UNIVERSITY OF CALIFORNIA, RIVERSIDE TURFGRASS RESEARCH PROGRAM

Better Turf Thru Agronomics

UCRTRAC Newsletter, April 1999

Snapshot of the Southern California Golf Industry

1998 Year-End Statistics Highlighted

by Deborah Silva

The golf industry in Southern California is one of the largest in the world. The region's 10 counties had 540 daily fee, municipal, and private golf courses as of Dec. 31, 1998, which converts to 470.5 18-hole equivalents, according to the National Golf Foundation (NGF, Table 1).

Statewide, California had 955 golf courses as of Dec. 31, 1998, according to the NGF. Thirteen courses opened last year, and more than 70 were under construction.

Regional economic data per 18-hole equivalent golf course is provided by the Golf Course Superintendents Association of America (GCSAA) in Table 2. Combining the GCSAA data with NGF data yields reliable documentation that more than $390 million was spent last year on golf course maintenance, equipment, and capital expenses in Southern California.

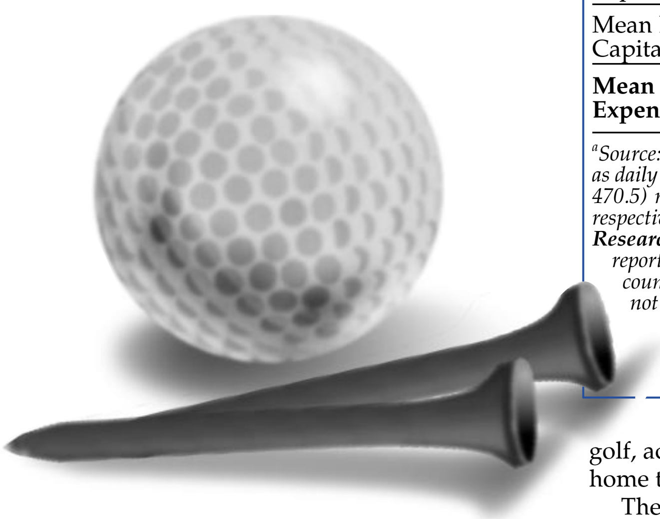
Table 1. Number of Golf Courses in Southern California

	Course Type			
County	Daily Fee[a]	Municipal[a]	Private[a]	Total[a]
Riverside	70	10	71	151
Los Angeles	28	58	39	125
San Diego	48	11	30	89
Orange	23	10	25	58
San Bernardino	18	6	10	34
Ventura	7	7	9	23
Kern	7	6	8	21
Santa Barbara	11	1	8	20
San Luis Obispo	8	5	2	15
Imperial	4	0	0	4
Grand Totals[a]	**224**	**114**	**202**	**540**
18-Hole Equivalent Grand Totals[a]	**191.0**	**97.5**	**182.0**	**470.5**

Table 2. Mean Expenditures Per 18-Hole Equivalent Golf Course in Southern California (Thousands)[b]

	Course Type			
10 County Region	Daily Fee[b]	Municipal[b]	Private[b]	Total[c]
Mean Maintenance Expenses	$581.7	$825.0	$796.2	$776.3[c]
Mean Equipment & Capital Expenses	$48.5	$37.5	$57.7	$53.1[c]
Mean Total Expenditures	**$630.2**	**$862.5**	**$853.9**	**$829.4[c]**

*[a]Source: **National Golf Foundation, March 1999**. All golf courses are categorized as daily fee, municipal, or private in the NGF database. The totals reported (540 and 470.5) represent all golf courses and 18-hole equivalent golf courses in the region, respectively. [b]Source: **Golf Course Superintendents Association of America Research, 1998**. [c]The mean total expenses per 18-hole equivalent golf course reported here represent all golf courses types in the GCSAA database for the 10-county Southern California region. The mean totals 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 has other golf course type categories in its database that are included in the mean total expenditures reported in Table 2.*



The NGF ranks California #1, as the state with the highest number of golfers age 12 and over. In recent years, 10 to 11% of Californians have participated in golf, according to the NGF, which means Southern California is home to more than 2 million golfers.

The median number of rounds played annually at each daily fee 18-hole golf facility in Southern California and Arizona (NGF region 8) was 53,060 in 1994, the most recent NGF data available. Twenty-five million rounds of golf were played last year at all courses in Southern California, using rounds at daily fee facilities as the basis.

Benefits of the Toro® HydroJect® 3000 for Golf Course Superintendents

Soil water infiltration and leaching of salts improve significantly when the summer cultivation program on putting greens includes using a Toro HydroJect 3000 in the raised position.

Using a Toro HydroJect in the raised position significantly increased field infiltration rates and decreased soil salinity during summer cultivation treatments, based on the results of a two-year study on an in-use annual bluegrass/creeping bentgrass practice putting green at Industry Hills Golf Courses in Industry, CA.

Golf course superintendents must employ the best management and cultural practices to reduce annual bluegrass/creeping bentgrass decline in the summer, which otherwise impairs the visual appeal and quality of putting greens in Southern California. Maintaining good soil physical characteristics is absolutely essential for successful putting green management in the summer. At that time of year, the detrimental effects of high traffic and prolonged high temperatures are compounded in soils that have compromised physical characteristics — limited gas exchange, limited soil water infiltration and percolation, and high concentrations of salts — which act together to increase plant stress and summer decline.

"In the raised position, the Toro HydroJect significantly improved field infiltration rates during four of five test dates and decreased the soil's electrical conductivity (EC_e) in the 1- to 3-inch and 3- to 6-inch root zone depth, based on the results of our two-year study. The magnitude of the decrease in soil EC_e is biologically important for management of annual bluegrass putting greens during the summer season," said **Robert Green**, UCR Turfgrass Research Agronomist, who collaborated with **Laosheng Wu**, UCR Irrigation/Water Management Specialist, on the study.

Using the HydroJect equipment in the raised position during the summer can help golf course superintendents in the region to reduce the combined stresses due to high soil and air temperatures, high foot traffic, and soil salinity by improving soil water infiltration and the leaching of salts.

Kit Available Now

"A kit is available now to run the HydroJect 3000 in the raised position," said **Dana Lonn**, Director of Advanced Turf Technology at the Toro Company in Minneapolis, MN. It is just as safe to use the equipment in the raised or lowered position, he said.

"My colleagues are excited about using the HydroJect in the raised configuration because I have told them that it works, based on my personal experience and UCR's research results at our facility," said **Bert Spivey**, Certified Golf Course Superintendent (CGCS) at Industry Hills Golf Courses and President of the GCSA of Southern California.

Please see **HYDROJECT 3000**, *page 4*

What Does EC Mean?

Electrical conductivity (EC) is a measure of the soil salinity or the total dissolved salts in the soil solution (640 ppm = 1 decisiemens (dS)/m). The EC of irrigation water in Southern California (EC_{iw}) ranges from 0.3 to 1.5 dS/m. If the EC_{iw} on a golf course is 1.0 dS/m, which is equal to 640 ppm or 640 mg/L, and the green is irrigated with 3.2 ft/yr, then a 5,000 sq ft golf course green would receive about 640 lb of salts yearly.

Salt inputs are not divided equally throughout the year. Most of the salts are delivered from April through October — about 85 lb/mo/5,000 sq ft green in the example above. Effective irrigation management prevents salts from accumulating to concentrations that damage the turf, particularly in the spring and summer months.

One standard method for measuring EC is to make a saturated paste, take an extract from it, and run the EC of the extract (EC_e), as was done in this study. Another standard technique is to take the EC_{iw}.

Typically, golf course superintendents in Southern California use an EC meter and check the readings from the meter against a calibration curve to get the EC_e value.

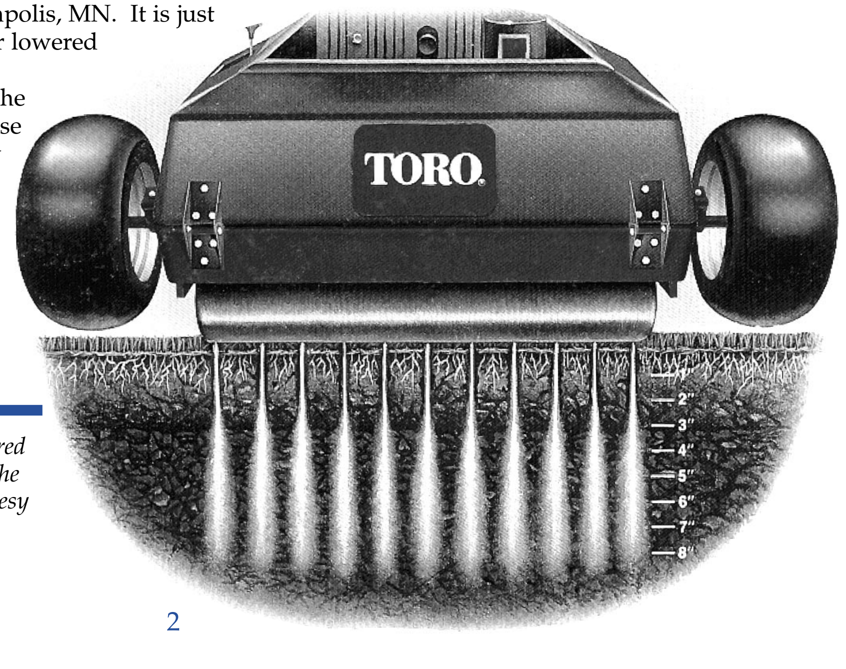


Fig. 1. *Toro HydroJect 3000 shown in the lowered position with 11 nozzles operating. (Photos of the Toro HydroJect 3000 on pages 2 and 4 are courtesy of Toro Company brochure No. 93-30-T.)*

Improvement of Spring Transition on Overseeded Bermudagrass Putting Greens

UCR research has revealed a three-phase pattern in bermudagrass transition in the Coachella Valley.

Research Results from Fall-Applied Treatments to Hasten Spring Transition

A trend emerged in the Coachella Valley to reduce the severity of fall renovation and overseeding of bermudagrass putting greens because it was believed that these practices encourage a more rapid spring transition.

Techniques include applying Primo plant growth regulator to reduce bermudagrass growth in the fall; using higher scalping rates, which leaves more green stubble; not applying diquat on putting greens; and withholding irrigation for a shorter duration.

"Our research revealed a significant pattern in bermudagrass green-up and coverage: Regardless of the fall renovation treatments applied, green-up and coverage showed three distinct phases — initial, lag, and actual transition — that were associated with soil and air temperatures," said **Robert Green**, UCR Turfgrass Research Agronomist, who recently completed a two-year study at Desert Horizons Country Club (Fig. 1).

In the UCR study, the fall-applied renovation treatments included the following: chemical treatments (Reward, Primo at two different rates, and none); two scalping level treatments ("stubble" = 41% bermudagrass green coverage on the day of scalping and "dirt" = 2%); and two seed rate treatments (40 lb perennial ryegrass + 10 lb *Poa trivialis*/1000 ft^2 and 25 lb perennial ryegrass + 10 lb *Poa trivialis*/1000 ft^2.

The initial bermudagrass green-up phase began in mid to late February and lasted until mid to late March when warm air temperatures from noon to 4 p.m. averaged 86°F. During this phase, average bermudagrass green coverage increased from 13% to 34%, Green said.

During the lag green-up phase, which lasted about 6 to 8 weeks, from mid to late March until mid to late May, bermudagrass green coverage remained more or less constant, at an average 36%, he said. Although average soil and air

Please see **SPRING TRANSITION,** *page 5*

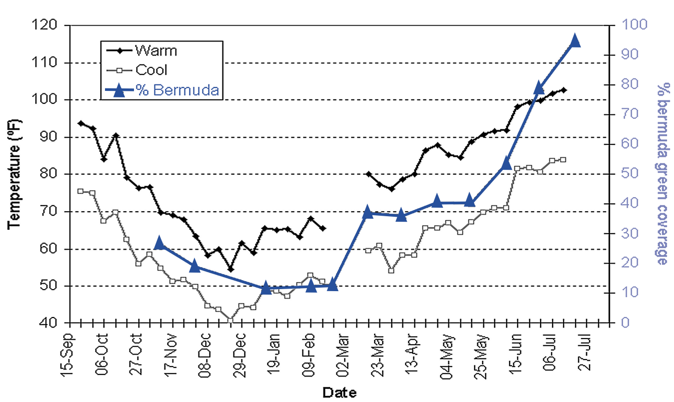


Fig. 1. *Percent bermudagrass green coverage showed three distinct phases — initial, lag, and actual transition — associated with soil and air temperatures. Depicted are average percent bermudagrass green coverage of all treatments and weekly mean warm (noon to 4 p.m.) and cool (2 a.m. to 6 a.m.) soil temperatures on site (2-inch depth) at Desert Horizons Country Club, Indian Wells, CA from 9/22/97 to 7/22/98.*

Background Information

The spring transition of overseeded bermudagrass back to a monostand of bermudagrass is a challenge for golf course superintendents. A literature review, recently published by **Robert Green** in ***Turf Tales Magazine***, highlights the folllowing principles:

Importance of Strong, Healthy Bermudagrass

Maintaining a strong, healthy bermudagrass in late summer and fall is essential for a rapid spring transition. Traits of healthy bermudagrass prior to spring growth include healthy rhizomes, roots, and bud tissue associated with the crown. Factors that increase plant stress, such as freezing temperatures, excess traffic, and extremely low mowing heights, result in weak bermudagrass prior to spring growth.

Influence of Air and Soil Temperatures

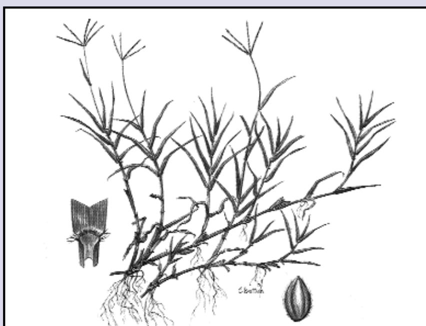
Spring transition occurs when air and soil temperatures favor bermudagrass growth and discourage growth of the cool-season overseed turfgrass. One paper reported that spring transition naturally occurs when soil and air daytime temperatures are above 80°F, when ryegrass roots begin to decline. Another paper reported that competitive bermudagrass growth is associated with air and soil temperatures at about 90°F. A third paper reported that mowing heights can be lowered when night temperatures approach 60°F.

Spring-Applied Treatments to Hasten Transition

Results from studies on spring-applied treatments are not consistent. Timing based on soil and air temperatures is required for success.

Genetic Variation

Genetic variation for spring/summer persistence in overseed turf has been reported. Genetic variation in cultivars of *Poa trivialis* is probable.



Bermudagrass (*Cynodon spp.)*
Illustration by Steve Batten Used by permission
Previously published in a Par Ex brochure ©Steve Batten

HYDROJECT 3000, *Continued from page 2*

"We benefit from opening our golf courses to university research," said Spivey, who cooperated with Green and Wu on day-to-day operations of the research project, which was conducted on one of the in-use practice greens Spivey manages, the Dwight D. Eisenhower practice green, which is 80% annual bluegrass and 20% creeping bentgrass. It is irrigated with effluent water and was constructed to USGA specifications in 1978. The golf courses are located in a mild, midland climate area of the region.

Putting UCR Results in National Perspective

The results from the UCR research add to the national database regarding the importance of turfgrass cultivation, Lonn said.

"Previous research by Paul Rieke at Michigan State and by Jim Murray at Rutgers showed that the Toro HydroJect 3000 increases water infiltration and provides an environment for better rooting. But you can't learn everything about a product's usefulness in one geographical location. Bob Carrow at the University of Georgia showed that the HydroJect in the raised position, used in conjunction with other management practices, such as topdressing, can decrease summer decline of bentgrass greens in the Southeast by managing the surface organic layer," Lonn said.

"In California and other areas of the Southwest, the soil must be leached periodically due to high concentrations of dissolved salts in the water. We were interested in finding out if the HydroJect could facilitate the leaching process. The results from the UCR research are solid evidence that the HydroJect 3000 significantly facilitates the leaching process in the raised position.

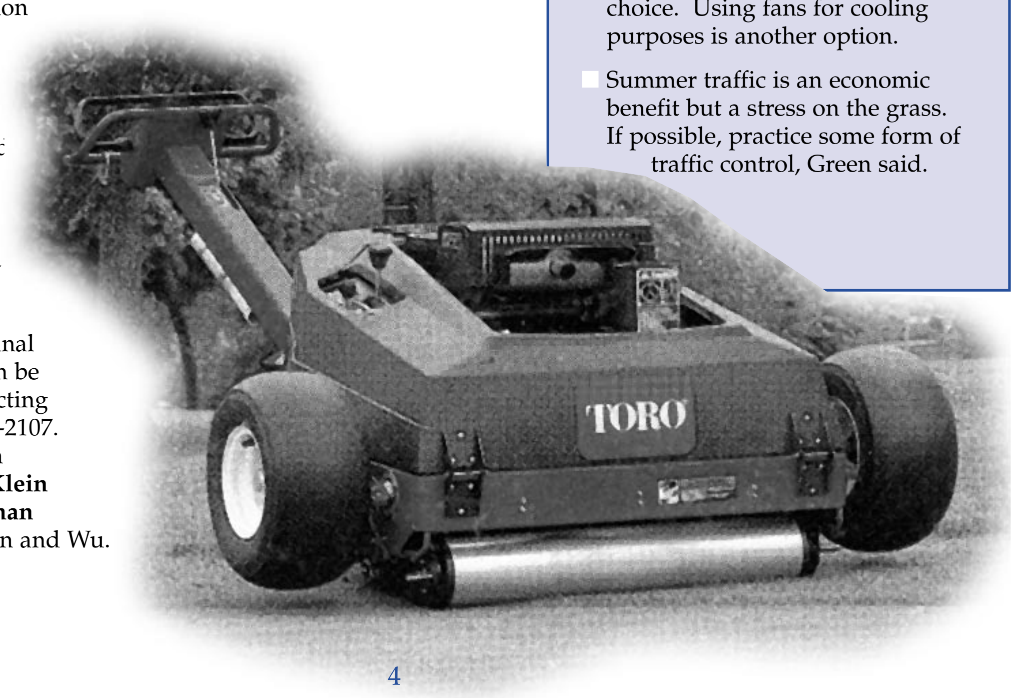
The Toro HydroJect 3000 uses short bursts of high velocity streams of water to cultivate the soil while minimizing surface disruption (Fig. 1). The equipment enables turf managers to use less plant stressful techniques to cultivate the soil, which is particularly helpful during the summer when annual bluegrass/creeping bentgrass is growing under stressful environmental conditions in Southern California.

The equipment did not have a significant effect on the soil's air-filled porosity, total porosity, and bulk density for a 19-week period at the 0.4 to 2.4-inch soil depth zone at 8 to 9 days following cultivation treatments, which was not unexpected, since creating channels does not alter soil texture. Results for the oxygen diffusion rate at the 1-inch soil depth 8 to 11 days following cultivation treatments were also insignificant using the HydroJect in the raised and lowered positions. The effects of the HydroJect on root mass density were also insignificant, Green said.

A copy of the final research report can be obtained by contacting Green at (909) 787-2107. UCR staff research associates **Grant Klein** and **Ralph Strohman** worked with Green and Wu.

Summer Management Principles

- Summer cultivations are not a substitute for spring and/or fall hollow-tine coring, followed with topdressing, Green said. Summer cultivation treatments are probably effective in reducing soil salinity due to surface/upper root-zone phenomena that limit water infiltration and percolation through the root zone, he said.
- Light topdressing (0.5 ft^3/1000 ft^2) has been shown to decrease surface soil organic matter (0 to 1.2 inches) and may be practiced from early to mid-summer. A knowledgeable fungicide program should be practiced at this time. Spoon-feeding fertilizers during the summer is highly recommended, Green said. Foliar applications of iron seem to improve annual bluegrass/creeping bentgrass.
- Hand-watering and wetting agents are effective when hydrophobic soil surfaces and layers impede water uptake.
- A higher height of cutting and a lower mowing frequency will improve annual bluegrass/creeping bentgrass putting greens in the summer.
- "The most successful way to cool grass is to move air across the canopy," Green said. If low air movement is a problem, thinning vegetation surrounding the green is the management alterntive of choice. Using fans for cooling purposes is another option.
- Summer traffic is an economic benefit but a stress on the grass. If possible, practice some form of traffic control, Green said.



New UCR Technique Gives Turf Managers An Easy Way To Increase Irrigation Efficiency

For the first time, a simple solution corrects for lateral flow and ring geometry in measurements of infiltration rate by single ring infiltrometers.

UCR Irrigation/Water Management Specialist **Laosheng Wu** of the Department of Environmental Sciences has developed a simple, practical method to measure the vertical infiltration capacity of the soil. Water infiltration into soil from ponded sources is of interest for many scientific and engineering aspects of water management, including irrigation, runoff prediction, and contaminant transport.

The rate at which water can be applied to the soil surface without generating runoff is determined by the one-dimensional (1-D) final vertical infiltration capacity of the soil, which can now be solved easily. Wu's method uses single ring (SR) infiltrometers and is based on knowing the soil's hydraulic properties, ring geometry, and boundary conditions.

Water flow into soil from a ring infiltrometer represents a three-dimensional (3-D) water flow. Thus, the total infiltration capacity from the ring can be divided into two components: (a) vertical infiltration capacity and (b) infiltration capacity due to lateral seepage (horizontal flow) driven by matric force. The contribution of lateral flow to the total infiltration capacity measured is affected by soil texture and water content, among other factors.

Using numerical simulation and scaling techniques that model water flow in the field, Wu quantified the effects of soil conditions and ring geometry on infiltration rates and developed simple equations to solve for the soil's vertical infiltration capacity ($i_{1\text{-}D}$).

Wu found that the steady-state vertical infiltration capacity of the soil ($i_{1\text{-}D}$) and the infiltration rate measured by a SR infiltrometer (i_f) differ by a factor of f, which is expressed by Eq. (1):

$$i_f = f\, i_{1\text{-}D} \qquad (1)$$

Turf managers can measure the infiltration rate using SR infiltrometers and can calculate f independently using the hydraulic properties of the soil, ring geometry, and initial and boundary conditions, as expressed in Eq. (2)

$$f = (H + 1/\alpha)/(d + r/2) + 1 \qquad (2)$$

where H (cm) is the ponding depth; d (cm) is the ring insertion depth; and r (cm) is the ring radius. Typical α values for sand, loam, and clay may be approximated by 0.36, 0.12, and 0.04, respectively. Since golf course greens are sandy, an α value of 0.36 can usually be used in Eq. 2.

Practical Applications

All turf managers need to do is use the value of f from Eq. (2) in Eq. (1) along with the infiltration rate measured experimentally by the SR infiltrometer (i_f). The ratio of i_f/f gives a measurement of the 1-D vertical infiltration rate of the soil ($i_{1\text{-}D}$). Making these calculations can reduce runoff and increase irrigation efficiency, Wu said.

Spring Transition

Continued from page 4

temperatures warmed up a little during this period, the average *cool* soil and air temperatures (2 a.m. to 6 a.m.) were 64°F and 57°F, respectively.

The actual bermudagrass transition occurred in phase three in a 6-week to 8-week period when the average percentage of bermudagrass green coverage jumped from 50% to 92.9%, which occurred from mid to late May to mid to late July. The average cool soil and air temperatures (2 a.m. to 6 a.m.) were 72°F and 69°F, respectively, during this period.

All of the fall-applied chemical, scalping, and overseed treatments did not affect the amount of bermudagrass green coverage in the following spring and summer, during the two-year study.

"One probable explanation why the fall-applied treatments were not significant is that fall and winter temperatures in the Coachella Valley are relatively mild, which means that there is little if any freezing plant stress to act as a synergist with stress-related renovation and overseeding treatments," Green said.

Since this research provided evidence that fall-applied treatments do not significantly affect the outcome of the actual bermudagrass transition in this region, future research in the Coachella Valley can be targeted to the development and timing of spring-applied cultural practices that might hasten or improve the actual bermudagrass transition. Techniques to shorten the lag phase might be a target of opportunity, Green said.

Cooperating with Green at Desert Horizons Country Club were former and current golf course superintendents Lane Stave and Will Friedner. Green's UC collaborators were his staff, **Grant Klein, Francisco Merino, and Jess Evans; Mike Henry,** UC Cooperative Extension Farm Advisor in Riverside and Orange Counties; and **Steve Cockerham**, UCR Superintendent of Agricultural Operations.

The study was funded by the Hi-Lo Desert Golf Course Superintendents Association.

UCRTRAC Annual Research Summary Report for 1998 Now Available

Robert Green, UCR Turfgrass Research Agronomist, presented the Annual Research Summary Report for 1998 at the UCR Turfgrass Research Advisory Committee (UCRTRAC) semi-annual meeting in December 1998. Fifteen research projects were summarized (Table 1).

"Our role is to be a major fund provider and advisor on the UCRTRAC with the goal of helping UCR become a significant turf research institution. This has great implications for the golf community in Southern California. Its success means that locally we have a land grant university that conducts research on projects that have impact on a national level and, perhaps more importantly, on issues that are unique to our area," said **Ed Holmes**, Board Member, Southern California Golf Association (SCGA).

In addition to the SCGA and UCR, other UCRTRAC member organizations include the Southern California Turfgrass Council, Southern California Turfgrass Foundation, the California Sod Producers Association, California Golf Course Superintendents Association (GCSA), GCSA of Southern California, Hi-Lo Desert GCSA, San Diego GCSA, Southern California Section Professional Golfers Association, and the United States Golf Association.

UCRTRAC member organizations support 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.

"Support from the UCRTRAC member organizations continues to provide new growth opportunities for the Turfgrass Research Program at UCR. In addition, UCRTRAC has contributed to the production of a newsletter, ***Better Turf Thru Agronomics***, that has broadened communication among UC researchers, Extension specialists, and farm advisors and the industry clientele who fund or stand to benefit from the resulting data," said **Vic Gibeault**, Extension Environmental Horticulturist and UCRTRAC delegate.

"The objectives of my research team are to conduct unbiased cultivar evaluations and management studies that can improve the playability and visual quality of the playing surface; to undertake unbiased product testing that will result in savings in fertilizer or plant protectant costs; and to oversee studies on drought tolerant cultivars that can maintain quality standards and result in significant savings in irrigation expenses," said Green. "When we accomplish these objectives and disseminate the results, then we have performed important research services for our UCRTRAC industry clientele," Green said. For a copy of the 1998 UCRTRAC Annual Research Summary, please call (909) 787-2107.

Table 1. Research Projects in the 1998 UCRTRAC Annual Research Summary Report

I. Five UCRTRAC Research Projects Completed and Final Research Report Prepared in 1998
Improvement of the Spring Transition of Overseeded Bermudagrass Putting Greens in the Coachella Valley ●
Measurement and Model Prediction of Pesticide Partitioning in Field-Scale Turfgrass Plots ● ■
Influence of Irrigation Frequency When Irrigating Bermudagrass and Zoysiagrass Below ET Crop During the Warm Season ■ ●
1997-1998 Agrium Coated Urea Fertility Trial Applied on Tall Fescue in Riverside, CA ■ ●
1998 Agrium Slow-Release Nitrogen Product Trial on Bonsai Tall Fescue ■ ●
II. Ten UCRTRAC Research Projects In Progress in 1998
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 ●
Evaluation of Water Conservation Surfactants on Two Warm-Season Grasses in Southern California ■ ●
Maintaining Putting Green Soil Aeration and Leaching Capability During the Summer with a Toro HydroJect ●
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 ●
Characterization of Markers for Leaf Firing Resistance Among Turf-Type Bermudagrasses ■ ●
Influence of Primo on Total Nonstructural Carbohydrate Partitioning of Tall Fescue ■ ●
● *Golf Course Turfgrass* ■ *General Turfgrass 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 Jack Van Hise, UCR Printing and Reprographics.