights: 2.5" for cool-season grasses except fine fescues (no mow), 2.0" for warm-season grasses, except St. Augustinegrass and buffalograss (3")

Experimental Design: Randomized complete block with 3 repetitions

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 thereafter

Irrigation Regimes: Once established, turfgrasses will be subjected to warm-season irrigation regimes (approximately 60% Et_o/DU). Supplemental irrigation will be applied to the cool-season turf as necessary by hand watering and the amount of water will be documented.

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

Acknowledgments: Special thanks to West Coast Turf, Southland Sod Farms, Pacific Sod, A-G Sod Farms, and Florasource, Ltd. for donating the plant materials for this study.

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**

Shade Tolerance and Performance of Bentgrass Varieties for Putting Greens in Southern California

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Objectives: Evaluate performance of 19 creeping bentgrass varieties and one velvet variety on a sand-based putting green under non-limiting and limiting light.

Location: UCR Turf Facility

Soil: Sand-based root zone

Mowing Heights: 1/4" at Field Day, 1/10" by initiation of experiment

Experimental Design: Strip-plot with 4 replications per treatment combination; bentgrass varieties represent main plots; half of each plot receives Primo Maxx at a rate of 0.125 oz./1000 ft^2/wk beginning on August 18, 2008.

Plot Size: 5' by 11'

Establishment: Varieties were seeded at a rate of 1 lb/1000 ft^2 on July 11, 2008

Fertility: 1 lb N/1000 ft^2 at planting; 0.5 lb N/1000 ft^2/wk thereafter

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

Acknowledgments: Special thanks to Stover Seed Company, Seed Research of Oregon, Tee 2 Green, Lebanon, Simplot/Jacklin, Pickseed, and Links Seed for donating the seed and to Syngenta for donating the Primo Maxx used in this study.

North

Primo	Primo	Primo	Primo	Primo
Tyee	Penn A-4	Penn G-6	Declaration	T-1
Shark	007	MacKenzie	SR 1150	Brighton
L-93	LS-44	Alpha	Independence	Mariner
Seaside II	Dominant Plus	Dominant Xtreme7	Penncross	Lengendary Velvet
Alpha	Tyee	Shark	Independence	SR 1150
Legendary Velvet	T-1	Seaside II	Brighton	Penn G-6
Penncross	Dominant Xtreme7	L-93	007	Penn A-4
Declaration	Mariner	MacKenzie	LS-44	Dominant Plus
SR 1150	Declaration	T-1	LS-44	Alpha
Mariner	Brighton	Penn A-4	L-93	Dominant Plus
Tyee	Penn G-6	Penncross	Dominant Xtreme7	007
Seaside II	MacKenzie	Legendary Velvet	Independence	Shark
Mariner	SR 1150	Seaside II	Declaration	MacKenzie
007	Dominant Plus	Alpha	Penn G-6	Dominant Xtreme7
Penn A-4	T-1	Tyee	Legendary Velvet	L-93
LS-44	Shark	Independence	Penncross	Brighton
Primo	Primo	Primo	Primo	Primo

Water Needs of Landscape Plants

Dennis Pittenger[1], Mike Henry[2], and David Shaw[3]
U.C. Cooperative Extension – Center for Landscape & Urban Horticulture

[1]Central Coast & South Region/L.A. County/ U.C. Riverside
[2]Riverside County, [3]San Diego County

Following years of below-average rainfall and very low snowmelt runoff in California, landscape managers, maintenance gardeners, and homeowners in most areas of California are now facing mandatory or voluntary water conservation targets. Water purveyors, local governments, landscape architects, and landscape management professionals are adopting the use of reference evapotranspiration (ET_o) estimates to determine precise landscape water budgets and irrigation schedules. Calculations that produce these budgets and schedules require multiplying ET_o estimates by a adjustment factor, known as a crop coefficient (Kc) or a plant factor (PF), that accounts for a particular plant's water need. These numbers are usually expressed as a percentage less than 100% or a decimal less than 1.0.

Urban landscapes are often blends of woody and herbaceous plants along with some type of turfgrass. Accurate and effective ET_o-based irrigation management of a given landscape requires reliable Kc or PF values for the plant species present. In order to maximize water conservation, an ETo adjustment factor should represent the minimum amount of water a plant species needs to maintain its expected function and minimally acceptable aesthetic appearance (i.e. a PF) rather than the amount of water it needs for optimum growth and development (i.e. a Kc).

However, there is limited research-based data on non-turf landscape plants' water needs for achieving either optimum growth or minimally acceptable performance. Most of the available ET_o-based information provides estimates or general ranges of PFs that enable selected groups of landscape plants to maintain acceptable functional and aesthetic performance after they are established. Studies show common landscape groundcovers, shrubs, and trees vary widely and unpredictably in their minimum water needs and responses to drought, but generally maintain aesthetic and functional value when irrigated at between 20% and 80% of ET_o, typically nearer to 50% of ET_o. Currently, UC Cooperative Extension's Landscape Workgroup is conducting a field research project, coordinated among sites in Coachella Valley, Davis, Hopland, and Santa Paula, designed to expand the research-based information on water needs of landscape plant species commonly used across the state.

The following table provides PF estimates derived to date for landscape plants to provide acceptable performance after they are established. Additional information on landscape water management can be found at http://ucanr.org/landscapewater.

Table 1. Research-defined water needs for selected landscape groundcovers and shrubs to provide acceptable landscape performance after establishment as a percentage of reference evapotranspiration and as recommended by WUCOLS[z, y].

		Percent of Reference ET (ET_o)						
			WUCOLS Climate Zone [u]					
Scientific Name	**Common Name**	**Research Defined**	**1**	**2**	**3**	**4**	**5**	**6**
Arbutus unedo 'Compacta', L.	compact strawberry tree	18-36	20-30	20-30	20-30	20-30	40-60	40-60
Arctostaphylos uva-ursi 'Pacific Mist', (L.) Spreng.	bearberry	18-36	<10	20-30	20-30	20-30	NA	NA
Artemisia x 'Powis Castle', L.	wormwood	0-36[x, v]	<10	20-30	20-30	20-30	20-30	20-30
Baccharis pilularis 'Twin peaks', (L.) DC.	Twin Peaks coyote bush	20	20-30	20-30	20-30	20-30	<10	<10
Calliandra haematocephala, Hassk.	pink powder puff	18-36	<10	<10	40-60	40-60	NA	70-90
Cassia artemisioides, Gaud.	feathery cassia	0-36[w, x]	20-30	20-30	20-30	20-30	20-30	20-30
Cerastium tomentosum, L.	snow-in-summer	25	40-60	40-60	40-60	40-60	40-60	40-60
Cistus x purpureus, Lam.	orchid spot rock rose	0-36[x]	20-30	20-30	20-30	20-30	20-30	20-30
Correa alba 'Ivory Bells', Andr.	white australian correa	18-36	20-30	20-30	20-30	20-30	NA	40-60
Drosanthemum hispidum, (L.) Schwant.	pink iceplant	20	20-30	20-30	20-30	20-30	NA	20-30
Echium fastuosum, Jacq.	pride of madeira	0-36[x]	20-30	20-30	20-30	20-30	NA	40-60
Escallonia x exoniensis 'Fradesii', Veitch.	Frades escallonia	18-36	40-60	40-60	40-60	40-60	NA	40-60
Galvezia speciosa, Gray.	bush snapdragon	0-36[w, x]	20-30	20-30	<10	20-30	?	40-60
Gazania rigens v. *leucolaena,* (DC.) Roessler.	yellow trailing gazania	50-80[v]	40-60	40-60	40-60	40-60	40-60	40-60
Grevillea x 'Noell', Knight.	Noell grevillea	0-36[x]	20-30	20-30	20-30	20-30	NA	40-60
Hedera helix 'Needlepoint', L.	Needlepoint english ivy	20-30	40-60	40-60	40-60	40-60	40-60	40-60

Scientific Name	Common Name	Percent of Reference ET (ET_o)						
			WUCOLS Climate Zone [u]					
		Research Defined	1	2	3	4	5	6
Heteromeles arbutifolia, M. J. Roemer.	toyon	0-36[x]	<10	<10	20-30	20-30	NA	NA
Hibiscus rosa-sinensis, L.	rose of china	40-60	40-60	40-60	40-60	40-60	NA	70-90
Lantana montevidensis, Briq.	trailing lantana	18-36	20-30	20-30	20-30	20-30	NA	40-60
Leptospermum scoparium, J. R. Forst & G. Forst	new zealand tea tree	18-36	40-60	40-60	40-60	40-60	NA	NA
Leucophyllum frutescens 'Green Cloud', I. M. Johnst.	Green Cloud texas ranger	0-36[w, x]	20-30	20-30	20-30	20-30	20-30	20-30
Ligustrum japonicum 'Texanum', Thunb.	texas privet	40-60	40-60	40-60	40-60	40-60	40-60	30-50
Myoporum x 'Pacificum', Banks & Sol. ex Forst. F.	prostrate myoporum	0-36[x]	20-30	20-30	20-30	40-60	NA	NA
Otatea acuminate, (Munro) C.E. Calderon & Soderstr.	mexican bamboo	18-36	40-60	?	40-60	40-60	NA	70-90
Phormium tenax, J. R. Forst & G. Forst.	new zealand flax	18-36	20-30	20-30	20-30	40-60	NA	40-60
Pittosporum tobira, Ait.	mock orange	18-36	20-30	40-60	40-60	40-60	40-60	40-60
Potentilla tabernaemontanii, Asch.	spring cinquefoil	70-80	40-60	40-60	40-60	40-60	NA	40-60
Prunus caroliniana, Ait.	carolina laurel cherry	0-36[x]	20-30	20-30	40-60	40-60	40-60	40-60
Pyracantha koidzumii 'Santa Cruz', Rehd.	Santa Cruz firethorn	0-36[x]	20-30	20-30	20-30	40-60	40-60	40-60
Rhaphiolepis indica, Lindl.	indian hawthorne	18-36	20-30	20-30	40-60	40-60	40-60	40-60
Sedum acre, L.	goldmoss	0-25	20-30	20-30	20-30	20-30	20-30	20-30
Teucrium chamaedrys, L.	germander	18-36	20-30	20-30	20-30	20-30	40-60	40-60
Vinca major, L.	periwinkle; myrtle	30-40	40-60	40-60	40-60	40-60	40-60	40-60

Scientific Name	Common Name	Percent of Reference ET (ET_0)						
		Research Defined	WUCOLS Climate Zone [u]					
			1	2	3	4	5	6
Westringia rosamarinaformis, L.	rosemary bush	18-36	20-30	20-30	20-30	20-30	NA	40-60
Xylosma congestum, Merrill.	shiny xylosma	18-36	20-30	20-30	40-60	40-60	40-60	40-60

[z] WUCOLS = Water Use Classification of Landscape Species (Costello and Jones, 2000).

[y] References:

Costello, L. R. and K. S. Jones. 2000. A guide to estimating irrigation water needs of landscape plantings in California – the landscape coefficient method and water use classification of landscape species III (WUCOLS III). Available at <http://www.owue.water.ca.gov/docs/wucols00.pdf>. Viewed May 29, 2008.

Pittenger, D. R., D. A. Shaw, D.R. Hodel, and D. B. Holt. 2001. Responses of landscape groundcovers to minimum irrigation. J. Environ. Hort. 19(2):78-84.

Shaw, D. A. and D. R. Pittenger. 2004. Performance of landscape ornamentals given irrigation treatments based on reference evapotranspiration. Acta Hort. 664: 607-613.

Staats, D. and J. E. Klett. 1995. Water conservation potential and quality of non-turf groundcovers versus Kentucky bluegrass under increasing levels of drought stress. J. Environ. Hort. 13: 181-185.

[x] Acceptable landscape performance with no summer irrigation shown only at the immediate coast. Inland plantings may require summer irrigation applied infrequently near the maximum amount listed for the species.

[w] Species typically provides unacceptable landscape performance in summer and fall months irrespective of irrigation amount.

[v] Requires renovation about every 2 to 3 years to maintain acceptable performance.

[u] Key to WUCOLS California climate zones
1: North-Central Coastal
2: Central Valley
3: South Coastal
4: South Inland Valleys and Foothills
5: High and Intermediate Desert
6: Low Desert
NA: Plant not appropriate for the zone

Pharmaceuticals and Personal Care Products (PPCPs), and Endocrine Disrupting Compounds (EDCs) Leaching in Reclaimed Municipal Wastewater Irrigated Turfgrass Soils

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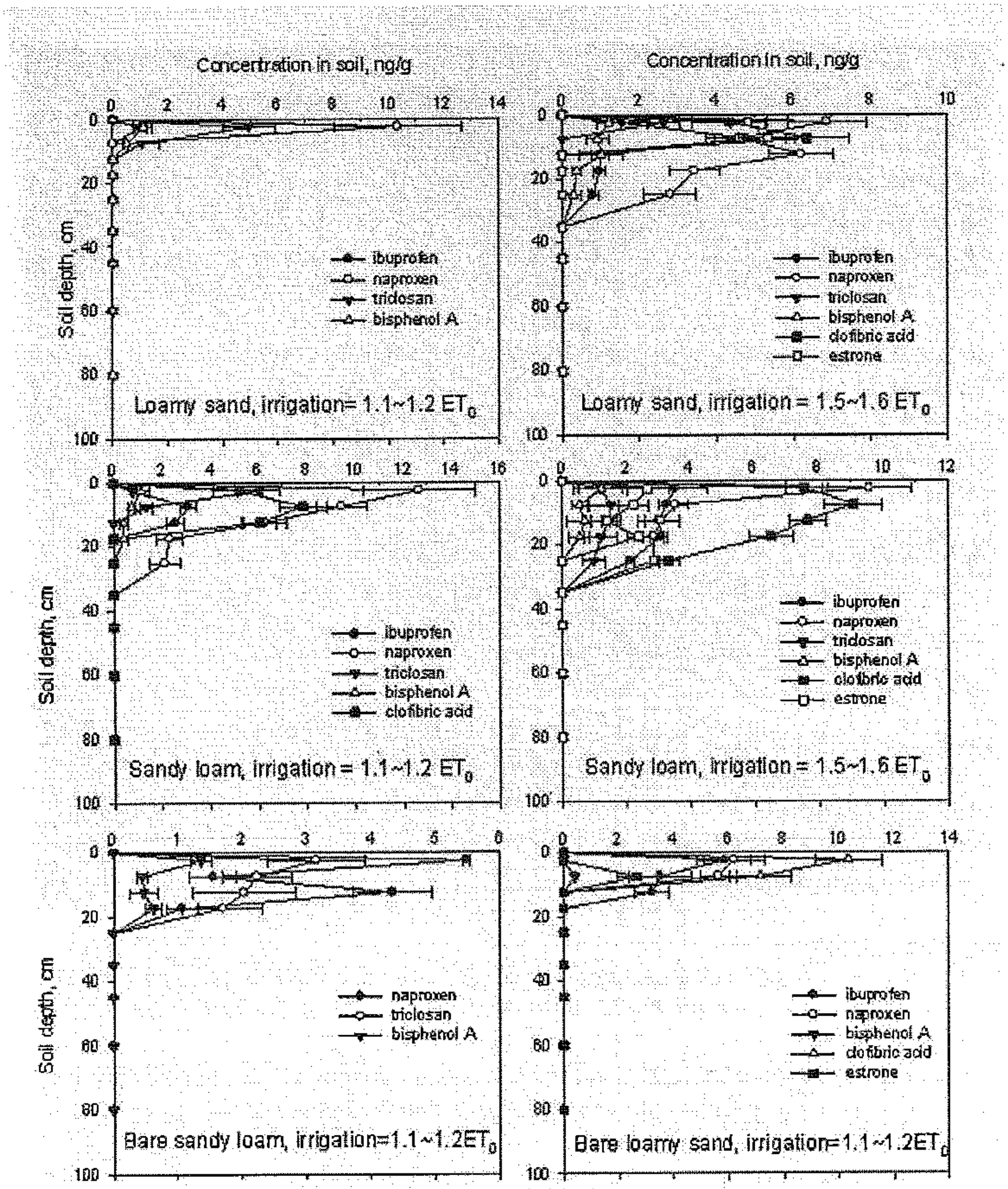
The practice of irrigation with reclaimed water on landscape has been employed for many years in the world. However, the fate and transport of trace organic contaminants in reclaimed water, such as endocrine disrupting compounds (EDCs), steroid hormones, pharmaceutical and personal care products (PPCPs), have not been well documented. A field study was performed to assess the environmental behavior of these chemicals in turfgrass soil receiving reclaimed wastewater irrigation at the UCR Turf Research Facility. Selected compounds (PPCPs and EDCs) were spiked in the irrigation water. Two irrigation rates (1.1 to 1.2 and 1.5 to 1.6 of reference crop evapotranspiration (ET_0)) were applied on plots with two types of soils (sandy loam and loamy sand). Leachates were collected after each irrigation event and analyzed for the targeted compounds. The control treatment of four plots (two for each soil type) was established by removing the turfgrass and irrigated at 1.1 to 1.2 ET_0. Four months after the experiment, soil samples from each plot were collected to a depth of 89 cm. The cores were sliced into nine sections and analyzed for the compounds in the soil profiles. Our study showed that no compound was detected in the leachates during the 4 mo of irrigation. Most compounds were found in the surface layers (0-30 cm depth). High irrigation rate (1.5 to 1.6 ET_0) enhanced the downward movement of chemicals in turfgrass soil and more compounds were found in the deeper depth, but no of them reached to the bottom of the 89-cm lysimeters.

Batch degradation experiments indicated that in turfgrass soils, microbial degradation was the dominant dissipation pathway for the tested compounds, whereas photochemical reaction only played a minor role.



Distribution of the 9 selected PPCPs and EDCs levels in the soil profiles at the end of 4-month irrigation.

Fertility Management in the Landscape

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Proper nutrient management in landscapes is important to maintain the integrity and aesthetics of plant material while simultaneously preventing nutrient runoff into neighboring environments. Strict regulations regarding runoff water quality are being enforced for many agricultural sites such as nurseries and farming systems. High nitrate (NO_3) concentrations (>10 ppm NO_3-N) in runoff waters have become a major concern with respect to fertilizer usage. It is imperative that landscape installation and maintenance programs incorporate sound cultural and fertilization practices that will simultaneously optimize landscape quality and minimize the likelihood of fertilizer runoff.

There are <u>three goals</u> with regard to fertility management in agricultural systems:

1. Optimize plant performance (growth, quality).
2. Optimize fertilizer use efficiency.
3. Minimize/eliminate nutrient runoff.

To achieve the above goals, four areas of landscape management must be addressed:

1. Soil Preparation
2. Plant Selection
3. Fertilizer Management
4. Irrigation Management

Soil Preparation

Soil Testing. *Always conduct a soil test when preparing a landscaped area. It is easier and less costly to correct chemical and physical problems of the soil before plants are installed.

Drainage. Adequate drainage is required. Poor drainage is often one of the primary causes of poor plant performance of landscapes. Plant roots are unable to take up water and nutrients in poorly drained soils.

**Water Holding Capacity*

+*Sandy Soils* – Additions of organic matter will increase water holding and nutrient retention capacity of soils. This will improve irrigation and fertilization efficiency of the site.

+*Clay Soils* - Heavy clays need to be amended to increase aeration for the root systems.

**pH.* A pH optimum of 6.5 to 7.5 is ideal for most crops. A pH of 5.0 to 6.0 is ideal for acid-loving plants such as ferns, camellia, azalea, and many other Ericaceous crops. In California, high pH is usually the reason for chlorosis of new foliage in azaleas and camellias.

**Fertility.* After a proper soil test, adjustments can be made to optimize the initial fertility status of the soil. This should be done prior to planting.
**Salinity.* High salinity will cause root necrosis in severe cases, limiting water and nutrient uptake. Salinity may be caused by poor drainage or over fertilization.
**Mulching.* Through proper mulching, water evaporation from soil is minimized.

Plant Selection
**Root System.* Select plants that are not root-bound in containers. If some root circling has occurred in containers, loosen roots to prevent continued circling once planted in the landscape.
**Root to Shoot Ratio.* Do not select plants with excessive shoot growth relative to roots. These plants will need frequent watering, which increases the likelihood of nutrient runoff from the landscape.
**Trunk Integrity.* Inspect trunks for any diseases or mechanical injury. Damaged trunks will inhibit water and nutrient uptake to shoots and carbohydrate translocation to roots.

Fertility Management
**Fertilization Method – Liquid vs. Granular.* Controlled Release Fertilizers offer slower release of nutrients over time. Nutrient availability in most formulations is based on temperature, with release rates increasing as temperature increases.
**Nutrient Balance.* The most important aspect of fertilization is nutrient balance. Many nutritional deficiencies are induced by over fertilization with a few essential nutrients (primarily nitrogen, phosphorus and potassium) without application of the other essential nutrients such has calcium, magnesium, etc. This occurs because not all bulk fertilizers contain all major essential elements in the relative proportions needed to optimize growth. Therefore, symptoms of calcium and especially magnesium deficiencies are occurring, through over fertilization with potassium and nitrogen. (See 'Nutrition Notes Handout' for a detailed description of nutrient deficiency and toxicity symptoms and the soil, environmental and cultural conditions that may be associated with these symptoms). These symptoms are evident in palms such as *Phoenix canariensis* and some dicots.
**Timing of Fertilizer Applications.* It appears that ornamentals take up the majority of nutrients after the flush of vegetative growth is reaching maturity not during the active growth of the flush. Therefore the best time for fertilizer application is in spring so that fertilizer is available as growth flushes begin maturing. Winter fertilization may result in nutrient runoff. The exception occurs for winter-growing shrubs and growth of cool-season annuals.

Irrigation Management
Next to fertilization programs, irrigation practices will have a major impact on the three objectives (plant performance, fertilizer use efficiency, and nutrient runoff). Irrigation management will be discussed at other stations.

Nutrition Notes

This should serve only as a general guideline since nutrient requirements will vary by differences in climate, cultural conditions and plant species.
The following list gives a general description of characteristics associated with each element.
*Number range (percentage or ppm) gives approximate nutrient concentrations for healthy plants.
*Nutrient Interactions (Toxicity) - describes possible deficiencies of other elements if said element is available in high quantities.
*Nutrient Interactions (Deficiency) – lists other elements, which when in high quantities, may induce deficiencies of said element.

Nitrogen (N) – mobile (1.0-6.0%)
Deficiency Symptoms
Mild. Uniform yellowing and senescence of older leaves.
Severe. Canopy chlorotic, plants stunted.
Soils
*Waterlogged; anaerobic; leached sandy soils may be nitrogen deficient.
Nutrient Interactions
Toxicity. NH_4^+ - competes with K, Ca, Mg. Ammonium uptake is optimum at neutral pH and uptake decreases at lower soil pH. Symptoms of ammonium toxicity include leaf necrosis, stem lesions and stunted root and shoot growth.
NO_3^- - competes with P and S. Nitrate uptake is optimum between pH 4.5 and 6.0.

Phosphorus (P) – mobile (0.2-0.5%)
Deficiency Symptoms
Mild. older leaves turn dark green to purple. Stems of herbaceous plants become dark red.
Severe. older leaves dark purple necrotic spots.
Soils
*pH. Precipitates with Fe (low pH) or Ca (high pH), inducing deficiency of Fe and P or Ca and P, respectively.
*Cold, wet soils induce P deficiency
Nutrient Interactions
Toxicity. P competes with Fe, Zn, and Cu.
Deficiency. Fe, Zn, Al, and Ca compete with P.

Potassium (K) – mobile (1.5-4.0%)
Foliar K:N ratio 1:1 considered ideal.
Deficiency symptoms
Mild. chlorosis and necrosis develop initially on leaf margins of 2nd and 3rd oldest leaves. Monocots exhibit orange-tan speckling.
Fruit and flower quality decrease (shorter shelf-life).
*Treatment - fertilizer (soil + foliar) effective only on newer leaves. Older necrotic leaves will not recover.
Soils
*Sandy, acid soil; organic soil; peat-based mix.
Nutrient Interactions
Toxicity. K competes with Ca and Mg.
Deficiency. Ca and Mg compete with K.

Calcium (Ca) – immobile (0.5-1.5%)
Foliar Ca:Mg ratio of 2:1 and K:Ca ratio of 4:1 considered ideal
Deficiency Symptoms
Mild. New leaves chlorotic, deformed, stunted.
Severe. Leaf necrosis, meristem dies.
Problematic Situations
*Dry soils, erratic irrigation.
*High humidity, which reduces transpiration.
Nutrient Interactions
Toxicity. Ca competes with Fe, Mn, Zn, Cu.
Deficiency. K and NH_4^+ compete with Ca.

Magnesium (Mg) – mobile (0.15-0.40%)
Foliar Ca:Mg ratios of 2:1 and K:Mg ratios of 8:1 considered ideal.
Deficiency Symptoms
Mild. Interveinal chlorosis of older leaves. Midribs remain green. In monocots, leaf chlorosis is striped or on leaf margins.
Severe. Older leaves become necrotic.
Dolomite and MgO - slow release forms for acid soils.
Fertilizer (soil + foliar) effective only on newer leaves.
Problematic soils
*Sandy soils; leached soils; organic media.
*pH. Low (<4.5) and high (<6.0) pH soil.
Nutrient Interactions
Toxicity. Mg competes with Mn.
Deficiency. K, NH_4^+, Ca, Na and Al (acid soils) compete with Mg.

Sulfur (S) – primarily immobile (0.15-0.50%)
Foliar S:N ratio of 1:14 considered ideal
Deficiency Symptoms
rare – atmospheric S from ocean and pollution.
Mild. Uniform chlorosis of old and new leaves.
Severe. Leaflet tips necrotic, stunted growth.
Problematic soils
*Nitrogen – high N may cause S deficiency.
*leaching – excess leaching.
Nutrient Interactions
Toxicity. Atmospheric SO_2 0.5-0.7 S/m^3 causes necrosis of tissue.

Iron (Fe) – immobile (50-75 ppm)
Deficiency Symptoms.
Mild. Interveinal chlorosis of young leaves. Chlorosis of younger leaves with green spots.
Severe. New leaves white or necrotic and stunted.
*Correctional treatments – Foliar sprays of iron sulfate or Fe chelates. Soils of high pH should be acidified. Acid fertilizers such as NH_4 rather than compounds of NO_3^--N will also reduce soil pH.
Foliar fertilization will be effective, but temporary. Soil must be corrected to prevent continued chlorosis.
Problematic conditions
*Poorly aerated soils; wet soils
*High pH cause "lime-induced chlorosis" = reduced Fe uptake into plant and physiologically unavailable Fe in plant.
*Cool soils, where roots are not actively growing, may induce iron deficiency. Foliar sprays cannot correct

chlorosis caused by cool soils. Once soils warm, new leaves will emerge healthy.

Nutrient Interactions

Toxicity. Excessive Fe in flooded soils – brown speckling on leaves – seen in rice.

Deficiency. Ca (high pH), P, B, Cu, Mn compete with Fe.

Manganese (Mn) – immobile (10-200 ppm)

Deficiency Symptoms.

Mild. varies among plant species. Chlorosis between veins of older leaves.chlorosis. "Frizzletop" in palms. Gray speckling at base on leaf bladed in monocots.

*Correctional treatments – Foliar sprays of manganese sulfate or Mn chelates will correct the chlorosis.

Special notes:

Soils

*acid soils (pH <5.4) may cause Mn toxicity

Environment

*Cold temperatures will induce Mn deficiency for some palms growing outside the recommended regions of culture. Chlorosis caused by cool soils cannot be corrected by foliar sprays. Once soils warm, new leaves will emerge healthy.

Nutrient Interactions

*Toxicity. Excessive Mn may induce symptoms of Fe, Zn, Cu, and/or Ca deficiencies. In acid soils, Mn toxicity appears as marginal yellowing of young leaves with central green area and black speckling in leaves and stems "measles".

*Deficiency. Excessive fertilization with Mg, Ca, or K may induce Mn deficiency.

Copper (Cu) – immobile (2-20 ppm)

Deficiency Symptoms.

New leaves emerge stunted and necrotic, especially near the leaf tips. In monocots, young leaf tips will turn white.

Special notes:

Soils

*Peat soils tightly bind Cu and therefore are more likely to induce Cu deficiencies

Nutrient Interactions

*Toxicity. Copper containing fungicides can induce Cu toxicity. Excessive Cu may induce symptoms of Fe deficiency. Root growth stunted.

*Deficiency. Excessive fertilization with Mn or Fe may induce Cu deficiency.

Boron (B) – immobile. (~20ppm)

Deficiency Symptoms.

Stunted growth and dieback of apical meristem followed by sprouting of lateral stems. Cracked roots and necrosis of meristems.

Soils and Waters

*Boron is often easily leached from soils in areas of regular rainfall. However, in dry desert regions, boron may accumulate to high concentrations.

*Boron levels above 5 ppm in water is toxic to many crops, causing symptoms of leaf tip necrosis

Nutrient Interactions

*Toxicity. Since B is required in such small quantities, B toxicity can easily occur with over fertilization.

Zinc (Zn) – immobile. (15-50 ppm)

Deficiency Symptoms.

Interveinal chlorosis and yellow mottling of new leaves. Decreased stem growth, which appears as rosetting of terminal leaves.

Special notes:

Nutrient Interactions

*Toxicity. High Zn in soil (>200 ppm) may induce Fe, Mn or P deficiencies.

*Deficiency. High concentrations of Cu, Ca, Mg and Fe may induce Zn deficiency.

Molybdenum (Mo) – (0.15-0.30 ppm)

Deficiency Symptoms.

Older then younger leaves become chlorotic to yellow-green and leaf margins will roll in. In severe cases, leaf lamina will not develop, leaving only the leaf midrib. "Whiptail" in Brassicas.

Soils

*Sandy acid-leached soils may be Mo deficient

Nutrient Interactions

*Deficiency. Excess sulfates may induce Mo deficiency.

Literature Cited

Bennett, W.F. (ed.). 1996. Nutrient deficiencies & toxicities in crop plants. Amer. Phytopath. Soc. Press, St. Paul, MN.

Brady, N.C. 1990. (ed.). The nature and properties of soils, 10th edition. MacMillan Publishing Company, New York.

Mills, H.A. and J.B. Jones, Jr. 1996. Plant Analysis Handbook II. MicroMacro Publishing, Athens, GA.

Irrigation Strategies for Water Conservation on Tall Fescue Turf

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Tall fescue, *Festuca arundinacea*, is the most commonly planted turfgrass in California. Thus, using strategies to conserve water for this popular turfgrass is very important. Tall fescue possesses a high degree of drought and heat resistance, relative to other cool-season turfgrass species. Generally, drought resistance is defined as the ability of a plant to endure and survive drought conditions. A lower water use rate (evapotranspiration rate) is one of several plant traits or mechanisms which increase drought resistance. Though the use of drought resistant plants is important, it needs to be coupled with appropriate irrigation management for water conservation to occur. Tall fescue drought resistance is primary due to a strong genetic rooting potential which results in increased water absorption and maintenance of tissue hydration. Thus, cultural practices involving plant and soil which promote rooting will also increase tall fescue drought resistance. Listed below is an outline of some of the practices for conserving irrigation water. Please note that water conservation will probably involve multiple practices, possibly customized to local circumstances, and that climate (especially evaporative demand) has a substantial effect in southern California.

Landscape

1. In order to satisfy a landscape-wide water budget, it maybe necessary to exchange some tall fescue with areas planted with more drought resistant plants, including warm-season turfgrasses.
2. Try not to plant irrigated turfgrass on extreme slopes or narrow areas.
3. Try to grow and maintain tall fescue on soils which possess sufficient physical and chemical properties, such as water and nutrient water holding capacity, water infiltration and percolation, porosity, fertility, pH, salinity characteristics, and others.

Irrigation System and Application

1. Pursue using recycled water instead of potable water.
2. As best as possible, implement landscape irrigation with hydrozones.
3. Maintain the highest possible irrigation system distribution uniformity.
4. Adjust (schedule) irrigation amount as frequently as possible and base it on climatic changes of evaporative demand along with rainfall amount.
5. If deficient irrigation amount, increase the number of irrigation days per week. If irrigation amount is close to 100% irrigation water requirement of tall fescue, then increase irrigation application efficiency, by using the lowest number of irrigation days per week.

Irrigation System and Application Continued

6. Increase irrigation application efficiency by not allowing irrigation application rates to exceed water infiltration rates into turfgrass and soil. To help achieve this, divide and schedule total daily irrigation run time into several run soak times. The use of irrigation heads and nozzles with lower water application rates also may help.
7. Schedule irrigation during the hours just prior to sunrise.
8. If there is irrigation runoff onto sidewalks and streets, keep working to improve the irrigation system and application efficiency.

Plant and Cultural Management

1. Maintaining a healthy tall fescue is the first step toward drought resistance and irrigation water conservation. This includes mowing and fertilizing within the range of recommended levels. It also includes controlling pests when necessary along with maintaining sufficient soil physical and chemical properties, as mentioned above.
2. During the latter part of spring, begin conditioning tall fescue for summer stress by promoting slower shoot growth and allowing visual drought symptoms to appear. Also, begin raising the height of cut. Continue these practices until optimal climatic growing conditions return in the fall.
3. Promote moderate shoot and root growth during the fall and spring. During these times of relatively high growth potential and recovery, use the more-aggressive practices of plant and soil improvements. In terms of climate, not including rainfall, tall fescue growth in southern California is most limited by low air and soil temperatures of winter.
4. Select tall fescue varieties with improved drought resistance. Please note that reports concerning field studies on this topic are limited. However, tall fescue varieties with a higher root to shoot ratio have been reported to possess greater drought resistance.

Additional information and resources on this topic and others are available on the UCR Turf website at http://ucrturf.ucr.edu

Field Screening for Turfgrass Drought Tolerance

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Objectives: To evaluate relative drought tolerance among *Festulolium* and tall fescue experimental lines, tall fescue commercial varieties, and commercial seed mixtures in the field using variable irrigation regimes.

Location: UCR Turf Facility

Experimental Design: Split-plot with 3 replications per treatment combination; irrigation regimes represent main plots or cells; cultivar or experimental line represent sub-plots.

Irrigation Cell Size: 20' by 20'

Seeding Date: 7/11/2008

Seeding Rate: *Festulolium* was seeded at 4.4 lbs/1000 ft^2; all other treatments were seeded at 7 lbs/1000 ft^2

Fertility: 1 lb N/1000 ft^2 at planting; 0.5 lb N/1000 ft^2/wk thereafter

Mowing Height: 2.5 inches

Irrigation Regimes: Once established, turfgrasses will be subjected to variable irrigation regimes chosen to evaluate drought tolerance in Riverside climatic conditions. Regimes will likely range from 60-80% ET_o/distribution uniformity (DU). Turf quality, color, density, leaf firing/wilting, and rooting will be evaluated periodically throughout the study.

Acknowledgments: Special thanks to West Coast Turf for donating sod for the plot borders and to Stover Seed Company for donating the commercial tall fescue varieties.

NORTH

Cell 12

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

Cell 11

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

Cell 10

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

Cell 9

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

Cell 8

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

Cell 7

d	**a**
c	**b**

Cell 6

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

Cell 5

a	**b**
d	**c**

Cell 4

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

Cell 3

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

Cell 2

d	**c**
b	**a**

Cell 1

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

Treatments:

<u>To be subjected to three irrigation regimes (likely 60, 70, 80% Et_o/DU); 5' by 5' plots</u>

1. B7.1143 *Festulolium*
2. B7.1142 *Festulolium*
3. 6.1657 tall fescue
4. 6.0891 tall fescue
5. 6.1534 tall fescue
6. 5.0541 tall fescue
7. 6.0726 tall fescue
8. 7.0536 tall fescue
9. 7.0537 tall fescue
10. 7.0535 tall fescue
11. 7.0534 tall fescue
12. Fawn tall fescue

<u>To be subjected to one irrigation regime (likely 70% Et_o/DU); 5' by 5' plots</u>

13. 7.0543 tall fescue
14. 8.0151 tall fescue
15. 7.0542 tall fescue
16. 7.1359 tall fescue

<u>To be subjected to two irrigation regimes (likely 70, 80% Et_o/DU); 5' by 5' plots</u>

17. Avenger tall fescue
18. Firenza tall fescue
19. Bonsai 3000 tall fescue
20. 2nd Millenium tall fescue

<u>To be subjected to one irrigation regime (likely 70% Et_o/DU); 10' by 10' plots</u>

The following seed were purchased at Lowe's

a. Pennington Turf Type Tall Fescue
(39% Forte tall fescue; 29%Duranna tall fescue; 29% Signia tall fescue)
b. Pennington Sun and Shade Mix
(68% Integra perennial ryegrass; 10% Blue Bonnet K. bluegrass; 10% Flyer creeping red fescue; 10% Shadow II chewings fescue)
c. Scotts Select Turf Landscapers' Mix
(44% Adobe tall fescue; 44% Chinook tall fescue; 4% Gulf annual ryegrass)
d. Scotts Pure Premium High Traffic Mix
(30% Roadrunner perennial ryegrass; 25% Inspire perennial ryegrass; 25% Abbey K. bluegrass; 19% Showtime perennial ryegrass)

Strategies for Converting Turf from Tall Fescue into Buffalograss

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University of California, Riverside

Objectives: Determine optimal timing and planting rate of UC Verde buffalograss plugs along with eradication method of tall fescue to achieve the most rapid conversion with the least amount visual discoloration.

Location: UCR Turf Facility

Soil: Hanford fine sand loam

Experimental Design: Randomized complete block with 3 replications

Plot Size: 5' by 10'

Species/Cultivars: Mature stand of Crossfire 2 tall fescue; UC Verde buffalograss

Application of Roundup ProMax: 8/19/2008, 4.7 qts/A

Application Information: CO_2 Bicycle sprayer
TeeJet 8002VS Nozzles
19" nozzle spacing
22" boom height
Speed: 1 mph
Output: 2gal/1000ft2
Pressure: 41psi tank and 38psi handle
Calibration of 1060ml/ nozzle minute

Plugs Established: 8/29/2008

Fertility: 0.5 lb N/1000 ft^2 at planting

Mowing Height: 3 inches

Irrigation Regimes: Once the buffalograss has overcome transplant shock, plots will be irrigated according to buffalograss water use needs.

Data Collection: Buffalograss cover (visual and with digital imaging)

Acknowledgments: Special thanks to Florasource, Ltd. and Monsanto for donating the UC Verde buffalograss and Roundup herbicide, respectively.

North

1	2	3	4	9	8
5	6	7	10	11	12
2	10	4	6	9	11
8	12	1	7	3	5
4	6	10	8	12	1
7	9	2	11	3	5

Treatments

1. Roundup entire plot, plant plugs at 6" spacing
2. Roundup entire plot, plant plugs at 12" spacing
3. Roundup entire plot, plant plugs at 18" spacing
4. Remove sod, plant plugs at 12" spacing
5. Roundup 10" strips, plant plugs within at 12" spacing
6. Roundup 10" strips, plant plugs within at 12" spacing; repeat procedure on adjacent living turf next June
7. Plant plugs at 12" spacing in untreated tall fescue turf

8-14. Same as treatments 1-7, but plant next June and August

Evaluation of Roundup ProMax for Non-Selective Vegetation Control

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Objectives: Test the efficacy of a new formulation of Roundup herbicide against other Roundup formulations and contact-type non-selective herbicides.

Location: UCR Turf Facility

Soil: Hanford fine sand loam

Experimental Design: Randomized complete block with 3 replications/species

Plot Size: 18" by 5'

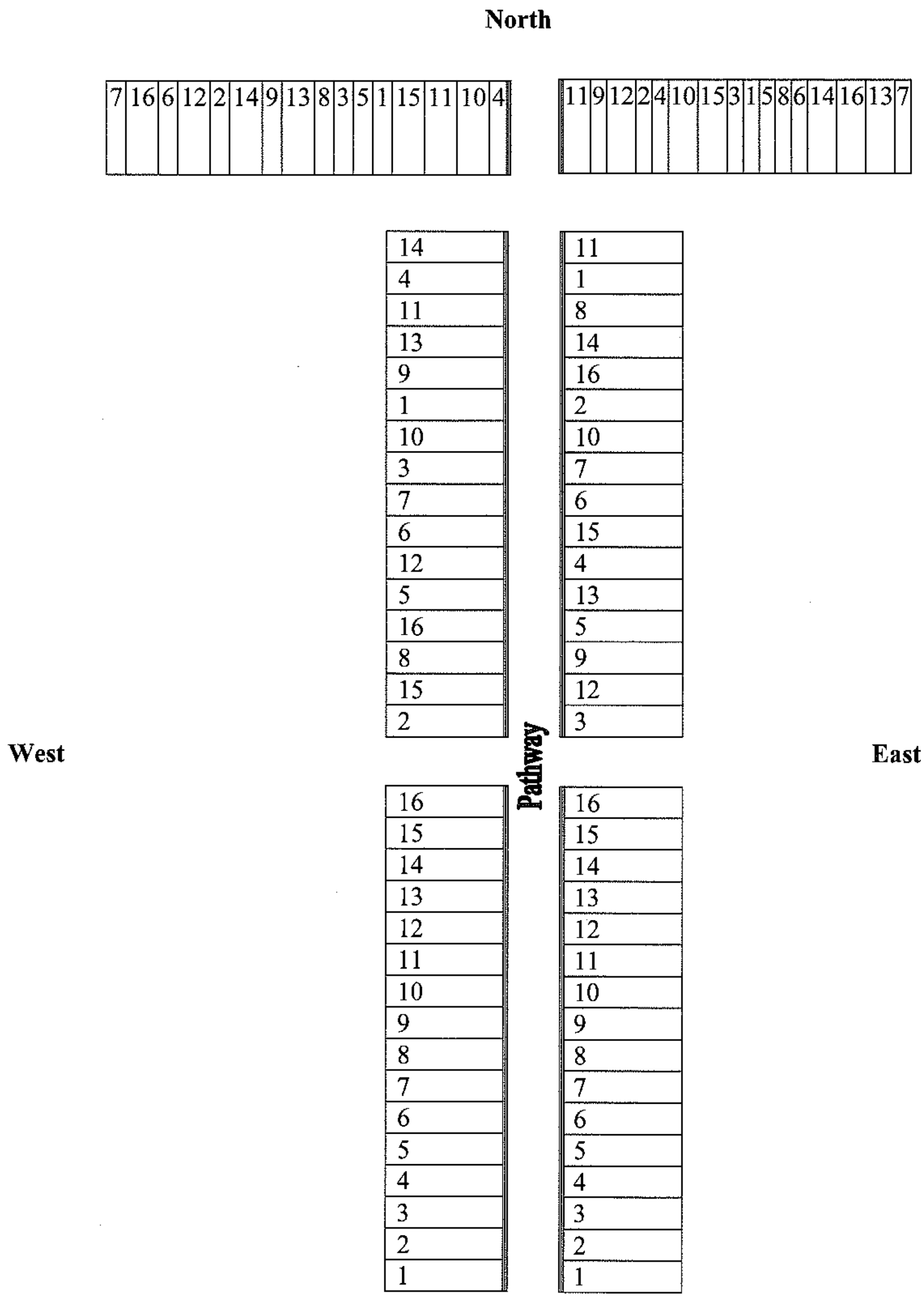
Turfgrass Species/Cultivars: Mature stands of Crossfire 2 tall fescue mowed at 2" and Tifgreen 328 bermudagrass mowed at 5/8"

Application Information: CO_2 Bicycle sprayer
TeeJet 8003EVS Nozzles
Single nozzle
8" boom height
Speed: 1 mph
Output: 2gal/1000ft^2
Pressure: 46psi on tank regulator
Calibration of 1060ml/ nozzle minute

Irrigation Regimes: Standard for bermudagrass and tall fescue turf

Data Collection: Visual control (0-100%) at 3,7, 14, 28, 56 DAT; digital images

Acknowledgments: Special thanks to Monsanto, Dow AgroSciences, and Bayer Crop Protection for providing product for this experiment.


North
7 16 6 12 2 14 9 13 8 3 5 1 15 11 10 4
11 9 12 2 4 10 15 3 1 5 8 6 14 16 13 7
14 4 11 13 9 1 10 3 7 6 12 5 16 8 15 2
11 1 8 14 16 2 10 7 6 15 4 13 5 9 12 3
West
Pathway
East
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

Treatments	**Rate**	**Timing**
1. Roundup PROMAX	4.7 qts/A	29 Days Before Field Day
2. Roundup PRO	7.0 qts/A	29 Days Before Field Day
3. Roundup QuickPRO	1.5 oz/gal	29 Days Before Field Day
4. Scythe	10% v/v	29 Days Before Field Day
5. Finale	6 qts/A	29 Days Before Field Day
6. Roundup PROMAX	4.7 qts/A	14 Days Before Field Day
7. Roundup PRO	7.0 qts/A	14 Days Before Field Day
8. Roundup QuickPRO	1.5 oz/gal	14 Days Before Field Day
9. Scythe	10% v/v	14 Days Before Field Day
10. Finale	6 qts/A	14 Days Before Field Day
11. Roundup PROMAX 3	4.7 qts/A	3 Days Before Field Day
12. Roundup PRO	7.0 qts/A	3 Days Before Field Day
13. Roundup QuickPRO	1.5 oz/gal	3 Days Before Field Day
14. Scythe	10% v/v	3 Days Before Field Day
15. Finale	6 qts/A	3 Days Before Field Day
16. Untreated Control		

The National Turfgrass Evaluation Program at UCR

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The National Turfgrass Evaluation Program (NTEP) is designed to develop and coordinate uniform evaluation trials of turfgrass varieties and promising selections in the United States and Canada. Test results can be used by national companies and plant breeders to determine the broad picture of the adaptation of a cultivar. Results can also be used to determine if a cultivar is well adapted to a local area or level of turf maintenance.

Information such as turfgrass quality, color, density, resistance to diseases and insects, tolerance to heat, cold, drought and traffic is collected and summarized by NTEP annually. Plant breeders, turfgrass researchers and extension personnel use NTEP data to identify improved environmentally-sound turfgrasses. Local and state government entities, such as parks and highway departments, use NTEP for locating resource-efficient varieties. Most important, growers and consumers use NTEP extensively to purchase drought tolerant, pest resistant, attractive and durable seed or sod. It is the acceptance by the end-user that has made NTEP the standard for turfgrass evaluation in the U.S.A. and many other countries worldwide.

NTEP is a cooperative effort between the non-profit National Turfgrass Federation, Inc., and the United States Department of Agriculture (USDA). NTEP is headquartered at the Beltsville Agricultural Center (BARC) in Beltsville, Maryland U.S.A.

NTEP tests are initiated, established, maintained and evaluated using standardized testing protocols. Data is collected across the U.S.A. and Canada by university researchers using standard procedures and formats. Data is submitted to NTEP, computer formatted and statistically analyzed. Annual progress reports are produced for each species tested and at the end of the testing period, a final summary report is produced. NTEP reports can be found at http://www.ntep.org/.

At UCR there are four current NTEP studies:

	entries	date planted
National Tall Fescue	113	Aug 06
National Bermudagrass	31	June 07
National Seashore *Paspalum*	6	June 07
National Zoysiagrass	11	June 07

AG Sod Company has generously helped support the care of the plots in the UCR NTEP program in 2007 and 2008.

2006 NTEP Tall Fescue Trial
(12E-1, 5, 9)

12E-9

N ↑

100	109	40	31	61	103	91	50	11	32
4	65	86	24	25	95	96	111	73	38
93	70	57	9	89	27	64	53	112	43
20	30	21	10	74	19	26	22	56	108
49	52	84	60	72	8	78	62	80	42
14	77	5	6	68	37	82	39	113	28
2	44	17	16	1	79	36	35	66	18
90	63	13	34	88	98	106	23	45	46
97	54	101	105	76	87	15	59	7	3
110	47	58	71	92	48	51	69	41	67
99	107	83	75	94	12	102	29	81	33
104	55	85							

2006 NTEP Tall Fescue Trial
(12E-1, 5, 9)

12E-5

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110
111	112	113							

2006 NTEP Tall Fescue Trial
(12E-1, 5, 9)

12E-1

42	66	111	23	65	13	69	95	99	43
103	50	8	49	110	109	45	88	52	48
72	101	68	19	100	44	78	75	113	73
25	105	92	41	7	67	59	24	79	96
85	77	70	83	57	35	76	9	61	97
62	33	106	46	74	30	51	34	98	28
39	5	36	102	54	56	112	2	90	94
84	26	15	10	107	86	47	14	27	87
16	32	53	22	37	4	12	38	93	104
82	6	58	60	80	18	108	89	29	55
17	71	21	63	11	1	3	64	91	20
31	81	40							

2006 NTEP Tall Fescue Trial
(12E-1, 5, 9)

entry	
1	KY-31
2	Z-2000
3	DP 50-9407
4	DP 50-9411
5	DP 50-9440
6	TG 50-9460
7	Plato
8	Lindbergh
9	Aristotle
10	Einstein
11	Silverado
12	LTP-610 CL
13	LTP-CRL
14	LTP-RK2
15	ATF 1247
16	RKCL
17	RK 4
18	RK 5
19	GE-1
20	SC-1
21	ATF 1328
22	Skyline
23	Hemi
24	Burl-TF8
25	Turbo
26	Bullseye
27	IS-TF-152
28	IS-TF-138
29	IS-TF-147
30	IS-TF-128
31	IS-TF-151
32	IS-TF-135
33	MVS-TF-158
34	IS-TF-159
35	IS-TF-153
36	IS-TF-154
37	IS-TF-161
38	MVS-341
39	MVS-1107
40	MVS-BB-1
41	MVS-MST
42	M4
43	0312
44	PSG-TTST
45	Col-1
46	J-130
47	Col-M
48	Col-J
49	Hunter
50	Biltmore
51	Padre
52	Magellan
53	NA-BT-1
54	NA-SS
55	RP 2
56	CE 1
57	RK 6
58	ATM
59	SH 3
60	BAR Fa 6363
61	BAR Fa 6253
62	RP 3
63	Tahoe II
64	06-WALK
65	Escalade
66	06-DUST
67	RAD-TF17
68	PSG-85QR
69	STR-8GRQR
70	PSG-82BR
71	K06-WA
72	GO-1BFD
73	STR-8LMM
74	STR-8BB5
75	Tulsa III
76	PSG-RNDR
77	PSG-TTRH
78	STR-8BPDX
79	Rembrandt
80	JT-41
81	JT-36
82	JT-45
83	JT-42
84	JT-33
85	BGR-TF1
86	BGR-TF2
87	PST-5HT
88	PST-5WMD
89	AST 7002
90	AST 7001
91	CS-TF1
92	KZ-1
93	LS-11
94	LS-06
95	DKS
96	LS-03
97	GWTF
98	KZ-2
99	AST-2
100	AST-3
101	RNP
102	AST-4
103	AST 7003
104	AST-1
105	J-140
106	ATF-1199
107	Justice
108	Rebel IV
109	Millenium SRP
110	RK-1
111	Rhambler
112	Firenza
113	Falcon IV

2007 NTEP Bermudagrass Trial
(12E-19)

12E-19

8	5	16	13	23	24	7	28
11	27	17	15	6	18	14	1
4	9	3	30	12	20	21	10
2	25	29	19	31	22	26	13
23	8	30	19	22	16	1	27
12	17	14	10	28	25	24	15
3	11	20	2	5	31	29	9
26	6	4	21	7	18	15	24
21	18	12	17	10	11	6	20
22	23	27	28	2	5	16	8
25	19	29	7	30	31	26	4
13	9	14	1	3			

↑ N

2007 NTEP Bermudagrass Trial
(12E-19)

entry	
1	Riviera
2	Princess 77
3	NuMex-Sahara
4	SWO-1070
5	SWI-1081
6	SWI-1083
7	SWI-1113
8	SWI-1117
9	SWI-1122
10	Midlawn
11	Tifway
12	Premier
13	SWI-1057
14	BAR 7CD5
15	PST-R6FLT
16	Sunsport
17	Patriot
18	OKC 1119
19	OKC 1134
20	RAD-CD1
21	OKS 2004-2
22	PSG 91215
23	PSG 94524
24	IS-01-201
25	IS-CD10
26	J-720
27	Yukon
28	Veracruz
29	PSG 9BAN
30	PSG PROK
31	PSG 9Y2OK

2007 NTEP Zoysiagrass Trial
(12E-18S)

N ↑

5	3	6	1	10	9	4
2	7	8	11	7	2	1
5	6	10	8	3	9	4
11	3	4	8	10	7	6
2	11	5	1	9		

entry	
1	Zenith
2	Meyer
3	Zorro
4	DALZ 0501
5	DALZ 0701
6	DALZ 0702
7	Shadowturf
8	L1F
9	29-2
10	240
11	380-1

randomization from www.randomization.com (5/31/07):

	block		
order	1	2	3
1	5	7	3
2	3	2	4
3	6	1	8
4	1	5	10
5	10	6	7
6	9	10	6
7	4	8	2
8	2	3	11
9	7	9	5
10	8	4	1
11	11	11	9
seed	8214	8222	6224

2007 NTEP *Paspalum vaginatum* Trial
(12E-18N)

7

7	5	6	2	4	3	1	3
	6	1	5	2	4	5	4
	6	1	3	2			

↑ N

entry

1	Salam
2	Sea Isle 1
3	SRX 9HSCP
4	UGA 7
5	Uga 22

Sampling for Plant Parasitic Nematodes in Turf

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Nematode-caused disease symptoms often resemble other problems such as fungal root diseases, insect damage, soil compaction, nutritional deficiencies or watering issues. Any turf sample will contain hundreds or thousands of nematodes, but most of them do not feed on plants. Identification of plant parasitic nematodes requires the use of a microscope. Nematodes that feed on plants differ in their ability to cause damage and correct diagnosis is essential in order to take appropriate countermeasures. Timely diagnosis of nematode-caused symptoms helps to avoid wasteful fertilizer or pesticide applications. In order to determine if plant-parasitic nematodes are causing a turf problem, samples need to be analyzed by an experienced nematode diagnostician. The quality of the sampling and the condition of the sample at the time it is processed determines the accuracy of the results.

A soil sampling tube, approximately 1 1/2 inch in diameter and 6 inches long, is the most appropriate tool. Nematodes do not occur uniformly distributed in soil; one individual sample might miss them completely or hitting a "nest" might vastly overestimate their occurrence. Randomly taking 15-20 soil cores from the root zone, combining and mixing them carefully in a bucket and taking about a quart as a sub-sample improves the precision of the analysis. It is essential that some roots are included.

Nematode-caused problems in turf often appear as circular damage with the grass in the center most affected. By the time the damage becomes apparent, the nematode population might already be reduced in the center because of lack of healthy roots. Consequently, it is preferred to take the samples from the outer region of the damaged area were roots still support a high nematode population. It is very helpful for the interpretation of the results if another sample is included from an area that appears to be unaffected.

Extraction methods differ among labs and some require the nematodes to be alive and actively moving. Use a sturdy plastic bag, seal it to prevent drying, and attach a label to identify the individual sample. Keep samples cool (50-58°F), pack them in a sturdy box and use next-day shipping.

To help the interpretation of the data, provide the lab with as much background information as possible on a separate sheet of paper (i.e. name, address, sample location, soil type, grass species, notable symptoms (yellowing/browning, root rotting or stunting, swellings or galls on root tips or distributed on all roots, last nematicide treatment with product name and application rate).

Breeding and Genetics for Improved Turf Quality and Stress Resistance

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Development of Intergeneric Hybrids of Ryegrasses with Fescues as new Stress and Pest Resistant Turfgrasses

Cool-season turfgrasses are important throughout the United States because of their adaptation to cooler climates, shade, and ability to maintain lush color year-round in warmer climates with supplemental irrigation. However, increased drought frequency and diminishing water resources are jeopardizing the future of turf and its benefits to urban culture, the environment, and the economy. This project aims to combine the desirable characteristics and mitigate the deficiencies of existing turfgrasses by developing turf-type intergeneric hybrids of *Lolium* and *Festuca,* or *Festulolium.* We have already developed a population with an extraordinary capacity to survive without supplemental irrigation in southern California. We will continue to select in the populations of perennial ryegrass, *L. perenne, x* meadow fescue, *F. pratensis,* hybrids for the best combinations of turf characteristics, specifically focusing on drought, heat, and disease resistance. To understand the genetics of turf characteristics, we have developed a set of single chromosome introgressions from *F. pratensis* into *L. multiflorum* and use them to assign desirable characteristics to individual chromosomes and their segments, and to tag such segments with molecular markers for marker assisted selection. Diversity Arrays Technology (DArT) will be used to aid in the discovery and scoring of genetic polymorphic markers with greater efficiency and much lower cost. At the conclusion of this project, the combined efforts of breeding, genetics, agronomy, and plant pathology will hopefully lead to the commercial release of improved turf-type *Festulolium* hybrids. Moreover, we will provide end-users with best management practices for successful establishment and culture.

Selection and Molecular Identification of Traits Responsible for Winter Color Retention, Shade Tolerance, and Stress Resistance in Warm-Season Turfgrasses

Despite the aforementioned strides to improve stress and pest resistance among cool-season turfgrass species, the future of turfgrass culture in southern California and other climates where water resources are diminishing lies with warm-season turfgrasses which are better adapted to drought and heat. However, widespread acceptance among end-users requires that warm-season turfgrasses maintain green color throughout the colder winter months and survive under low light conditions from neighboring trees and frequent cloud cover. We intend to focus our efforts primarily on bermudagrass by evaluating both commercially available and experimental germplasm under field conditions in Riverside. We will also examine kikuyugrass from populations originally collected by Dr. Cheryl Wilen because this species possesses among the best winter color retention among the warm-season turfgrasses and because we believe that there is potential for further improvement of kikuyugrass as a desirable turfgrass species. Once again, our trans-disciplinary approach hopefully will lead to the commercial release of warm-season turfgrasses that are better adapted to meet the challenges that await our industry.