

Better Turf Thru Agronomics

UCRTRAC Newsletter, April 1998

Turf Research Makes Good Business Sense: UCRTRAC's Impact in Southern California Presented in Annual Research Report

By Deborah Silva

Within its first two years of operation, the UCR Turfgrass Research Advisory Committee (UCRTRAC) is impacting the golf industry and general turf and sod interests in Southern California. UCRTRAC supports turf research to improve the playing surface for golf, baseball, and other sports; preserve the environment; increase the efficient use of inputs; develop unbiased information on cultivars and products (fertilizers, pesticides, equipment); decrease operating costs; and stay abreast of innovation. Member organizations represent golf course superintendents, professional golfers, sod producers, general turfgrass interests, and UCR researchers with expertise in turf improvement, physiology, and culture.

The Southern California golf industry is one of the largest in the world. The region's 10 counties have 464.5 18-hole equivalent golf courses, according to the National Golf Foundation (NGF, Table 1). More than \$385 million is spent on golf course maintenance, equipment, and capital expenses in Southern California every year (Table 1).

Ten to 11% of Californians participate in golf, according to the NGF, which means Southern California is home to more than 2 million golfers. In the region, golfers play, on average, 53,000 rounds of 18 holes at each course yearly, according to the NGF, which equates to more than 24.6 million rounds of golf per year in Southern California.

"A golf course is a living organism with many dynamic features. Maintaining it for optimum performance, manicured appeal, and sensitivity to environmental concerns requires a working marriage between agronomics and business interests. Supporting scientific research makes good business sense because research can reduce operating expenses for maintaining quality turf, while at the same time improving playing conditions for our members," said **John Martinez**, Superintendent, Southern California Golf Association (SCGA) Members' Club in Murrieta and UCRTRAC delegate.

"Research can strengthen environmental compliance and cost effectiveness by elucidating the impacts of fertilizers and pesticides and fine tuning the need for specific inputs," he said.

Statewide, California has 942 golf courses, with 20 new openings in 1997 and 71 under construction as of Dec. 31, 1997, according to the NGF. The NGF ranks California #1, for the state with the highest number of golfers age 12 and over.

Table 1. 18-Hole Equivalent Golf Courses in Southern California by Golf Course Type, Including Expenditures for Maintenance, Equipment and Capital Improvements

County	-----Course Type-----			Total ^a
	Daily Fee ^a	Municipal ^a	Private ^a	
Riverside	60.5	6.5	59.5	126.5
Los Angeles	21.5	46.5	35.5	103.5
San Diego	42.5	9.0	27.5	79.0
Orange	21.5	9.0	22.0	52.5
San Bernardino	16.5	5.5	10.0	32.0
Ventura	6.0	6.0	8.5	20.0
Kern	5.5	6.0	7.0	18.5
Santa Barbara	8.5	1.0	8.0	17.5
San Luis Obispo	6.0	4.0	1.5	11.5
Imperial	3.0	0	0	3.0
Totals	191.5	93.5	179.5	464.5
Expenses Per 18 Hole-Equivalent Golf Course^b (\$Thousands)				
Mean Maintenance Expenses^b	\$581.7	\$825.0	\$796.2	\$776.3 ^c
Mean Equipment & Capital Expenses^b	\$48.5	\$37.5	\$57.7	\$53.1 ^c
Mean Total Expenditures^b	\$630.2	\$862.5	\$853.9	\$829.4^c

^aSource: **National Golf Foundation**, March 1998. All golf courses are categorized as daily fee, municipal, or private in the NGF database. The total reported (464.5) represents all 18-hole equivalent golf courses in the region. ^bSource: **Golf Course Superintendents Association of America Research**, 1998. ^cThe total means provided by the GCSAA are not derived solely from the mean expenses of the three NGF golf course types (daily fee, municipal, private) because the GCSAA database has other golf course type categories that are included in the totals reported. The three total mean expenses reported here are totals representing all 18-hole equivalent golf courses in the region.

Turf Biotech at UCR: Identifying LFR Genes to Reduce Irrigation Costs, Conserve Water, and Improve Drought Resistance

Maintenance costs will be reduced and research progress will accelerate when turf improvement to conserve water occurs at the molecular, cellular, physiological, and whole-plant levels.

Turfgrasses differ significantly in their ability to remain green and functional during drought conditions, a plant response known as leaf firing resistance (LFR). When scientists can identify regions of the genome that contain genes which confer the LFR trait, then breeding grasses with drought tolerance will be speeded up because the screening and selection process will be aided by state-of-the-art 'molecular-marker-assisted' technology. The practical benefit to the turf industry is that maintenance costs for water will be reduced due to broader availability of drought-tolerant turf.

About 25% of water delivered by the Metropolitan Water District in Southern California is used for landscape irrigation, including turf. Some golf courses in the region spend \$50,000 to \$100,000 per year on irrigation. A 15% to 25% reduction due to less thirsty turf would be a significant monetary savings.

"Developing a rapid screening procedure for the LFR trait is important because it will accelerate breeding turf that conserves water by permitting increased time between required irrigations. Irrigation costs would be reduced and demand for limited water resources would decline while still maintaining green, functional turf," said **Robert Green**, UCR Turfgrass Research Agronomist.

Green teamed up with UCR Geneticist **Tim Close** and UCR Plant Physiologist **Jodie Holt** and recently completed a two-year study to identify a rapid screening procedure to select for LFR among turf-type bermudagrasses, such as 'Arizona common' (Fig. 1). Results will be applicable to other turf species.

"When we undertook this research, no definitive molecular markers had been associated with drought tolerance in any plant," Close said.

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Demystifying Biotech: A Useful Tool For Plant Improvement

Communicating about genetic engineering and biotechnology is a challenge because the terminology can be overwhelming. For a commodity like turf, the bottom line is the most important point: These technologies are just new tools that fine-tune the research process so that scientists can meet the needs of end-users more efficiently.

Turf researchers who specialize in whole-plant agronomics now have the opportunity to partner with scientists who specialize in working at the molecular level -- with genes, with pieces of DNA -- so that future turf improvements can be more trait-specific and customized and the screening process accelerated.

Scientists have always been "genetic engineers" because they manipulate ("engineer") the genetic makeup of plants via selection for specific, inherited traits (disease or pest resistance or drought tolerance), but they have worked at the whole-plant level, which can be tedious and slow.

However, a new synergism can occur when whole-plant researchers team up with a colleague whose expertise is in the lab, deep inside plant cells, who knows how to identify genes and the proteins they code for; how to insert genes into a turf plant to transform it to express traits from other sources, if needed; and how to identify "molecular markers" and "map" the major genes that code for a desired trait. The accompanying article on turf biotech at UCR is one example.

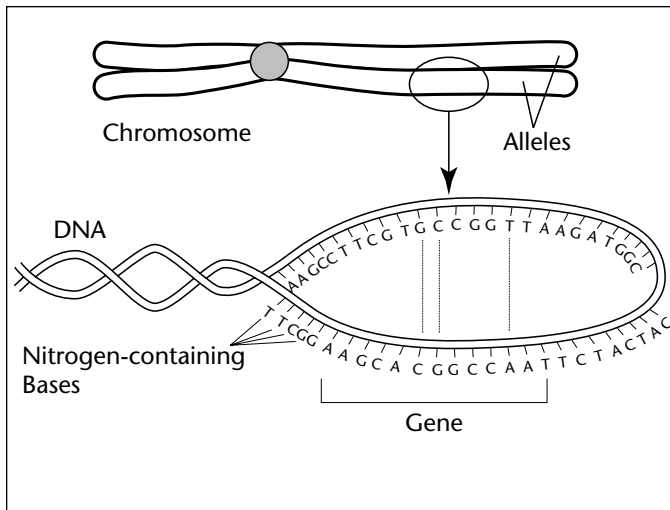


Fig. 1. 'Arizona common' bermudagrass, a tetraploid, has 36 chromosomes in each cell. Depicted is one chromosome with two alleles, its alternative forms. Chromosomes are thread-like structures found in the nucleus of each cell. Shown on one segment of one allele is a hypothetical gene, a piece of DNA (deoxyribonucleic acid) that stores genetic information and contains instructions for an inherited trait. Many inherited traits, such as drought tolerance, are controlled by several genes working together and are known as "quantitative traits." Genes typically code for proteins, such as enzymes. The letters refer to the nitrogen-containing "bases" adenine (A), guanine (G), cytosine (C), and thymine (T), components of the DNA molecule, which is configured in a double helix. Genes vary in length. Shown is a hypothetical gene consisting of 13 base pairs. G pairs with C and A pairs with T. Plants contain DNA in the cell nucleus and in chloroplasts and mitochondria, two other important organelles in plant cells.

Kikuyugrass Can Provide High-Quality Turf With the Right Maintenance

Rather than fight this noxious weed, some turf managers have adopted a different strategy: Use best management practices to transform kikuyugrass into high-quality turf.

Since kikuyugrass (*Pennisetum clandestinum*) is such an invasive, noxious weed, it has become an important turfgrass by default in many locations in California. Rather than continually fighting kikuyugrass with sequential herbicide applications, which UCR weed scientists have shown to be effective (see Nov. 1996 issue of *Better Turf Thru Agronomics*), an alternative strategy is to adopt maintenance practices that convert the unwanted kikuyugrass into a high-quality turf, which is exactly what some turf managers have decided to do.

If low- and high-maintenance turf facilities, such as parks, home lawns, and golf courses, are located in a kikuyugrass-infested region, they will probably convert to kikuyugrass, regardless of the species in the original sward because kikuyugrass is such an aggressive invader.

"Several golf courses, including upscale facilities, are successfully managing kikuyugrass as high-quality turf. To determine the best management practices to maintain kikuyugrass, we conducted studies on ecology, fertilization, mowing, and overseeding," said **Steve Cockerham**, Superintendent of UCR's Agricultural Operations.



KIKUYUGRASS *Pennisetum clandestinum*
Drawing courtesy of Tom Yutani

Fertilization, Traffic, and Thatch. Applying 2.0 lb of nitrogen (N) per 1,000 sq. ft in April reduced kikuyugrass quality compared to 1.0 lb N. Three applications of 1.0 lb N per 1,000 sq. ft in April, June, and August produced high quality, traffic-tolerant kikuyugrass but led to heavy thatch buildup without traffic. Five applications of fertilizer per year at 0.5 lb N per 1,000 sq. ft in May - September produced good quality, but less traffic-tolerant kikuyugrass turf. Thatch increased with increasing N without traffic or vertical mowing.

Vertical Mowing. Traffic alone will reduce thatch, but on kikuyugrass with no or low traffic, vertical mowing should be performed three times per season, in May, July, and August.

Mowing. Due to selective pressures, mowing favors plants with a prostrate growth habit, such as kikuyugrass, which spreads mainly by rhizomes and stolons. Mowing heights for kikuyugrass range from 0.5 - 2 in., depending on use. Fairway-quality turf and sports fields are maintained at 0.625 in. Golf course roughs are maintained at 2 in. or higher.

Overseeding. Tall fescue is the better choice for overseeding because it competes better with kikuyugrass in the fall than perennial ryegrass. The optimum overseeding rate that we have found is about 10 lb per 1,000 sq. ft. (See the March 1997 issue of *Better Turf Thru Agronomics*.)

SCGA Members' Club Participates in a National Putting Green Trial with UCR Turf Researcher

Jointly sponsored, on-site turf performance evaluations are a new strategy to address end-user needs.

Robert Green, UCR Turfgrass Research Agronomist, will conduct a five-year study on bentgrass and bermudagrass putting greens as part of the National Turfgrass Evaluation Program's (NTEP) on-site cultivar testing and performance evaluation.

The study will be at the Southern California Golf Association (SCGA) Members' Club in Murrieta.

"We are excited to provide our membership with live research that they can putt on," said **Thomas Pinch**, General Manager of the SCGA Members' Club.

The two test greens, located between the club's grill room and the ninth green, will be in regular use as practice putting greens during the five-year research program.

Green's research is one of 16 projects nationwide to be conducted on actual golf course settings. The study is sponsored jointly by the NTEP, the U.S. Golf Association (USGA), and the Golf Course Superintendents Association of America (GCSAA).

Although on-site cultivar testing is not a new concept, joint sponsorship of on-site putting green trials is new, said **Bob Shearman**, Executive Director of the NTEP. "Superintendents have long asked for information that bridged the gap between small-plot university trials and their end-use needs," he said.

"It is an honor to be part of the national study. We are managing and maintaining the research site so that reliable data can be collected," said **John Martinez**, Superintendent, SCGA Members' Club.

Green will cooperate with Martinez and **Pat Gross**, Southwest Region Director, USGA Green Section.



"A common research approach is to consider genes that are switched on in response to stress as 'candidate genes' for heritable tolerance. Studies in other plant species had already identified about 15 distinct families of proteins, many of which are referred to as LEA (late embryogenesis abundant), which together can become as much as about 20% of total soluble protein in plants in response to stresses that have a dehydration component. Many of these proteins also are produced in response to low temperature," he said.

"But in turf," Close said, "there were no published studies of changes in gene expression and only a few reports of changes in protein synthesis associated with drought stress, so the LEA proteins seemed like a good spot for us to tee off our molecular effort."

Close's UCR lab has focused on the LEA proteins for several years and has recently found evidence from studies on corn and barley that these proteins serve as surfactants to preserve the structural integrity of the cell's interior. Close and his staff applied their expertise to turf for the first time in their collaboration with Green and Holt.

**"...the LEA proteins seemed
like a good spot for us
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Dr. Tim Close, UCR Geneticist

"Our objective in this study was to work together to identify molecular, cellular, physiological, and whole-plant markers that are closely associated with LFR," Holt said.

Root development and the ability of the root system to mine water out of the soil are closely associated with LFR in bermudagrass and were an integral focus of the screening procedures, Green said. The plant hormone abscisic acid (ABA) allows root growth to continue during dehydration. Dehydration sources, such as drought or cold temperatures, will induce the production of ABA and LEA proteins, he said.

Preliminary results show that it takes representative growth of the root system to express the LFR trait with fidelity, Green said. Research done in pots in the glasshouse will not be predictive of actual field results due to the depth limitations on the root system, he said.

The UCR scientists hope to build a research program capable of mapping the major genes controlling LFR using the same technology that has been successful in cereal grasses for other traits. Molecular markers, including LEA-encoding and other candidate genes can then be tested for genetic association with the LFR trait, Close said.

"Ultimately," Close said, "if there is an association between changes in gene expression of suites of stress-related genes and the LFR trait, which would be consistent with what has been observed in cereal grasses in regards to various environmental stresses, then LFR genotypes could be readily screened and selected in a breeding program by using markers derived from these genes."

The Southwest Consortium on Plant Genetics and Water Resources funded the UCR study, which was the first turf research funded by that program.

Management of Annual Bluegrass Putting Greens Studied in First GCSAA Chapter Cooperative Research Program in California

Robert Green, UCR Turfgrass Research Agronomist, and **Vic Gibeault**, Extension Environmental Horticulturist, have been awarded California's first Golf Course Superintendents Association of America (GCSAA) Chapter Cooperative Research Program matching grant.

Fertility and Hydroject treatments will be tested to determine their effects on annual bluegrass performance and soil conditions.

"This is an important research project because it will investigate some of the more common putting green management practices to help solve problems associated with the maintenance of annual bluegrass putting greens in California," said **John Pollok**, President, California Golf Course Superintendents Association (CGCSA) and Superintendent, El Caballero Country Club in Tarzana.

Annual bluegrass is the major putting green turf in Southern California, he said. In more inland, hotter locations, such as Palm Springs, bermudagrass and creeping bentgrass putting greens are maintained, Pollok said.

The CGCSA matched resources from the GCSAA Foundation to underwrite the three-year UCR study, which will be conducted at the Industry Hills Golf Courses beginning this month. The CGCSA is composed of six chapters (Hi-Lo Desert; Southern, Northern, and Central California; San Diego; and Sierra Nevada), which are all contributing to the study.

Cooperators are **Bert Spivey**, Superintendent, Industry Hills Golf Courses; and UC's **Steve Cockerham** and **Janet Hartin**.



Nitrogen and Iron Enhance Zoysia Winter Color Better Than Overseeding When Temperatures Are Moderate, Reducing Maintenance Costs

Where winter temperatures and the chilling influence are moderate, the value of overseeding may not be worth the economic or horticultural costs of reduced sward quality the following summer since N and Fe enhance zoysia winter color significantly and sufficiently under these conditions.

Nitrogen (N) and iron (Fe) applications during late fall and winter significantly enhance winter color performance of two recently patented UC Riverside zoysiagrasses, 'De Anza' and 'Victoria', making overseeding unnecessary where winter temperatures and chilling are moderate.

'De Anza' and its sibling, 'Victoria', will be available commercially for the first time in 1998. 'De Anza' and 'Victoria' have good potential for use on golf courses, playgrounds, parks, and home lawns. 'De Anza' has already been chosen as the turf for the new baseball stadium in Phoenix, home of the Arizona Diamondbacks.

To address industry and consumer demand for green lawns and playing fields year-round, UCR turf researchers continue to evaluate economical cultural methods that will enhance winter color retention in warm-season grasses.

"'De Anza' responded very strongly to nitrogen fertilization by consistently giving high color ratings during winter months. Iron moderately influenced the winter color of 'De Anza'. In contrast, 'Victoria' showed winter color improvement with iron alone, as well as with nitrogen fertilizers," said **Vic Gibeault**, Extension Environmental Horticulturist at UC Riverside.

There were no significant differences between ammonium sulfate and calcium nitrate nor between applications once every 2 weeks or once every 4 weeks for either variety, Gibeault said. The magnitude of the N effect was approximately 2.7 units (rating scale of 1 to 9) for 'De Anza' but only 1.3 for 'Victoria'.

With both grasses, N and Fe treatments resulted in better color retention than N or Fe fertilization alone; however, 'De Anza' was influenced much more by N, while 'Victoria' was influenced much more by Fe.

In a related study to evaluate the effects of overseeding on color retention, 'De Anza' zoysia was overseeded with perennial rye (*Lolium perenne* L.), tall fescue (*Festuca arundinacea* Schreb.) and *Poa bulbosa* L. Overseeding provided slightly improved cool-period turfgrass quality, but, during the following warm period, the competitive cool-season grasses resulted in slightly less desirable turfgrass stands because of reduced uniformity of growth and color.

The two studies are published in the *International Turfgrass Society Research Journal* (Vol. 8, 1997). Gibeault cooperated with **Steve Cockerham**, Superintendent, UCR Agricultural Operations, and their staff research associates.



'De Anza' Zoysia To Make Its Major League Debut

'De Anza' zoysia is an important new turfgrass for many sports facilities in the west, including home lawns. Mowing heights of 3/8", 1/2", and 3/4" are acceptable.

After years of development and evaluation by UCR turf researchers, 'De Anza' zoysia will make its major league debut this spring in Bank One Ballpark in Phoenix, the home of the Arizona Diamondbacks, a new baseball franchise.

The new stadium presents novel, low-light and air movement situations due to its retractable roof, and 'De Anza' has tested as the sports turf of choice for such challenges.

"'De Anza' has an important role to play in sports fields where warm-season grasses are adapted because it has good color, texture, density, uniformity, shade adaptability, and traffic tolerance, and it can be maintained at varying mowing heights, depending on the requirements of the facility," said **Vic Gibeault**, Extension Environmental Horticulture Specialist at UCR. 'De Anza' will be



available commercially for the first time this year.

Mowing heights of 3/8", 1/2", and 3/4" are acceptable for optimum growth and development of 'De Anza', according to recent studies at UCR published in the *International Turfgrass Society Research Journal* (Vol. 8, 1997).

The study showed that repeated vertical mowing reduced sponginess and increased firmness by 16% in the summer and by 34% in the autumn.

Zoysias tolerate heat, drought, salinity, and heavy traffic, have lower maintenance requirements than most other grasses, and are not usually susceptible to disease, insect pests, or weed invasion problems.

UCRTRAC RESEARCH

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"Our cultivar evaluations, environmental and management studies, and product testing can improve the playability and visual quality of the playing surface. We are confident that adoption of our research findings can help to deliver the same quality turf product and more efficiently. When you're talking about a regional golf industry with expenditures of more than \$385 million for maintenance, equipment, and capital expenses in Southern California, the savings associated with research and education can be significant. Our intent is to be of service to the turf industries in Southern California, and one of the benefits of our research and education is that we can improve the bottom line for our UCRTRAC industry clientele," said **Robert Green**, UCR Turfgrass Research Agronomist.

"The more long-term research on turf physiology, biochemistry, and genetics complement the short-term projects and lead to long-term progress for the industry," he said.

Listed in Table 2 are the projects summarized in Green's recent annual report to UCRTRAC delegates. Green is the principal investigator on 24 research projects since the inception of UCRTRAC in 1996 that impact golf course turf, general turf, and sod interests.

"Support from the UCRTRAC member organizations has added new dimensions to UCR's Turfgrass Research Program and has made possible additional projects with end-user needs as their focus," said **Vic Gibeault**, Extension Environmental Horticulturist.

Table 2. Research Projects in the 1997 UCRTRAC Annual Research Summary

I. Six UCRTRAC Research Projects Completed and Final Research Report Prepared in 1997

- Two-Year Evaluation of Nitrogen Products Applied on Tall Fescue in Riverside, CA: 1995-1997 ■
- 1996-1997 Evaluation of Slow-Release and Fast-Release Nitrogen (N) Fertilizer Products Applied on an Overseeded Common Bermudagrass During the Cool Season ● ■
- One-Year Evaluation of Iron Applications Applied With Three N Fertility Rates on Tall Fescue in Riverside, CA 1996-97 ■
- Annual Evaluation of Bio-Feed Fertilizer on Tall Fescue ■
- Evaluation of the Phytotoxicity of Six Experimental Aqueduct Formulations Applied on a Creeping Bentgrass Putting Green in August ●
- Evaluation of Experimental Coated Urea Fertilizers on Kentucky Bluegrass During the Cool Season ■

II. Ten UCRTRAC Research Projects In Progress in 1997

- Maintaining Putting Green Soil Aeration and Leaching Capability During the Summer with a Toro Hydroject ●
- Improvement of the Spring Transition of Overseeded Bermudagrass Putting Greens in the Coachella Valley ●
- Influence of Primo on the Water Stress Relations of Tall Fescue During the Warm Season ● ■
- Nitrogen Leaching and Best Management Practices for Overseeded Bermudagrass Fairways ● ■
- UCR Bentgrass Variety Trials ●
- Measurement and Model Prediction of Pesticide Partitioning in Field-Scale Turfgrass Plots ● ■
- Characterization of Markers for Leaf Firing Resistance Among Turf-Type Bermudagrasses ● ■
- Influence of Primo on Total Nonstructural Carbohydrate Partitioning of Tall Fescue ● ■
- Influence of Irrigation Frequency when Irrigating Bermudagrass and Zoysia Below ET Crop During the Warm Season ● ■
- Study of the Efficacy of Agrium Controlled Release Urea on Established Tall Fescue in Southern California ■

III. Five New UCRTRAC Research Projects on the Books

- The Development of Irrigation and N Fertilization Programs on Tall Fescue to Facilitate Irrigation-Water Savings and Fertilizer-Use Efficiency ■
- Management of Annual Bluegrass Putting Greens in California ●
- GCSAA, USGA, and NTEP On-Site Testing Program for Bentgrass and Bermudagrass on USGA Specification Golf Course Putting Greens ●
- Minimizing Nitrate Leaching and Salt Accumulation in a Creeping Bentgrass Putting Green Irrigated with High-Salinity Water ●
- Risk Assessment of Human Exposure and Risk Management of Chemical Pesticides and Fertilizers Used on Golf Courses ● ■

● Golf course turf ■ General turf and sod production.

Better Turf Thru Agronomics is prepared for the delegates and membership of the University of California, Riverside Turfgrass Research Advisory Committee (UCRTRAC). Member organizations are the Southern California Golf Association; California Golf Course Superintendents Association (GCSA); GCSA of Southern California; San Diego GCSA; Hi-Lo Desert GCSA; California Sod Producers Association; Southern California Section, Professional Golfers Association; Southern California Turfgrass Council; Southern California Turfgrass Foundation; United States Golf Association; and UCR. The intent is to present summaries of turfgrass research results and topical information of interest to the Southern California turfgrass industries. The newsletter is written by Deborah Silva and edited by Dr. Vic Gibeault and Dr. Robert Green and designed by Brad Rowe, UCR Creative Design Services.