University of California

TITLE: The Fate of Pesticides and Nitrogen in a Turfgrass Environment

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THE FATE OF CHEMICALS AND FERTILIZERS IN A TURFGRASS ENVIRONMENT
UNIVERSITY OF CALIFORNIA RIVERSIDE
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PURPOSE

The purpose of this research project is to study the fate of pesticides and fertilizers applied to turfgrass in an environment which closely resembles golf course conditions. The goal is to obtain information on management practices that will result in healthy, high quality turfgrass while minimizing detrimental environmental impacts. The proposed integrated research project has been designed so that all combinations of all treatments can be statistically analyzed. By simultaneously looking at interactions between soils, turfgrasses, irrigation amounts, pesticides, and fertilizers; questions about "best management practices" for turfgrass growth and maintenance will be able to be answered.

OBJECTIVES

1) Compare the leaching characteristics of pesticides and fertilizers applied to two turfgrass treatments.
2) Study the effects of the soil type and irrigation regime on the leaching of pesticides, nitrates and phosphorus.
3) Compare the leaching characteristics of nitrates from different fertilizers.
4) Measure the volatilization rate of pesticides from turfgrasses into the atmosphere as a function of time since application.
5) Monitor the effects of different irrigation regimes, fertilizers, and soil types on the quality of the turfgrass.

PROGRESS

Site Preparation

The soil in the plots was allowed to settle, and more soil was added where necessary. Sod was laid on the plots on February 3, 1992. Creeping bentgrass (Agrostis palustris) was installed on the green plots, and hybrid bermudagrass (Cyndon dactylon by Cyndon transvaalensis var. Tifway II) on the fairway plots. Soil-water sampling devices were installed in all plots. In the plots from which pesticide samples will be collected, the porous metal suction cups were installed to prevent pesticide adsorption; porous ceramic cups were installed at all other sites. A plot plan showing the locations of the various treatments is shown in Figure 1.

Irrigation

Two irrigation treatments were initiated on the plots on March 23, 1992: 100% ET_c and 130% ET_c. ET_c (crop evapotranspiration) is calculated from the following equation:

$$ET_c = (ET_o \times K_c)/(\text{application rate} \times \text{distribution uniformity})$$

ET_o is the reference evapotranspiration rate of 4-6" tall fescue. This information is obtained weekly from a CIMIS (California Irrigation Management

Information System) weather station located on the turf plots. K_c is the crop coefficient for the particular crop of interest, in this case turfgrass. Crop coefficients have been determined for cool season (bentgrass) and warm season (bermudagrass) grasses as a result of extensive research at the UCR turf plots over the years. The crop coefficient used in the above equation changes monthly; the specific values are shown in Table 1. The average application rate of the sprinklers is 1.3 inches/hr, and the distribution uniformity is 80%. The required values are used in the above equation to determine the water needs of the turfgrass on a weekly basis in minutes, and the irrigation timers set accordingly. Average daily irrigation amounts are shown in Table 2.

Table 1. Monthly Crop Coefficients for Turfgrass

Month	Warm Season	Cool Season
January	0.55	0.61
February	0.54	0.64
March	0.76	0.75
April	0.72	1.04
May	0.79	0.95
June	0.68	0.88
July	0.71	0.94
August	0.71	0.86
September	0.62	0.74
October	0.54	0.75
November	0.58	0.69
December	0.55	0.60

Fertilization

Two fertilizer treatments have been established for the plots. The green plots are fertilized at a rate of 1 lb N/1000 ft^2/month, and the fairway plots at a rate of 0.5 lb N/1000 ft^2/month. The two fertilizer sources are urea and sulfur-coated urea (SCU). The SCU applied to the green plots is in the form of miniprills to minimize losses during mowing operations. Fertilizer is applied twice per month to each plot individually to ensure even distribution of the fertilizer. Green plots receive 358.8 g N and fairway plots receive 179.4 g N per application. Fertilizer treatments were initiated on April 17, 1992.

Pesticide Application

To date, a pesticide application program has not been initiated on the plots. A survey of golf course personnel in the area has been conducted to

Table 2. Summary of Nutrient Leaching Experiments, April - September 1992

Species	Source of N	Single rate	Season[1] rate	Irrigation	Soil	% Applied water leached	% Applied N leached	$Nitrate_{drain}$	$Nitrate_{tube}$	$Phosphate_{drain}$	$Phosphate_{tube}$	Turf Rating
		(kg N ha^{-1})	(kg N ha^{-1})	(mm d^{-1})				(mg l^{-1} N)	(mg l^{-1} N)	(mg l^{-1} P)	(mg l^{-1} P)	
Agrostis palustris	SCU	24.34	267.74	5.59	sand/peat	44.5[2]	0.63	0.400152	0.268151	0.511167	3.72142	5.20833
						8.8[3]	0.52	0.238242	0.08507	0.006411	0.872896	0.077951
	SCU	24.34	267.74	7.26	sand/peat	35.2	0.46	0.280152	0.48697	1.469394	3.331818	5.291667
						8.1	0.17	0.0745	0.412722	0.630614	0.370886	0.077951
	Urea	24.41	268.51	5.59	sand/peat	57.8	0.26	0.234394	0.185119	0.729288	4.697399	5.833
						4.8	0.12	0.081123	0.028033	0.294322	0.600354	0.058926
	Urea	24.41	268.51	7.26	sand/peat	39.7	0.58	0.352273	0.179078	1.731894	3.196747	5.854167
						8.5	0.25	0.17149	0.033037	0.729426	0.085546	0.077951
Cyndon dactylon by Cyndon transvaalensis												
	SCU	12.17	133.87	4.61	loamy sand	21.5	0.26	0.276609	2.497703	0.095115	0.229019	5.306
						12.8	0.18	0.013926	2.663319	0.016219	0.007392	0.0982
	SCU	12.17	133.87	5.99	loamy sand	48.3	0.545	0.207035	2.914865	0.142424	0.250051	5.22
						22.1	0.21	0.02962	3.480014	0.013458	0.037551	0.137
	Urea	12.21	134.31	4.61	loamy sand	25.1	0.27	0.306241	0.198238	0.100599	0.206815	5.513
						3.6	0.05	0.122926	0.0455	0.013749	0.039186	0.07
	Urea	12.21	134.31	5.99	loamy sand	50.5	0.64	0.205931	4.707108	0.135851	0.227633	5.569
						10.1	0.15	0.021202	6.232858	0.016042	0.054029	0.10936
	SCU	12.17	133.87	4.61	sandy loam	1.0	1.0	14.45549	128.5022	0.716	0.821667	6.181
						1.2	1.4	1.86989	172.8466	0.370934	0.047317	0.1534
	SCU	12.17	133.87	5.99	sandy loam	14.2	0.244	0.470455	10.1218	0.371364	0.906605	6.075
						10.0	0.172	0.206364	13.6814	0.147727	0.221881	0.0245
	Urea	12.21	134.31	4.61	sandy loam	0.15	0.177	26.27798	61.16479	0.948056	0.684043	6.33
						0.02	0.20	13.69494	74.60308	0.513075	0.127996	0.03402
	Urea	12.21	134.31	5.99	sandy loam	2.4	0.66	11.65429	2.244865	0.27481	0.950338	6.277
						1.9	0.089	7.687741	0.951406	0.093099	0.158186	0.07082

[1] April 17, 1992 - September 25, 1992, [2] Average of three replicate values, [3] Standard deviation of replicate values

determine a "typical" pesticide application program. The results of this survey will allow us to finalize our pesticide application program. During July 1992, the green plots became heavily infested with sod webworm. After consultation with Dr. Richard Cowles, UCR entomologist, it was decided to apply Bacillus thuringensis (BT) at a rate of 2 lb/acre on August 7. The application was repeated on August 11 and 12. Because there was no decrease in the webworm population, Dr. Cowles recommended application of Dursban 2E at a rate of 1.5 oz/1000 ft^2 on August 26. A second application was made on September 2. This treatment was effective in eliminating the population of the webworm; however, substantial damage was done to the turf. In some plots, essentially 100% of the turf was gone. For this reason, it was decided to delay the initiation of the regular pesticide application program.

Drainage Water Quality

Samples of drainage water were collected from each of the 36 plots on a weekly basis. Average nitrate-N and phosphate-P concentrations for all samples collected between April and September are listed by treatment in Table 2. Drain volumes are measured and recorded several times per week, allowing a calculation of the mass of N and P leaching from the plots. The average volume of drainage water from the plots is shown in Figures 2-4. The percent of applied N leaching was calculated for each of the 12 treatments and shown in Table 2. The percent of applied water collected in the drains is also given in Table 2.

Soil-Water Quality

Soil-water samples are obtained from each plot by means of suction cup lysimeters on a weekly basis. The samples are analyzed for nitrate-N and phosphate-P. Average concentrations (for all samples collected between April and September) for each treatment are shown in Table 2. A comparison of the nitrate-N concentrations in the drainage water and the soil water for two of the treatments on a weekly basis is shown in Figures 5 and 6. It can be seen that while these two methods often give similar readings, there are occasions when the measured concentrations can differ by a significant amount.

Turfgrass Quality

Each plot is rated every two weeks for turfgrass quality. Prior to fertilizer application, all plots were given a rating of 6 on a scale of 0 to 9, with nine being the best possible rating. The average ratings between April and September (April and July for the green plots due to sod webworm damage) for each treatment are shown in Table 2. Weekly ratings for the green, loamy sand, and sandy loam soil plots are shown in Figures 7, 8, and 9, respectively. Evaluation of the green plots has continued since the webworm infestation; however results are recorded as a percentage of the plot damaged. These data are contained in Table 3.

Table 3. Damage (%) to Green Plots, August 1992

Plot	Replicate	Fertilizer	Irrigation	Date		
				8/7	8/23	9/14
01G	1	SCU	100	0.5	100.0	40.0
06G	3	SCU	100	5.0	40.0	20.0
05G	2	SCU	100	40.0	100.0	50.0
10G	1	SCU	130	40.0	60.0	5.0
02G	2	SCU	130	40.0	90.0	30.0
09G	3	SCU	130	5.0	40.0	15.0
08G	2	Urea	100	10.0	80.0	30.0
04G	1	Urea	100	10.0	100.0	50.0
12G	3	Urea	100	5.0	20.0	5.0
11G	2	Urea	130	0.5	30.0	5.0
07G	1	Urea	130	0.5	40.0	5.0
03G	3	Urea	130	5.0	10.0	1.0

Figure 1. USGA TURF PLOT--UC RIVERSIDE

Rep 1	01G F1 I1 S3	04G F2 I1 S3	07G F2 I2 S3	10G F1 I2 S3
Rep 2	02G F1 I2 S3 P	05G F1 I1 S3	08G F2 I1 S3	11G F2 I2 S3
Rep 3	03G F2 I2 S3	06G F1 I1 S3 P	09G F1 I2 S3	12G F2 I1 S3

Rep 1	01F F1 I1 S1 P	04F F1 I1 S2	07F F2 I2 S1	10F F1 I2 S1	13F F2 I1 S2	16F F2 I2 S2	19F F1 I2 S2	22F F2 I1 S1
Rep 2	02F F1 I2 S1	05F F2 I1 S2	08F F2 I2 S2	11F F1 I1 S2 P	14F F1 I1 S1	17F F2 I1 S1	20F F1 I2 S2	23F F2 I2 S1
Rep 3	03F F1 I2 S2 P	06F F1 I1 S2	09F F2 I1 S2	12F F1 I2 S1 P	15F F2 I2 S2	18F F1 I1 S1	21F F2 I1 S1	24F F2 I2 S1

Key: F1 = SCU, F2 = urea
I1 = 100% ET_c, I2 = 130% ET_c
S1 = loamy sand, S2 = sandy loam, S3 = green sand
P = pesticide plot

Figure 2. Weekly Drain Volumes

Green Plots

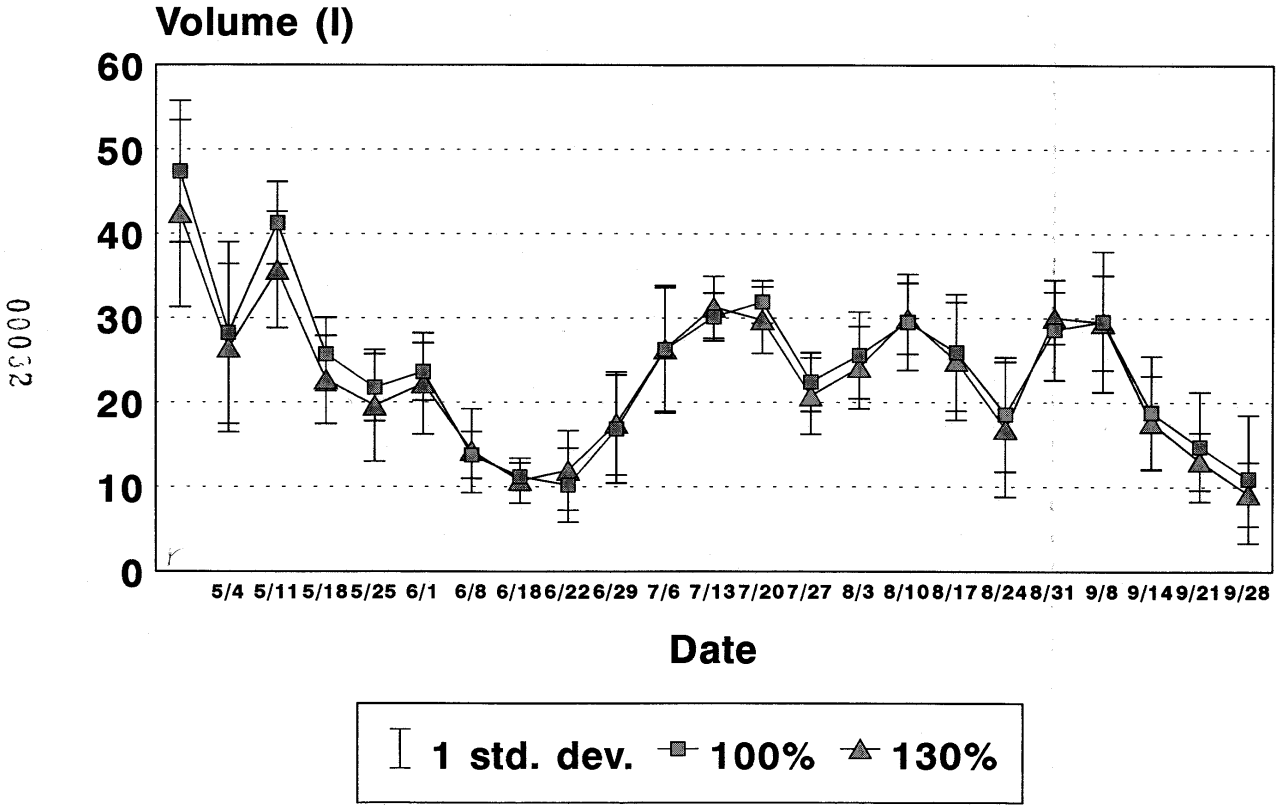

Figure 3. Weekly Drain Volumes

Fairway Loamy Sand Plots

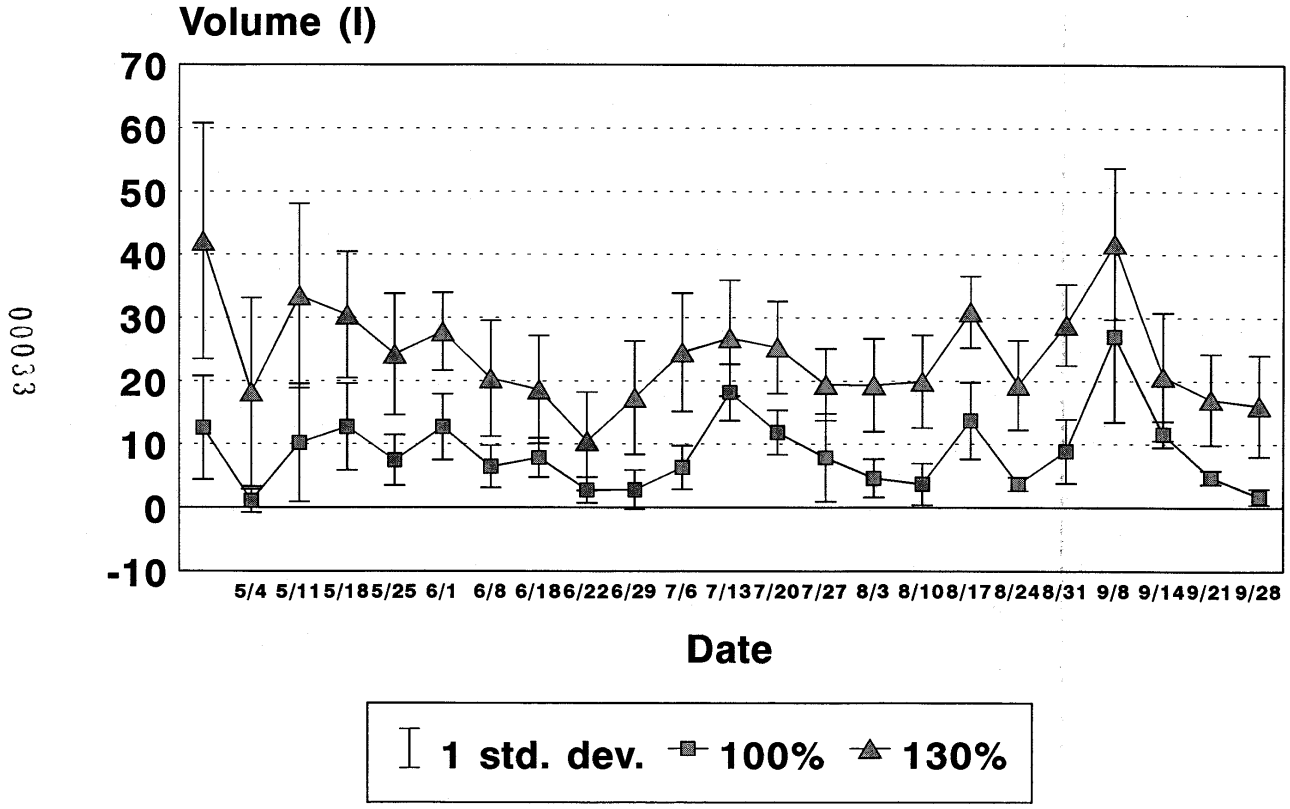

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Figure 4. Weekly Drain Volumes

Fairway Sandy Loam Plots

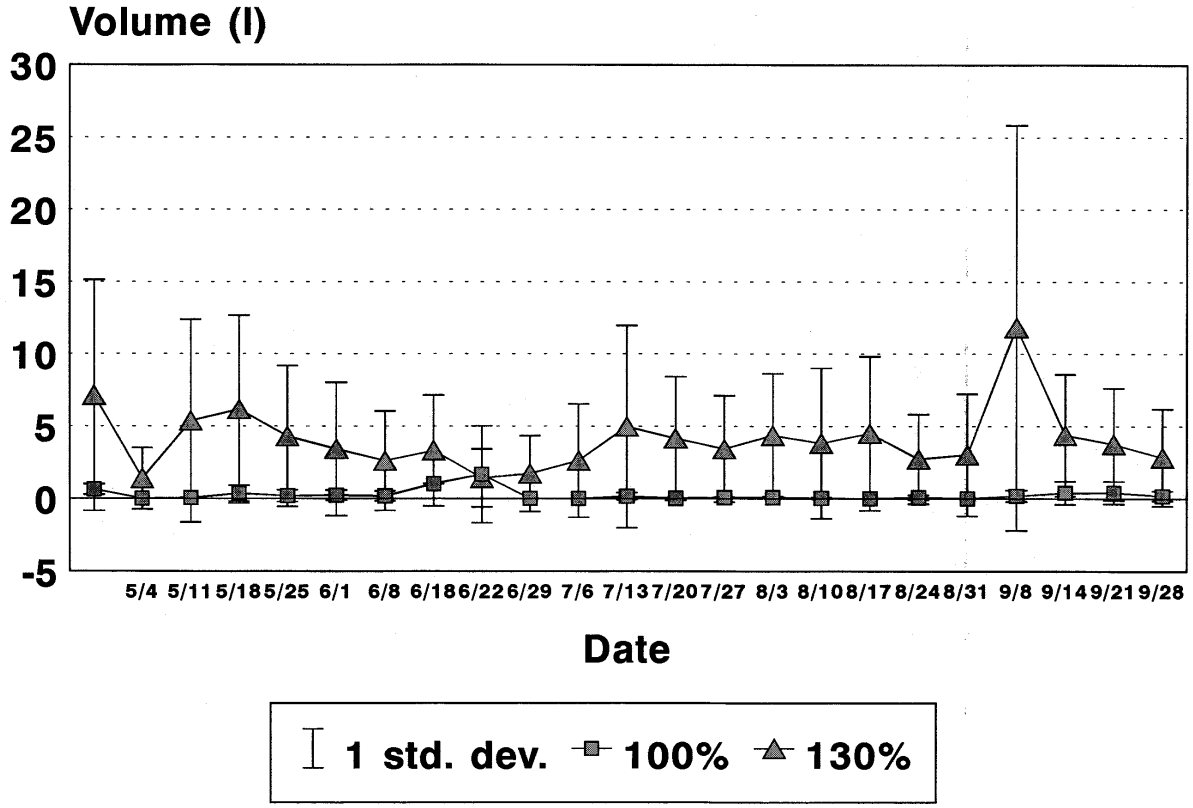

Figure 5. Nitrate-N in Leachate
(Green sand, SCU)

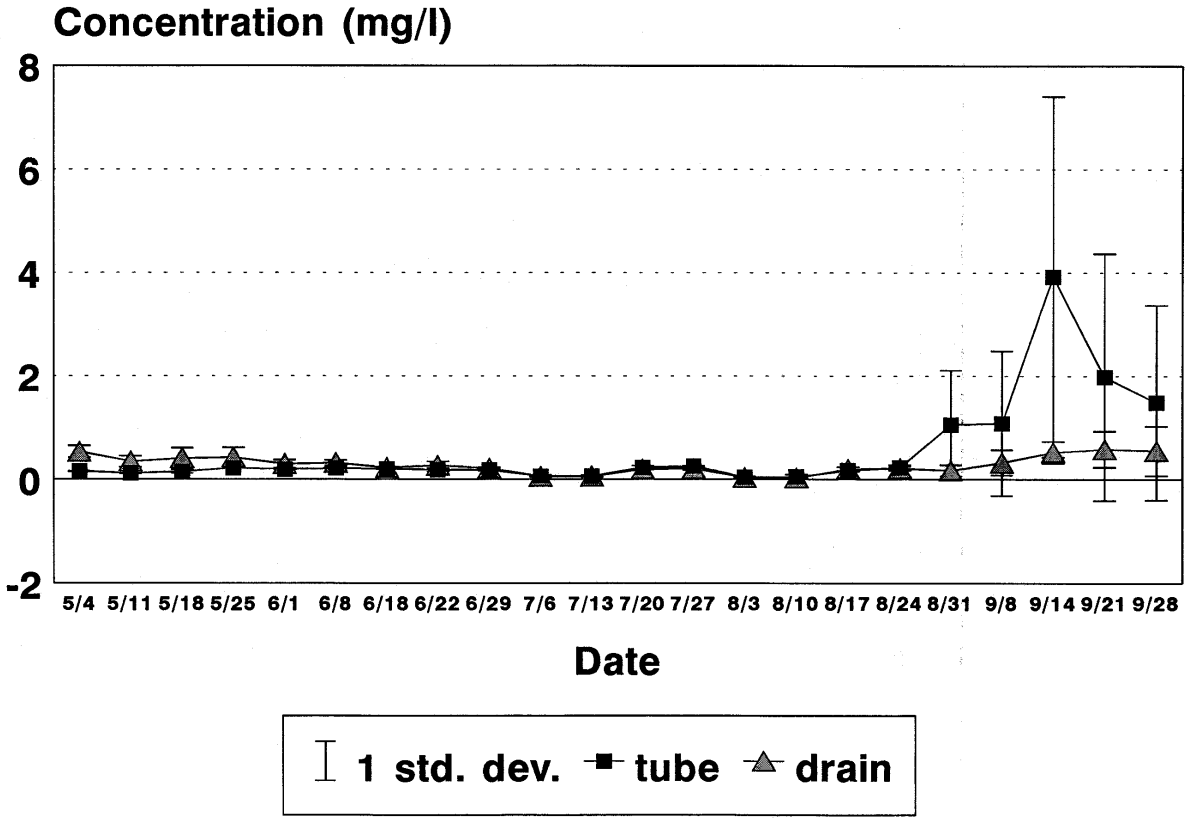

Figure 6. Nitrate-N in Leachate
(Sandy loam soil, urea)

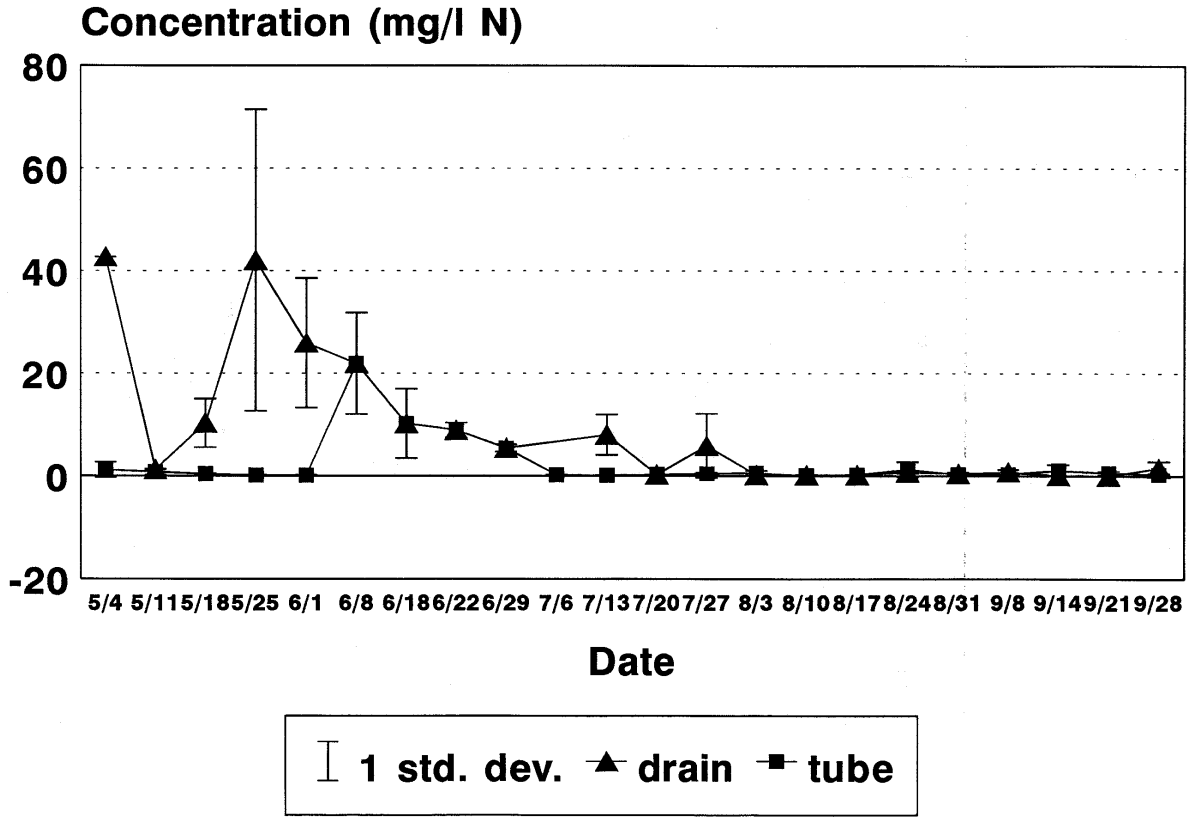

Figure 7. Turf Quality Ratings

Green Plots

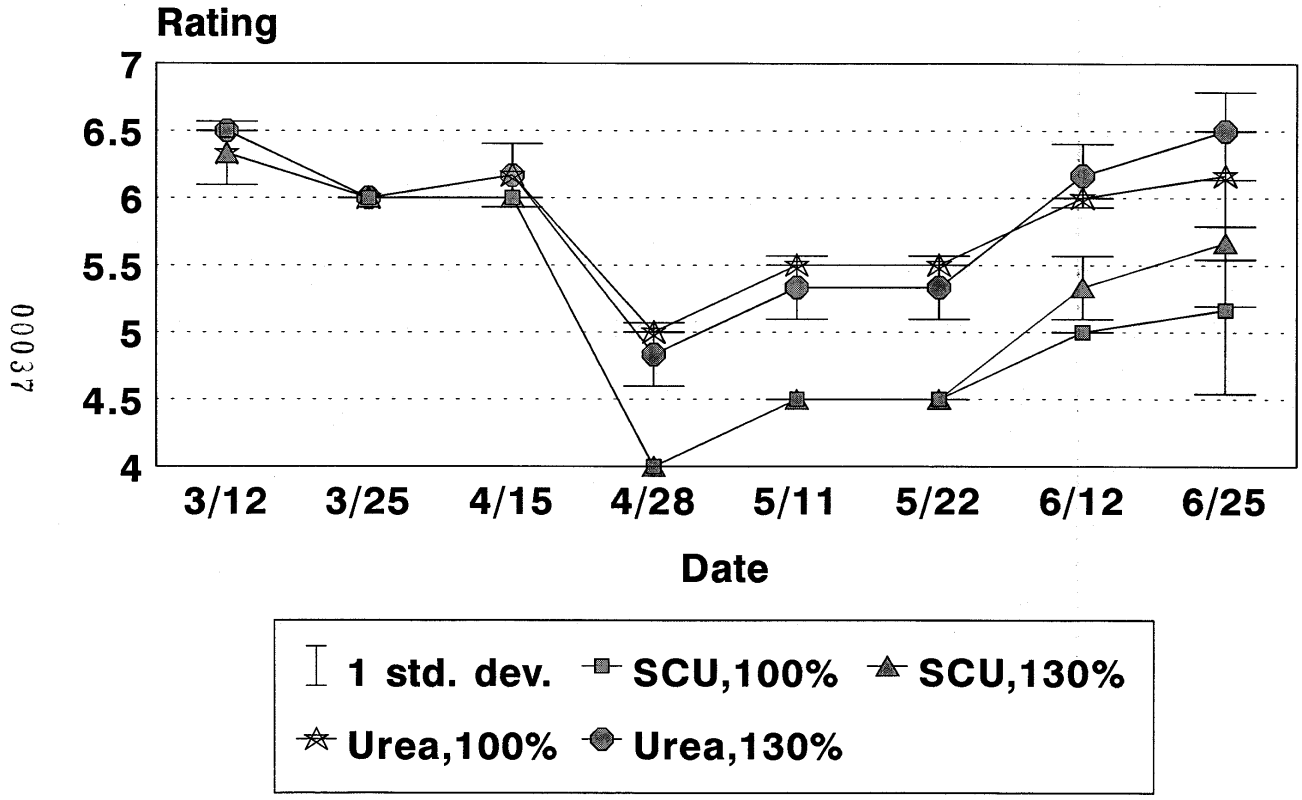

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Figure 8. Turf Quality Ratings

Fairway Loamy Sand Plots

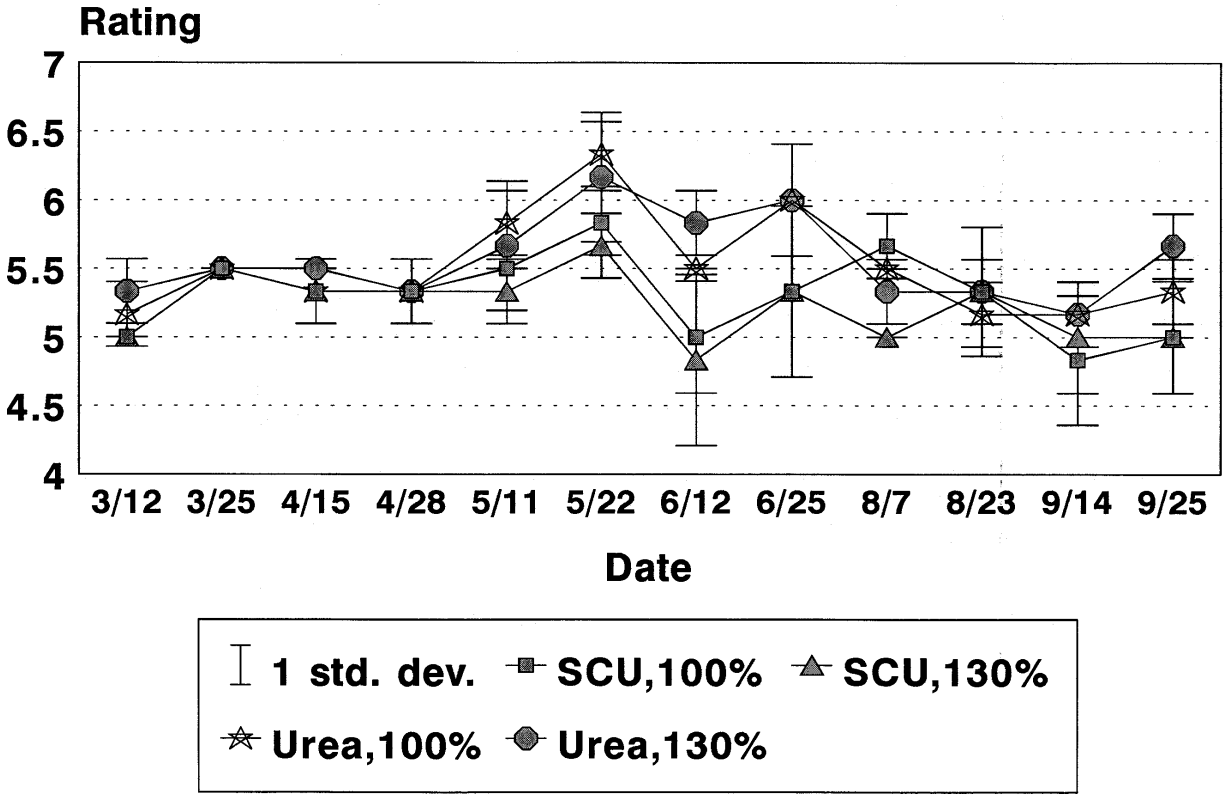
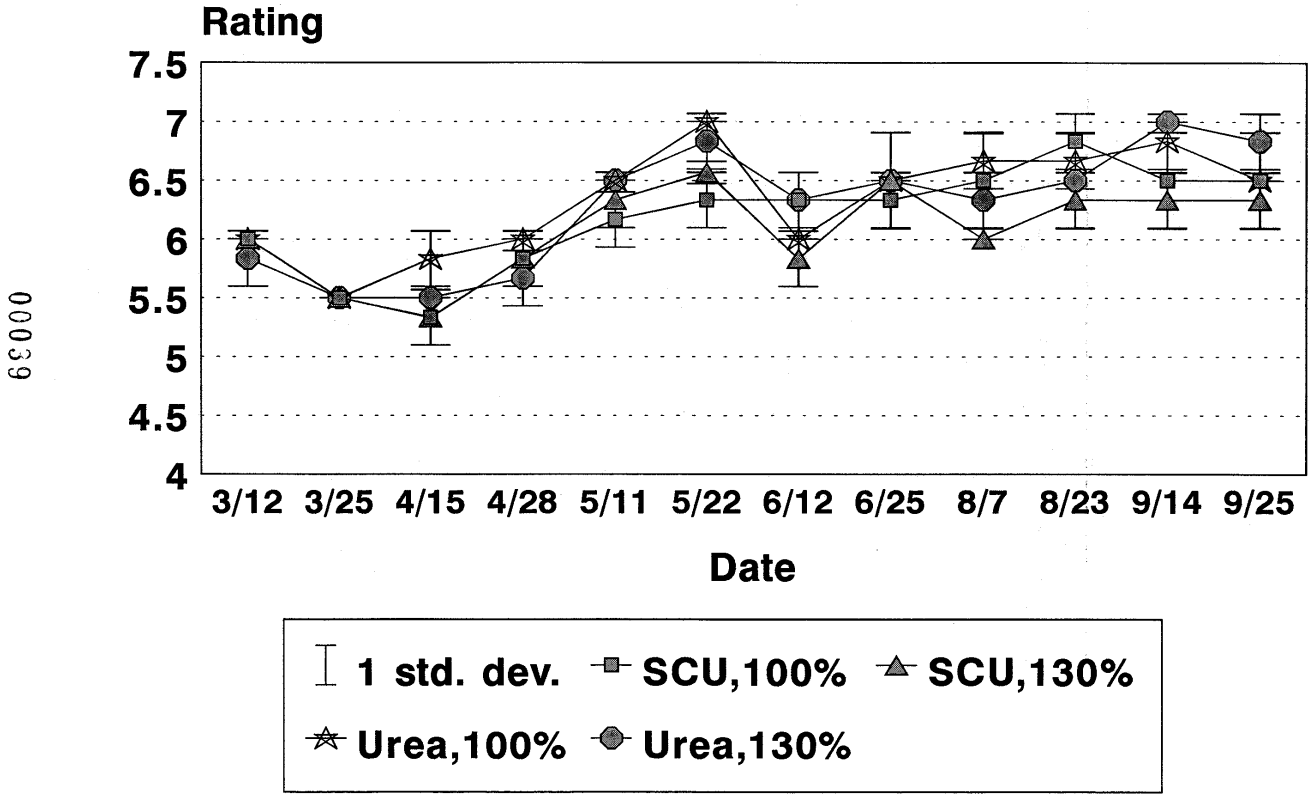


Figure 9. Turf Quality Ratings

Fairway Sandy Loam Plots



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