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Water Use and Turf Quality of Warm-season and Cool-season Turfgrasses

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ABSTRACT: *A long-term study consisting of two consecutive experiments was conducted to develop guidelines for turfgrass irrigation practices. Two warm-season grasses, St. Augustinegrass [Stenotaphrum secundatum (Walt.) Kuntze] and common bermudagrass [Cynodon dactylon (L.)] Pers. were used in the first experiment and two cool-season grasses, Alta tall fescue (Festuca arundinacea Schreb.) and Merion Kentucky bluegrass (Poa pratensis L.) in the second one. They were subjected to five irrigation treatments: a control based on common practice, irrigation based on evaporation from a pan, and three automatic irrigations activated by tensiometers at different settings. Each of the two experiments lasted more than 3 years. For the warm-season grasses, quality was not affected by the treatments, although there was as much as a two-fold difference in mean annual water application. Rooting depth was not significantly affected by the treatments. Invasion of annual bluegrass (Poa annua L.) and thatch thickness differed among treatments. In the cool-season grass experiment, quality was significantly affected, especially for Kentucky bluegrass. Weed population was related to irrigation treatment, but rooting depth was not. Soil salinity levels at the end of the experiments did not differ among the treatments. Automatic tensiometer control can provide water needs of turfgrasses more efficiently at all seasons than can visual estimation of water needs.*

Introduction

In many parts of the world, turfgrasses are grown under irrigation much of the year. Nevertheless, few sound guidelines exist for the determination of turf irrigation practices. Turf irrigation has been more of an art than a science, dependent upon the skill of the individual irrigator. As a result, faulty irrigation practices often cause poor quality turf. Furthermore, water is becoming scarce and expensive in many places, making efficient irrigation a necessity.

Hagan (1955) presented general concepts and practices of turf irrigation and urged less frequent but higher amounts of water per irrigation compared to the then current practice of light, frequent irrigations. This became a popular recommendation but still provided no basis for determination of actual amounts and frequencies. Blaney and Criddle (1962) developed a simple formula for’ determining expected water needs based on local climatic data. It is more useful for determining water needs in designing irrigation systems than as a day-by-day guide for water application.

Gypsum electrical resistance blocks (Bouyoucos and Mick, 1940) have had limited use in turf soil moisture studies. They most effectively measure moisture in relatively dry soils and, thus, have not been practical for determining turf water needs. Tensiometers (Richards and Marsh, 1961) are better

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for this purpose, because they read most accurately in the higher range of soil moisture at which turfgrasses are usually grown. They have been used to activate sprinkler systems automatically (Marsh, 1969).

Evaporation (E) from a water surface was shown to be a good measure of evapotranspiration (ET), and evaporation pans have been developed for this purpose (Pruitt, 1964). Actual ET is usually 70 to 80 percent of pan evaporation, so irrigations based on pan evaporation normally would replace water loss at that ratio.

Long-term studies were begun at the University of California in 1966 with the following objectives: 1) to determine consumptive water use of several turfgrasses, 2) to determine how these grasses would respond to various irrigation levels, and 3) to evaluate tensiometers and evaporation pans as guides for scheduling irrigation.

Table 1. Description of the Irrigation Treatments

Treatment Number	Description
I-l	Automatic irrigation when tensiometers at either depth reached 15 cb.
1-2	Automatic irrigation when tensiometers at either depth reached 40 cb for warm-season (35 cb for cool-season grasses).
I-3	Automatic irrigation when tensiometers at either depth reached 65 cb for warm-season (55 for cool-season grasses).
I-4	Manual irrigation based on evaporation from a sunken evaporation pan.
I-5	Control treatment with manual irrigation to simulate that of local turfgrass managers.

Materials and Methods

The study consisted of forty, 20-by-20-ft plots containing two turfgrass varieties, five irrigation treatments and four replications in a randomized block design. A wave or oscillating type sprinkler was set in the center of each plot to distribute water in a square pattern and not throw the water beyond the edges of the plot in which it was located.

Irrigation treatments, all activated by a controller, are shown in Table 1. Individual plots in treatments I- I, I-2 and I-3 received water automatically, when soil around either of two tensiometers installed in each plot at 6-and 12-inch depths, dried to the described value. Irrigation was terminated automatically when soil suction levels fell below the tensiometer settings. The controller was activated manually for treatments I-4 and I-5 at the prescribed times. For all treatments, the controller was set to allow irrigations only at night and for several repeated cycles.

Treatment I-4 was based on evaporation from a sunken evaporation pan. Irrigations were whenever evaporation, measured daily, totalled 1 inch. Irrigation rates were 87 percent of measured evaporation during summer and 75 percent of measured evaporation minus rainfall during the cool fall, winter and spring months. Treatment I-5, was a visual estimate of water need based on a continuing assessment of the practices of nearby professional turf managers. Meters measured the amount of water applied to each plot.

The study consisted of two consecutive parts: the first used two warm-season grasses, common bermudagrass *[Cynodon dactylon (L.) Pers.]* and St. Augustinegrass *[Stenoruphrum secundatum* (Walt.) Kuntze], and the second used two cool-season grasses, Merion Kentucky bluegrass *(Poa pratensis L.)* and Alta tall fescue *(Festucu arundinacea* Schreb). Treatments were not started until the grasses were well established. Each experiment lasted more than 3 years. All plots were

Table 2. Annual Water Use and Pan Evaporation by Cynodon *dactylon* (Cy.) and Stenotaphram secundatum (St.) for a 3-year Period

	Irriaation treatment (inches)										
	I-1		I-2		I-3		I-4		I-5		Pan
Month	cv.	St.	cv.	st.	CY.	st.	CY.	st.	CY.	st.	evaporation
Jan.	.67	.55	.12	.16	.04	.12	.67	1.54	1.54	1.69	1.69
Feb.	1.22	1.06	1.02	.55	.83	.39	1.18	1.22	1.50	1.50	1.54
Mar.	1.06	1.34	.95	.79	.75	.43	1.42	1.38	1.56	1.56	3.54
Apr.	1.81	1.97	1.69	1.46	1.73	1.53	2.32	2.32	2.40	2.52	4.25
May	3.35	3.39	3.03	3.03	2.80	3.62	3.62	3.62	4.45	4.45	4.88
June	3.93	3.50	3.11	3.31	3.11	3.23	4.21	4.21	4.29	4.29	5.04
July	5.43	4.04	4.72	4.37	3.93	4.41	7.05	7.05	9.80	9.76	8.23
Aug.	5.55	5.24	5.39	4.53	4.69	4.02	7.01	7.01	8.86	8.90	8.07
Sept	3.58	2.99	2.56	2.28	2.24	2.24	4.80	4.80	7.05	6.69	5.98
Oct.	3.03	2.56	2.68	2.05	2.20	2.09	3.78	3.78	6.26	6.26	4.57
Nov.	1.14	.83	.55	.55	.71	.79	1.89	1.93	3.39	3.23	2.32
Dec.	1.77	.32	.28	.51	.24	.24	1.65	1.61	1.06	1.06	2.32
Total	32.52	28.58	26.50	23.58	23.30	23.30	39.60	39.60	52.20	51.77	52.44

fertilized at the rate of 1 lb per 100 sq ft of actual nitrogen per month of growing season. The warm-season grasses were mowed weekly at 3/4 inch and the cool-season grasses at 1 1/2 inch.

The climate was Mediterranean with a strong marine influence (warm, dry summers and cooler but mild wet winters). The soil was a San Emigdio sandy loam (Calcareous), thermic Typic Xerofluvents.

Results and Discussion

Warm-season grasses. Mean annual water use and pan evaporation by the warm-season grasses for a 3-year period is shown in Table 2. Mean annual precipitation for this period was 17.8 inches. The automatically controlled and evaporation based treatments all applied less water to both grasses than the control (I-5), approximately half or less for treatments I-2 and I-3.

Peak months for water application were July and August. The relatively low amounts in April, May, and June are related to reduced evapotranspiration resulting from morning and evening coastal fog common at that season. Irrigations based on tensiometers or evaporation followed changing weather patterns more closely than did visual estimation of water needs.

Throughout the experiment turf quality of St. Augustinegrass was good under all treatments with no significant differences in quality ratings (Table 3). Common bermudagrass quality was also good throughout all treatments, except that significantly more annual bluegrass was present in the control treatment, which can be attributed to the generally wetter conditions of the control. St. Augustine contained no annual bluegrass in any treatment, probably due to competition and to the great depth of thatch in all treatments. Although thatch depth was slightly less in the three wettest treatments, it was still deep enough to inhibit annual bluegrass establishment.

Mean maximum root depth across all treatments was significantly greater for bermudagrass than for St. Augustinegrass at the end of the experiment (32.5 vs. 21.4 in.). However, there were no significant differences in root depth among the treatments for either species.

Table 3. **Poa *annua* Density, Thatch Depth and Turf Quality Rating for *Cynodon dactylon* (Cy.) and *Stenotaphrum secundatum* (St.) at End of Study**

Treatment	Pao annua		Thatch depth		Quality rating	
	CY.	St.	CV.	St.	cy.	St.
	plants/plot		--------cm--------		——rating†——	
I-1	0.8z*	0.0	1.47	3.26	8.8NS	7.3NS
I-2	0.0z	0.0	1.59	3.63	8.2	7.5
I-3	0.0z	0.0	1.54	3.61	7.8	7.0
I-4	4.8z	0.0	1.51	3.26	8.5	7.8
I-5	15.2v	0.0	1.41	3.37	7.5	8.5

‘Numbers in the same column with the same letter are not significantly different at the 5% probability level (Duncan's Multiple Range test).

†Ratings at 1 being poorest and 10 being best.

Soil salinity levels as measured by the electrical conductivity of the saturation extract (EC,) at the end of the study were not significantly affected by irrigation treatments. No diseases were evident at any time.

Cool-season grasses. Mean annual water use and pan evaporation by the cool-season grasses in the second experiment for a 3-year period is shown in Table 4. During this period, mean annual precipitation was 10.4 in. Results were somewhat different from those of the first experiment. Largest amounts of water were applied in the evaporation-based (I-4) and 15 cb tensiometer-controlled (I- 1) treatments. The I-3 (55cb) tensiometer-controlled treatment again applied the lowest amount of water. The decreased magnitude of the differences among treatments can be attributed to several factors: increased evaporation and decreased rainfall during the study period, better water management by local turfgrass managers and lower tensiometer settings for the I-2 and I-3 treatments. Kentucky bluegrass in general used less water than tall fescue: likely this is a result of greater heat stress during the summer months. The relationship to weather conditions as measured by pan evaporation was again evident.

Turf quality was affected by the irrigation treatments as shown by selected representative evaluations in Table 5. Poorest quality resulted from the driest treatment (I-3) throughout the study for Kentucky bluegrass. The turf in this treatment showed considerable reduction in density and an increased incidence of disease from *Fusarium roseum* (LK) Snyd. and Hans. in the second and third year. Wilting from water stress also occurred frequently. Quality of tall fescue was affected by the driest irrigation treatment only during the first part of the study. After the root system had developed fully, it showed no further effects. All treatments produced comparable quality from then on.

Significant differences among treatments in weed population were evident only in tall fescue (Table 6). In general, the wetter treatments had the most weeds with the control highest of all, perhaps because the soil surface was kept moist for a greater part of the time. Most abundant weeds in the tall fescue were annual bluegrass, *Poa trivialis L.* and velvetgrass *(Holcus lanatus L.).* Because the *P. trivalis* was found only in the tall fescue, seed contamination was suspected. It accounted for a major portion of the weed population.

At the end of the study, maximum root depth measured across all treatments was significantly greater for tall fescue than for Kentucky bluegrass (24 vs. 18 in.). Variability within treatments was great for both grasses, and no clear effect of treatments on root depth was evident. Although soil salinity as measured by EC, generally increased during the 3-year period, no treatment relationship was discernible.

Table 4. Annual **Water** Use and Pan Evaporation (in.) by *Festuca arundinacea* (Fes) and Poa *pratensls* (Poa) for a &year Period

Month	Treatment (inches)										Pan evaporation
	I-1		1-2		I-3		I-4		I-5		
	Fes.	Poa	Fes.	Poa	Fes.	Poa	Fes.	Poa	Fes	Poa	
Jan.	1.10	1.30	.71	1.14	.71	.55	.91	.95	1.22	1.30	1.54
Feb.	1.46	1.77	1.46	1.22	.98	1.10	1.61	1.54	1.30	1.30	2.36
Mar.	2.40	2.24	2.32	2.36	2.52	2.05	2.36	2.36	2.09	2.05	3.23
Apr.	4.25	3.90	4.96	3.50	4.45	3.78	4.45	4.41	4.37	4.49	‘4.92
May	4.69	3.82	4.09	3.50	3.86	3.54	4.17	4.17	3.86	3.62	5.12
June	6.50	5.71	5.87	5.04	4.13	4.96	5.55	5.51	5.26	5.08	6.06
July	7.32	6.97	6.97	6.38	6.54	5.83	6.73	6.72	6.58	6.54	7.60
Aug.	6.65	6.50	6.02	5.59	5.75	5.24	6.50	6.26	5.75	5.91	6.81
Sept.	4.96	4.65	4.06	4.69	3.86	4.09	4.17	4.17	4.41	4.41	4.96
Oct.	3.03	3.58	2.64	2.80	3.27	3.15	3.19	3.07	3.23	3.23	3.90
Nov.	1.89	1.85	1.14	1.61	1.34	1.06	1.73	1.69	1.61	1.61	2.48
Dec.	1.65	1.54	.75	.75	.71	.39	1.42	1.46	1.10	1.06	1.84
Total	45.91	43.82	40.98	38.58	38.11	35.75	42.80	42.32	40.79	40.59	50.83

Table 5. Turf Quality Ratings of Festuca arundinacea (Fes) and *Pea pratensis* (Poa)

Treatment			Ratinos* on date of evaluation							
	8-22-71		2-16-72		8-15-72		2-8-73		9-7-73	
	cy.	st.	cy.	st.	cy.	St.	cy.	St.	cy.	St.
I-1	8.5xy*'	7.0y	8.8NS	8.8NS	8.3NS	7.8y	9.0NS	8.3y	8.ONS	8.3y
I-2	7.8xy	7.oy	9.0	8.8	8.5	8.0y	8.8	8.3y	7.8	7.8yz
I-3	7.3z	5.8z	8.3	8.3	7.8	6.3z	8.5	7.oz	8.3	6.8z
i-4	9.0x	6.5yz	9.0	8.5	8.3	8.3y	8.8	8.3y	8.0	8.3y
I-5	8.5zy	6.5xy	8.8	8.5	8.3	8.0y	8.5	8.0y	8.8	8.3y

‘Ratings of 1 being poorest and 10 best.
“Numbers in the same column with the same letter are not significantly different at the 5% probability level, Duncans Multiple Range Test.

Table 8. Mean Weed Population in Cool-season Grasses in 3rd Year of Study

Treatment	Mean weed population (% ground cover)	
	Festuca arundinacea	*Poa* iaratensis
I-1	6.0y**	4.3NS
I-2	4.oyz	2.3
I-3	3.0z	2.5
I-4	6.0y	1.8
I-5	10.0x	3.0

“Numbers in the same column with the same letter are not significantly different at the 5% level (Duncan’s Multiple Range Test).

These studies have shown that tensiometers and evaporation pans can be effective irrigation guides, and that significant water savings may often result. For the warm-season grasses used in this study, reduction of the water applied to less than one-half of the control did not reduce general turf quality. The cool-season grasses, especially Kentucky bluegrass, required more water than the warm-season grasses and showed greater damage from water stress. The surprising and most significant result of the studies, however, may be that the irrigation treatments had so few differential effects on the turf. Variations in turf appearance or quality occurred frequently but could seldom be related to specific irrigation treatments.

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Chemical and Cultural Control of Kikuyugrass in Turf[1,2]

David W. Cudney, Victor A. Gibeault, Richard L. Baldwin, James R. Breece[1]

Kikuyugrass, *Pennisetum clandestinum* Hochst. ex Chiov., was introduced into California about 60 years ago as a turf and erosion-control species. It is a native of eastern and southern Africa and is now found in such wide-ranging areas as Colombia, New Zealand, Hawaii, and Brazil. This perennial grass has become established in California from the Mexican border to San Francisco Bay. Stands are confined almost entirely to coastal areas where minimum average temperatures are above 60° F.

Kikuyugrass is a vigorous competitor in turfgrass and crowds out desirable species. It develops an undesirable thatch of rhizomes or stolons. When managed properly, kikuyugrass can be a desirable turf with good color and high durability, but it is usually considered a weed in golf courses. bowling greens, and some home lawns. It resembles St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze., and has been mistakenly propagated as that desirable species.

There are sterile and fertile types of kikuyugrass. Since the fertile type predominates, seedlings, as well as the established perennials, usually must be controlled.

The purpose of our experiment was to evaluate the use of glyphosate to control established kikuyugrass. followed by the establishment of a competitive cool-season grass that would allow preemergence use of siduron to control germinating kikuyugrass seedlings.

Turf trials

The experiment was established in 1978 at two sites within 3 miles of the coast, separated by 200 miles. The Ventura County trial was begun in September on a silty clay soil and the San Diego trial in October on a sandy loam soil. Both sites had adequate phosphorus and potassium. The trials were designed as a split-split plot arrangement with three replications.

There were three main blocks: no glyphosate treatment; one glyphosate treatment; and one glyphosate treatment followed by a second treatment two weeks later. All glyphosate treatments were applied at 4 pounds active ingredient per acre with a CO_2 pressurized backpack sprayer operated at 35 psi with a spray volume of 30 gallons per acre.

Normally a waiting period of seven days is advised after glyphosate treatments before thatch removal. In the experiment, thatch was removed 48 hours after treatment to minimize the time that the turf area would be unavailable for recreational use. Previous unreported work by the experimenters has indicated that 48 hours is sufficient for adequate kikuyugrass control.

Each of the three main blocks was then split into three and reseeded with one of the following turf species at rates per 1000 square feet: ‘Derby’ perennial ryegrass at 6 pounds: ‘Alta’ tall fescue, 10 pounds: and ‘Fylking’ Kentucky bluegrass. 3 pounds. The sub-blocks were further split into four plots each for treatment: no siduron: siduron applied preemergence: siduron applied preemergence and repeated in February; and siduron applied preemergence and repeated in February and July. Each siduron application was at I2 pounds active ingredient per acre in water to 30 gallons per acre with the CO_2 pressurized backpack sprayer.

After the three cool-season turfgrass species became established. they were regularly irrigated and fertilized with soluble nitrogen to maintain good turf quality. The test sites were mowed weekly at a 1 1/2-inch cutting height. No other primary or secondary turfgrass maintenance was performed on the two sites.

Kikuyugrass cover ratings were made over a 30-month period after the trial began. Kikuyugrass cover was evaluated on a 0 to 10 scale with 0 representing no kikuyugrass and 10 representing 100 percent cover. All data were subjected to statistical analysis and mean separation using the Duncan multiple range test.

Results and discussion

At both San Diego and Ventura. either one or two applications of glyphosate resulted in significantly less kikuyugrass reinvasion than no glyphosate treatment. but there was no significant difference between the two herbicide treatments (table 1) At both test sites. practically no kikuyugrass recovered after the first and before the second glyphosate application. which would account for the lack of difference between the two treatments.

Siduron also affected kikuyugrass reinvasion primarily by limiting seedling germination. All siduron treatments resulted in significantly less kikuyugrass than no treatment at

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[2] Reprinted from *California Agriculture* (Vol. 36. nos. 1 and 2).

Ventura and San Diego (table I). At both sites, there was no significant difference in kikuyugrass reinvasion among one, two, or three siduron treatments, which demonstrates the importance of applying siduron at the time of renovation. Apparently kikuyugrass begins reestablishment right after the glyphosate/thatch-removal/over-seeding treatment, so siduron is needed immediately.

The importance of glyphosate in the combined treatments is readily apparent (table 2), because plots receiving no glyphosate treatments were entirely covered with kikuyugrass, irrespective of the siduron treatments. Any combination of glyphosate and siduron produced the greatest decrease of kikuyugrass cover.

Perennial ryegrass and tall fescue, which germinate and become established much more rapidly than Kentucky bluegrass, resulted in significantly less reinvasion of kikuyugrass 1 1/2 years following herbicide treatments (table 3). Evidently, initial competition of the overseeded grasses is very important in reducing kikuyugrass regrowth. This conclusion is further supported by turfgrass cover ratings six weeks after the Ventura trial was seeded. Perennial ryegrass and tall fescue, with ratings of 6.9 and 7.7, respectively, covered the plots significantly more quickly than Kentucky bluegrass, with a 3.7 rating.

The best combination of treatments in Ventura (fig. 1 and 2) 2% years after application of glyphosate to control established kikuyugrass was overseeding with tall fescue followed immediately by one or more treatments of siduron for kikuyugrass seedling control. Kentucky bluegrass grew slowly and proved to be a poor choice for kikuyugrass renovation. Perennial ryegrass equaled tall fescue 1 1/2 years after glyphosate treatment but was weakened, because of low maintenance levels, and eventually reinvaded by kikuyugrass after 2 1/2 years.

TABLE 1. **Kikuyugrass cover at two California sites treated with glyphosate or siduron, rated 1% years after initial treatment**

	Kikuyugrass rating*†at:	
Herbicide	Ventura	San Diego
GLYPHOSATE TREATMENT:		
None	9.4 y	7.8 y
One	2.8 z	5.1 z
Two	2.7z	4.4 z
SIDURON TREATMENT:		
None	6.4y	6.5y
One	4.5 z	5.5 z
Two	4.7 z	5.5 z
Three	4.2 z	5.5 z

TABLE 2. **Kikuyugrass cover as influenced by glyphosate and siduron teatment at Ventura, 1% years after first application**

Siduron	Kikuyugrass rating*†		
	Glyphosate treatment		
treatment	None	One	Two
None	9.7 z	4.7 y	4.8 y
One	9.2 z	2.1 z	2.1 z
Two	9.3 2	2.7 z	2.2 z
Three	9.2 2	1.9z	1.6z

TABLE 3. **Kikuyugrass cover at two California sites overseeded with three cool-season turfgrasses, rated 1% years after herbicide treatment**

	Kikuyugrass rating*†	
Turfgrass	Ventura	San Diego
Kentucky bluegrass	5.8 y.	7.5 x
Perennial ryegrass	4.5 y	4.0 2
Tall fescue	4.6 z	5.8 y

'Kikuyugrass cover rating on a 0 to 10 scale, with 0 representing no klkuyugrass and 10 representing 100 percent kikuyugrass.

†Values in a column followed by the same letter are not significantly different at the 5 percent level according to Duncan's multiple range test. Data ate analyzed across all treatments

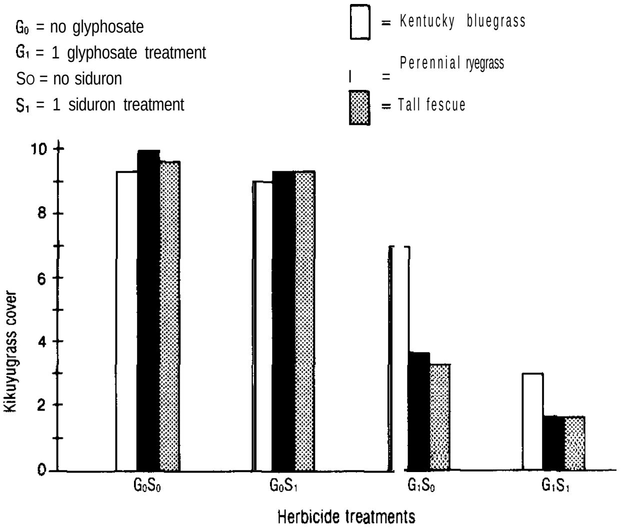

Fig. 1. Cumulative effect of kikuyugrass control (0 = no weed cover; 10 = 100% cover) 1l/2 years after first treatment, Ventura.

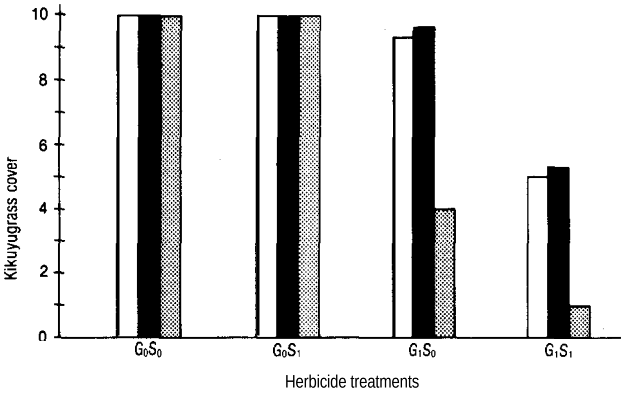

Fig. 2. Cumulative effect of kikuyugrass control (0 = no weed cover; 10 = 100% cover) 21/2 years after first treatment, Ventura.

UC TURF CORNER

UC Turf Corner contains summaries of recently reported research results, abstracts of certain conference presentations, and announcements of new turf management publications. The source of each summary is given for the purpose of further reference.

Cool-season Turfgrass Heat Tolerance

The heat tolerance of 22 Kentucky bluegrass cultivars, annual bluegrass, and 4 perennial ryegrass cultivars was evaluated at the Pennsylvania State University.

Plants were exposed for 30 minutes to temperatures ranging from 41 to 49 C (106 to 120°F) in single degree intervals. Ten-week-old plants which had been grown under a low level of nitrogen fertilization and watered infrequently to maximize heat tolerance development were sealed in plastic bags, placed in a constant temperature water bath for treatment, and then replanted. Recovery was evaluated by visually rating the plants 4 weeks after treatment or by harvesting and weighing plants 2 weeks after treatment and expressing the weight as a percent of the weight of a nonstressed control. Cultivar comparisons were based on the average recovery weight over a given temperature range.

Initial injury occurred at 41 to 43°C (106 to 109°F) with complete kill at 47 to 49°C (117 to 120°F), the Pennsylvania researchers report. Kentucky bluegrass was more heat tolerant than the annual bluegrass and perennial ryegrasses. Heat tolerance of the latter two species was approximately equal. The Kentucky bluegrass cultivars tested were similar in heat tolerance. Among the ryegrasses, ‘Loretta’ was less heat tolerant than ‘Diplomat,’ ‘Pennfine.’ and ‘Citation.’ Of all the grasses, ‘Sydsport’ Kentucky bluegrass ranked the highest and Loretta perennial ryegrass the lowest in heat tolerance. The correlation between dilute acid extractable carbohydrate reserves and recovery weight for these five cultiyars was not significant. There was a significant negative correlation between recovery weight and iron and aluminum concentration.

(See “Heat Tolerance of Kentucky Bluegrasses, Perennial Ryegrasses and Annual Bluegrass.” by D. J. Wehner and T. L. Watschke, *Agronomy Journal* Vol. 73. No. 1. January-February 1981.)

Turfgrass Rust Update

A recent article in *California Turfgrass Culture* (Vol. 30. No. 2, 3, and 4: “Rust on Kentucky Bluegrass and Perennial Ryegrass Cultivars” by Harivandi and Gibeault) cited *Pucciniu striiformis* as the primary species of rust affecting Kentucky bluegrass *(Poa pratensis* and perennial ryegrass *(Lolium perenne)* in the northern and central areas of California. Dr. John Hardison. Pathologist at Oregon State University, Corvallis, subsequently informed the authors that *Pucciniu coronata* is the primary causal agent of rusts on perennial ryegrass in Oregon during winter and spring months. with stem rust. *P. graminis* dominating during warm summer and fall months. Hardison’s concern that *P. striiformis* might reach Oregon. prompted sampling of infected perennial ryegrass and Kentucky bluegrass research plots in San Jose, California. Samples were sent to Hardison and Dr. Art McCain. Pathologist at University of California Berkclcy. for rust identification. Tests confirmed that the rust affecting Kentucky bluegrass was *P. striiformis* (stripe rust). hut revealed that rust on perennial ryegrass was caused by *P. coronata* (crown rust). These results suggest that in Northern and Central coastal areas of California. as in Oregon. the primary cause of rust in ryegrass is *P. coronata.* The authors wish to thank Drs. Hardison and McCain for their help in clarifying this subject.

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