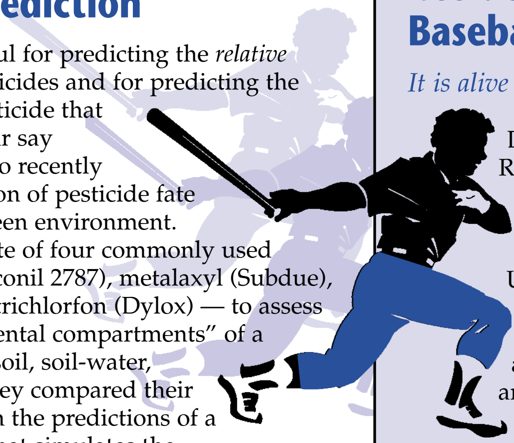
UNIVERSITY OF CALIFORNIA, RIVERSIDE TURFGRASS RESEARCH PROGRAM

Better Turf Thru Agronomics

UCRTRAC Newsletter, December 1998

Pesticide Partitioning in a Putting Green Environment: Field Measurements vs. Computer Model Prediction



Computer models are useful for predicting the *relative* behavior of different pesticides and for predicting the relative amounts of a pesticide that will end up in soil, water, and air say researchers at UC Riverside, who recently completed a three-year evaluation of pesticide fate and partitioning in a putting green environment.

UCR scientists studied the fate of four commonly used pesticides — chlorothalonil (Daconil 2787), metalaxyl (Subdue), chlorpyrifos (Dursban 2E), and trichlorfon (Dylox) — to assess partitioning into the "environmental compartments" of a turf system — the atmosphere, soil, soil-water, leachate, and clippings. Next, they compared their actual, experimental results with the predictions of a mathematical transport model that simulates the environmental fate of pesticides, known as CHAIN_2D.

"The goal of using a computer model is to assist the turfgrass manager in identifying potential site-specific problems so that measures to avoid environmental contamination can be taken. Because of the myriad combinations of pesticides, soil types, cultural practices, and environmental conditions that occur on golf courses in Southern California, it is impractical to evaluate experimentally each combination to predict potential environmental impacts. Computer models may be able to substitute for experimental data, if they are found to be accurate in their predictions," said **Marylynn Yates**, Professor of Environmental Microbiology and Extension Groundwater Quality Specialist and project leader.

"Our results indicate that models may be useful for predicting the relative behavior of different chemicals under specified conditions. For example, the model predicted that a much greater quantity of chlorpyrifos would volatilize than that of any of the other chemicals, which did occur," Yates said (Table 1). "The model also did a relatively good job predicting compartmentalization of a chemical among the soil, water, and air," she said.

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Table 1. Pesticide Partitioning Into Environmental Compartments: Actual Results vs. Computer Model Predictions

% of Applied Pesticide Mass	Metalaxyl		Chlorothalonil		Chlorpyrifos			Trichlorfon		
	Actual	Predicted	Actual	Predicted	Actual		Predicted	Actual		Predicted
					1996	1997		1996	1997	
Volatilized	0.08	0	0.017	0.6	15.7	2.8	10.5	0.094	0.089	Trace
Leached	0.072	0.0027	0.0012	0	0.00037	0.00089	Trace	0.00303	0.00084	3.8
In Clippings	0.139	NA	0.137	NA	0.237	0.14	NA	0.05	0.03	NA
In Soil	0	45.5	0.08	0	0.44	3.2	29.3	0.99	2.23	1.1

What Happened to the Grass in the Retractable Roof Baseball Stadium?

It is alive and well.

Dubbed the "sod god" by Riverside's newspaper, *The Press-Enterprise*, **Steve Cockerham**, Superintendent of UCR's Agricultural Operations, put a natural grass playing surface into a roofed baseball stadium and managed to keep the turf healthy during the 1998 season, despite restricted light conditions.

'De Anza' zoysiagrass, a newly patented UCR release, was installed as thick cut sod in February in Bank One Ballpark, home stadium of the Arizona Diamondbacks.

"What we were doing had never been done before — putting turf in a retractable-roof baseball stadium and demanding that it stand up to major league baseball standards for an entire season. During our research trials using restricted light and simulated traffic from cleats, 'De Anza' outperformed 'Tifgreen' bermudagrass, the standard in outdoor baseball fields, so we had

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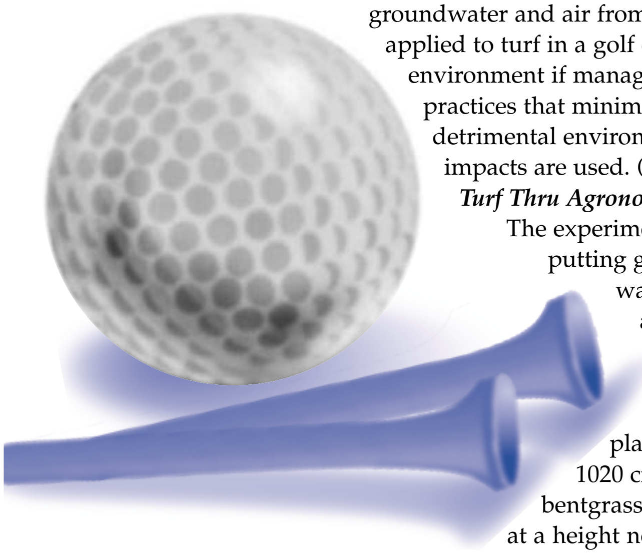
"The model simulates the movement of water, heat, and contaminants in unsaturated, partially saturated, and fully saturated media. The program includes provisions for partitioning between soil and liquid components and liquid and gaseous components. It also includes water uptake by plant roots, changes in atmospheric conditions, and first-order degradation processes," Yates said.

One discrepancy between actual and predicted values is the amounts of metalaxyl and chlorpyrifos retained in the soil (Table 1). Both compounds had been removed to essentially non-detectable levels by the end of the experiments, but the model predicted that 45% and 29% of the metalaxyl and chlorpyrifos would remain in the soil. The differences are likely due to the fact that the actual biodegradation rate in the soil was higher than assumed in the model, which used literature-derived values for this parameter, Yates said.

The accuracy of model predictions can be increased by using input values for certain parameters, such as degradation rate, that are obtained experimentally using soil from the site and under environmental conditions that exist at the site, Yates said.

Consideration must be given to the level of accuracy required. If obtaining more precise data is expensive and yields a relatively small change in accuracy, it may not be economical in some cases, Yates said.

The volatilization and leaching results reported in Table 1 are consistent with prior UCR experiments which showed that little potential exists for contamination of groundwater and air from pesticides applied to turf in a golf course environment if management practices that minimize detrimental environmental impacts are used. (See ***Better Turf Thru Agronomics***, 9/96.)



The experimental putting green, which was located at UCR's Turfgrass Research Facility, was planted to SR 1020 creeping bentgrass sod mowed at a height not more than 3/16 inch before any experimental data were taken. The putting green soil met USGA specifications, and the experimental plots were managed to meet industry standards, said **Robert Green**, UCR Turfgrass Research Agronomist, a collaborator on the project.

Metalaxyl and chlorpyrifos were each applied at a rate of 2 oz/1000 ft^2 (2 lb active ingredient per gallon). Chlorothalonil and trichlorfon were each applied at rates of 8 oz/1000 ft^2 (500 g active ingredient/liter) and 3 oz./1000 ft^2 (80% active ingredient), respectively.

The study was funded by the United States Golf Association.

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good reason to expect 'De Anza' to perform well in Phoenix," said Cockerham.

"In April, when 14 games were played in 17 days, the field took quite a beating. May was cool and the turf did not grow enough to adequately recover from injury. The quality and performance of the playing surface were good, certainly well within the range required for major league baseball, but not quite at the level expected by the UCR researchers," Cockerham said.

"By the first week of June, temperatures were closer to normal and the turf responded quickly. Once the turf growth reached the expected level, it provided an excellent playing surface for major league baseball," Cockerham said.

Each major league baseball game does not normally produce excessive traffic. But pre-game activities — batting and infield practice and workouts by each team — can put some stress on the turf, he said.

Challenges were frequent and often quite significant.

As an example, artificial lights were used on the infield to supplement the natural light of the late winter and early spring. In the summer, artificial lights were also used to overcome the severely shaded areas in right field due to the closing of the roof for the air conditioning.

The novel concept of a roof that would close to provide comfort for fans in inclement weather, open to provide fresh air in good weather, and allow natural grass to grow was put to the test and it worked.

Nitrogen Fertilizer Movement in a Turf System

Fertilization of mature turf swards does not pose a threat to the environment from N contamination.

UCR scientists who have monitored the movement of fertilizer nitrogen (N) below the root system of mature cool-season turfgrasses when the nutrient was applied at high rates and frequent intervals have concluded that nitrate leaching from turf is insignificant under the conditions of their study.

Nitrogen fertilizer sources tested for their NO_3^- leaching potential were granular urea (46-0-0), sulfur-coated urea (SCU, 37-0-0, 30% dissolution rate), and blood meal (13-0-0) These sources, classified as soluble, slow-release, and natural organic, respectively, represented the possible range of NO_3^- leaching potential.

"This study showed that even at very high nitrogen fertilization rates, there is little probability of significant nitrate leaching from any of the tested sources on a mature turfgrass stand. Only urea fertilization gave levels of nitrate leachate that were above the tap water content, but still below federal guidelines. The slow-release sources, particularly the blood meal, presented the lowest potential for nitrate leaching," said **Vic Gibeault**, Extension Environmental Horticulturist in the Department of Botany and Plant Sciences.

The concentration of NO_3^- given in parts per million (ppm or mg/l) in collected leachate from the four fertilizer treatments are presented in Fig. 1. The NO_3^- content of the tap water used for irrigation ranged from 6.1 to 6.5 ppm NO_3^-.

Since NO_3^- is not bound to soil colloids, the fate of NO_3^- applied to any crop needs to be evaluated because NO_3^- can move with soil water off-site via runoff and leaching into surface or ground waters, Gibeault said.

This study and others have shown that mature turf swards act like "sponges" that soak up fertilizer N, leaving little for leaching (Fig. 1).

Gibeault's collaborators were **Marylynn Yates**, UCR Professor of Environmental Microbiology and Groundwater Quality Specialist; **Jewell Meyer**, retired Extension Soil and Water Specialist; and **Matthew Leonard**, former staff research associate.

Practical Applications

Numerous research studies have shown that fertilizer N applied to a dense, mature, and well-maintained turf sward is normally used rapidly by turf and its associated soil microbes: The N stays in the turf system with few losses. Best management practices minimize N losses via runoff or volatilization.

- **"Water-in" fertilizer immediately after application.** NH_4^+ (ammonium ions) is mineralized rapidly to gaseous ammonia (NH_3) and lost via volatilization, unless dissolved quickly in water. Gaseous N loss can be minimized to about 1% if fertilizer is watered-in.

- **Avoid overirrigation after fertilization.** In saturated soil, microbes reduce NO_3^- to nitrous oxide (N_2O) gas and elemental N (N_2) gas, which are both subject to volatilization losses.

- Use low N rates or slow-release sources on sands or very leachable soils.

- Avoid runoff after fertilization to protect surface waters from N contamination.

- Apply fertilizer when NO_3^- levels are expected to be low, when turf roots can use the nutrient.

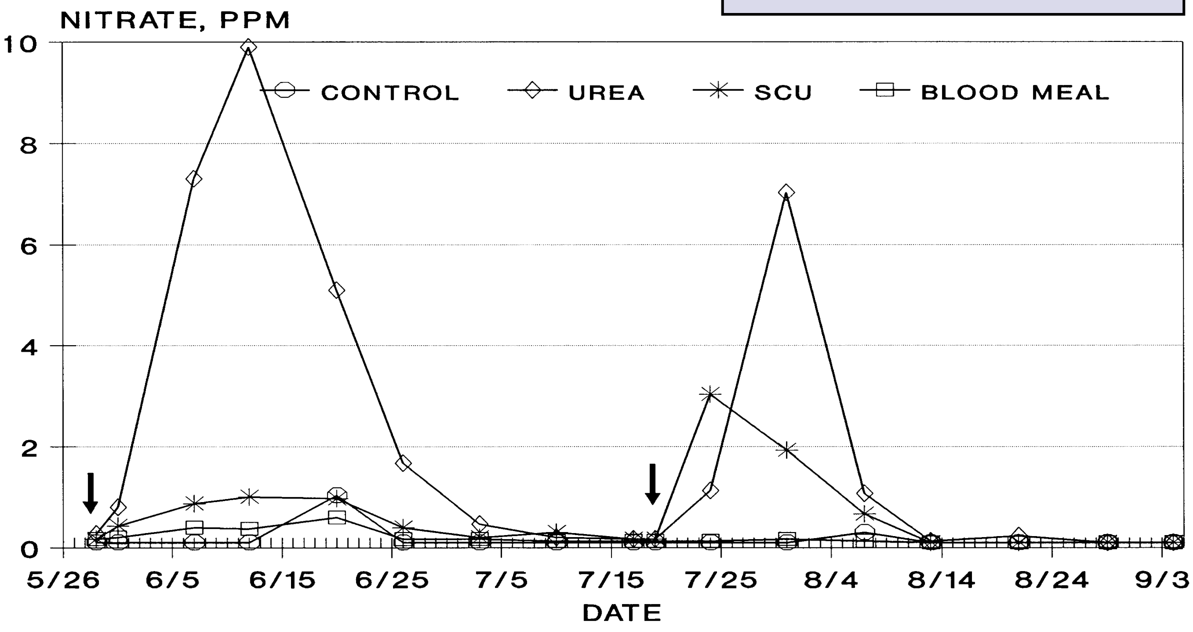

Fig. 1. Nitrate concentration in collected leachate over time. Arrows indicate fertilizer applications.

NTEP Variety Trials: Bermudagrass Cultivar Performance Results

The performance of 26 hybrid and common bermudagrasses was recently studied and evaluated at UC Riverside's Turfgrass Research Facility (UCR) and at the UC South Coast Research and Extension Center in Irvine (SCREC) as part of the National Turfgrass Evaluation Program (NTEP).

Through its participation in NTEP, a not-for-profit cooperative effort of the United States Department of Agriculture and the Turfgrass Federation, Inc., UCR's Turfgrass Research Program contributes to the development of a nationwide database of unbiased, independent information on cultivar performance.

UCR is evaluating more than 150 turf varieties for spring greenup, density, drought tolerance, disease or weed activity, color, and overall quality. NTEP trials, which usually last several years, are replicated at many locations nationwide.

NTEP provides leadership in turfgrass evaluation and improvement by linking the public and private sectors of the industry through their common goals of improving grasses, developing new cultivars, and establishing uniform evaluation standards.

Results from the UC and other university research facilities nationwide are collated, analyzed, and disseminated by NTEP annually. Seed companies and plant breeders use the NTEP information to determine grass adaptation and quality ratings.

In California, NTEP studies of the commonly used warm- and cool-season turfgrass species are conducted at UCR, SCREC, and the UC Bay Area Research and Extension Center in Santa Clara.

Rating the Bermudagrass Cultivars Tested

Monthly ratings were made following NTEP-accepted protocols. ***Quality***, which integrated all aspects of turfgrass quality was on a 1-9 scale, with 9 being best (Table 1). ***Genetic color*** reflected inherent color of the genotype when not under stress on a 1-9 scale, with 9 being dark green (Table 2). ***Winter color*** was the average color during winter months (Table 2). ***Spring greenup*** measured the relative rate of breaking dormancy on a 1-9 scale, with 9 being fast (Table 2). ***Scalping*** measured relative mower damage on a 1-9 scale, with 9 being no damage (Table 2).

Mild winters prevailed at the two test locations. Since bermudagrass is a warm-season (subtropical) grass, it grows best under extended periods of high temperatures. The subtropical turfgrass zone in California includes the low elevation areas from the Mexican border to the north end of the Sacramento Valley. Bermudagrass can also be grown successfully in the transitional zone along the southern coast and in certain areas surrounding San Francisco Bay.

Table 1. Bermudagrass Quality Summaries: California and National Results for 1993-1996

Cultivar	Southern California Mean		NTEP
	SCREC[a]	UCR[b]	MEAN[c]
	Seeded		
Mirage	5.2	5.2	5.4
OKS 91-11	5.2	5.3	5.3
J-27	5.1	5.2	5.2
Jackpot	4.9	5.0	5.2
Guymon	5.1	5.2	5.0
Sultan	4.8	4.9	5.0
Sundevil	4.8	5.1	5.0
FMC 5-91	4.9	5.1	4.9
OKS 91-1	4.5	4.7	4.8
FMC 3-91	4.8	5.0	4.7
FMC 2-90	4.8	4.9	4.7
Sahara	4.7	4.9	4.6
Cheyenne	4.5	4.9	4.5
Sonesta	4.6	4.8	4.5
Primavera	4.5	4.8	4.4
AZ Common	4.5	4.7	4.2
LSD	0.2	0.3	0.2
	Vegetative		
Baby	5.7	6.1	6.3
Tifgreen	5.6	5.7	6.1
Tifway	5.9	6.1	6.0
Midlawn	5.3	5.6	6.0
Midiron	5.4	5.8	5.9
Midfield	5.5	5.7	5.9
STF-1	5.4	5.2	5.5
Texturf 10	5.6	5.5	5.4
Floradwarf	4.6	5.0	4.5
AZ Common	4.3	4.4	4.0
LSD	0.3	0.3	0.2
Overall LSD	0.3	0.3	0.2

[a]SCREC = South Coast Research and Extension Center. bUCR = University of California, Riverside Turfgrass Research Facility. [c]NTEP Mean = the National Summary Mean compiled by the National Turfgrass Evaluation Program.

LSD: Interpreting the NTEP Research Results Statistics

Cultivar differences are based on the use of "least significant difference" (LSD) statistics for mean separation. To determine whether a cultivar's performance is truly different from another, subtract one entry's mean from another entry's mean. If this value is larger than the LSD values, which are reported in Tables 1 and 2, then the observed difference in cultivar performance is significant and did not happen by chance.

Table 2. Performance of Bermudagrass Cultivars in Southern California, 1993-1996: Selected Traits

Cultivar	Genetic Color		Winter Color		Spring Greenup		Scalping	
	SCREC[a]	UCR[b]	SCREC	UCR	SCREC	UCR	SCREC	UCR
Seeded								
OKS 91-11	8.0	7.4	5.3	1.0	6.7	5.5	6.2	6.0
Jackpot	7.0	7.0	7.0	3.7	5.7	6.0	6.3	6.0
Sultan	6.7	6.7	6.0	3.0	5.7	6.0	6.2	6.0
J-27	7.0	7.3	5.7	2.0	5.8	6.0	6.3	6.4
Mirage	7.0	6.8	7.0	3.0	6.0	6.3	6.3	6.5
FMC 5-91	6.7	6.5	6.0	3.3	5.7	6.0	6.4	7.1
FMC 2-90	7.3	6.8	6.3	3.0	6.2	6.0	6.2	6.4
Guymon	6.7	7.3	6.0	2.0	5.3	6.0	6.0	5.8
OKS 91-1	7.0	6.3	6.0	3.0	5.0	6.0	6.1	7.1
FMC 3-91	7.0	6.7	6.3	3.7	5.8	6.0	6.4	6.8
Sahara	7.0	7.0	6.3	3.7	5.3	6.0	6.2	6.1
Sundevil	7.0	6.5	6.0	4.0	5.5	6.0	6.4	7.1
Sonesta	7.0	6.2	5.3	3.3	5.7	5.7	5.7	7.2
Primavera	6.7	6.3	5.3	3.7	5.3	6.0	6.0	6.9
Cheyenne	6.7	6.0	6.3	4.0	5.5	6.0	5.7	7.6
AZ Common	6.7	5.8	6.0	3.3	5.8	6.0	6.1	6.7
LSD	0.6	0.5	1.0	0.8	1.8	0.4	1.7	1.3
Vegetative								
Baby	8.0	7.2	5.3	3.7	6.2	6.7	6.5	7.3
Tifgreen	7.0	7.5	5.0	2.7	5.7	6.7	6.3	6.4
Tifway	8.3	7.5	8.0	5.0	7.5	6.7	6.3	7.0
Midiron	7.0	7.2	3.0	1.7	5.3	7.0	6.1	6.8
Midlawn	6.7	7.0	4.0	1.0	5.0	5.0	5.1	5.1
Midfield	6.3	6.8	5.0	1.3	5.3	5.3	5.9	6.7
STF-1	7.0	6.6	5.3	2.0	5.7	6.5	5.8	6.4
Texturf 10	8.3	7.5	7.3	2.7	6.3	6.0	6.4	7.1
Floradwarf	8.0	8.3	3.3	2.7	5.2	6.0	7.5	7.8
AZ Common	7.0	6.0	6.0	3.7	5.2	6.3	6.1	6.5
LSD	0.9	0.8	1.2	1.1	2.6	1.2	1.1	1.3
Total LSD	0.8	0.7	1.0	0.9	2.1	0.8	1.2	1.3

[a] *SCREC = South Coast Research and Extension Center.* [b] *UCR = University of California, Riverside Turfgrass Research Facility.*

New UC Strategy Controls Bermudagrass in Cool-Season Turf

Sequential Herbicide Applications Render Site Usable During Renovation

Bermudagrass *(Cynodon spp.)*

Illustration by Steve Batten Used by permission
Previously published in a Par Ex brochure ©Steve Batten

Until now, the only practical method to restore desirable cool-season turf invaded by common bermudagrass has been complete renovation with loss of site use for up to 4 months, while the desired cool-season species is reestablished.

UC weed scientists have developed a new strategy: When sequential treatments of fenoxaprop (Acclaim) and triclopyr (Turflon) are applied alone and in combination, unwanted common bermudagrass (*Cynodon dactylon*) can be suppressed in cool-season grasses without losing use of the turf area.

"This control method has the advantages of reestablishing the desired species slowly and making the site usable during renovation. With sequential applications, the competitive edge shifts from the aggressive, weedy bermudagrass to the desired cool-season grass, allowing it to reestablish. These results parallel our prior, successful work to control kikuyugrass in cool-season species, using a sequential herbicide application strategy," said **Dave Cudney**, UCR Extension Weed Scientist.

Often, common bermudagrass is the turf species of choice, but in California's warm, temperate climate, it routinely invades cool-season turf swards planted to perennial rye and tall fescue, acting as an aggressive, perennial weed. The resulting turf mix has a patchy, nonuniform appearance with poor color, especially when the bermudagrass goes dormant in the winter.

"Fenoxaprop was more effective than triclopyr in reducing common bermudagrass, but it was also more injurious to the newly seeded perennial ryegrass. The combination of the two herbicides offers the advantage of controlling additional grass and broad-leaved weeds. Sequential applications were required over a 2-year period for control of common bermudagrass but considerable progress was made in the first year, particularly at Riverside," Cudney said.

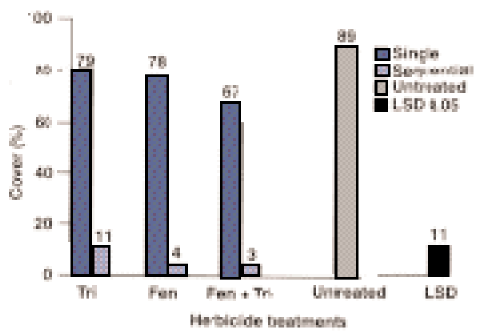

Fig. 1. Effects of single and sequential herbicide applications over 2 years on percent bermudagrass cover, Riverside.

Field experiments in Riverside and Willows consisted of an annual herbicide application compared to 4 sequential applications of fenoxaprop (0.19 and 0.38 lb/acre) and triclopyr (0.5 and 1.0 lb/acre), permitting analysis of low and high rates alone and in combination. At the end of the growing season, common bermudagrass cover was estimated visually.

In Riverside, after 2 years with 4 sequential treatments/yr, common bermudagrass cover with triclopyr (TRI), fenoxaprop (FEN), and the combination treatment (FEN + TRI) was 11%, 4%, and 3%, respectively (Fig. 1). The single, annual herbicide treatment was ineffective. In Willows, TRI was not as effective as FEN or the combination treatment; the latter two reduced common bermudagrass cover to 8%; whereas, TRI reduced bermudagrass cover to 28%.

Retreatments will be required in succeeding years because common bermudagrass will continue to reinvade, but proper cultural techniques (optimum mowing height, fertilization, and irrigation for cool-season species) should slow reinvasion, Cudney said.

In related studies, Cudney and his colleagues previously showed that sequential treatments of MSMA, triclopyr, fenoxaprop, and quinclorac provided effective control of kikuyugrass in cool-season turf without loss of site use when applied every 5 to 6 weeks over a 5-month period under experimental conditions in several Southern California locations, as reported in the Nov. 1996 issue of ***Better Turf Thru Agronomics***.

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.