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This enlarged issue of *California Turfgrass Culture* combines the Spring, Summer, and Fall issues of 1980. This was determined to be the best method of presenting several pest-related articles within the time available. The Winter 1981 issue will return to the quarterly format of the "Culture."

Mixing Turfgrasses Controls Fusarium Blight

Victor A. Gibeault. Richard Autio, Stanley Spaulding, and Victor B. Youngner *

Appealing color, density, texture, and overall uniformity make Kentucky bluegrass *(Poapratensis L.)* the most commonly used cool-season turfgrass species in California. It grows best along the coast but also is planted in inland areas where it is not as well adapted because of high summer temperatures. During the summer, Kentucky bluegrass can be damaged by Fusarium blight, a disease caused by the fungus *Fusarium roseum,* which bleaches the leaves and causes a severe root rot, killing the grass.

Perennial ryegrass *(Lolium perenne)* is another cool-season turfgrass adapted to the same California climatic zones as Kentucky bluegrass. Excellent turf-type perennial ryegrass cultivars have been developed recently that closely resemble Kentucky bluegrass in color, texture, and overall appearance but are not susceptible to Fusarium blight. In a study designed to find a practical, non-chemical method for controlling Fusarium blight in Kentucky bluegrass, we evaluated various mixes of Kentucky bluegrass and perennial ryegrass for Fusarium blight resistance and overall turf quality response.

The study was conducted at the University of California South Coast Field Station in Santa Ana. Eleven bluegrass/ryegrass mixes were established in September 1975 in 25-square-foot plots, and each was seeded at a rate equivalent to 3 pounds of seed per 1,000 square feet. The treatments were replicated four times and arranged in a completely randomized block design. Once established, the experimental area was c ut at a 1 3/4-inch height and fertilized with a slow-release nitrogen source at a rate equivalent to 3 pounds of nitrogen per 1,000 square feet per year. Irrigation was based on water loss from an evaporative pan. No other primary or secondary maintenance was performed.

Park Kentucky bluegrass and a blend of 50 percent Manhattan and 50 percent Pennfine perennial ryegrass were used in all treatments. Table 1 shows weight and seed count percentages of the 11 treatments.

Observations were made regularly on plot appearance. At least two persons made monthly turf scores (visual appearance ratings based on color, texture, density, pest activity, and uniformity of the turfgrass treatments), The plots were rated for color intensity three times during 1976. Fusarium blight was noted in August 1978, and data were recorded as percent area affected by the disease. During the winter of 1978-79, the Kentucky bluegrass and perennial ryegrass tillers were counted in three 2-inch plugs harvested from each plot. All data were subjected to an analysis of variance, and significant differences determined by the Duncan's Multiple Range Test.

During the warm season (May to September), all bluegrass/ryegrass mixes had a somewhat better overall appearance than the 100 percent Kentucky bluegrass plots, although the differences were not great (fig. 1). In comparison, all mixes of bluegrass/ ryegrass had significantly higher turf scores than the straight bluegrass treatment during the cool season (October to April). The perennial ryegrass, which has excellent vigor during those months, obviously exerted a positive response in

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TABLE 1. Study Treatments

Treatment	Weight		Seed count*	
	Kentucky blue	Perennial rye	Kentucky blue	Perrennial rye
	%	%	%	%
1	100	–	100	–
2	95	5	90.7	1.3
3	90	10	97.2	2.8
4	85	15	95.0	4.2
5	80	20	94.1	5.9
6	75	25	92.4	7.6
7	70	30	90.4	9.6
8	65	35	88.1	11.9
9	60	40	86.0	14.0
10	55	45	82.2	16.8
11	50	50	80.2	19.8

*Based on 2,463 seeds Of Kentucky blue per gram and 606 seeds of perennial rye per gram.

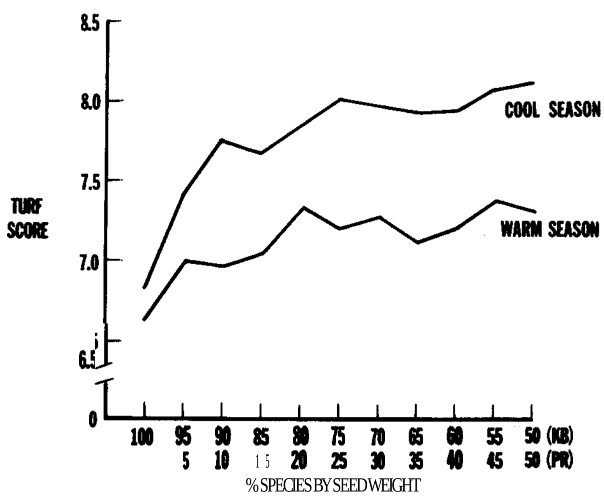

Fig. 1. Average scores of Kentucky bluegrass (KB) and perennial ryegrass (PR) mixes in warm (May-September) and cool (October-April) seasons, Scale from 0 to 10; 10 is best turf.

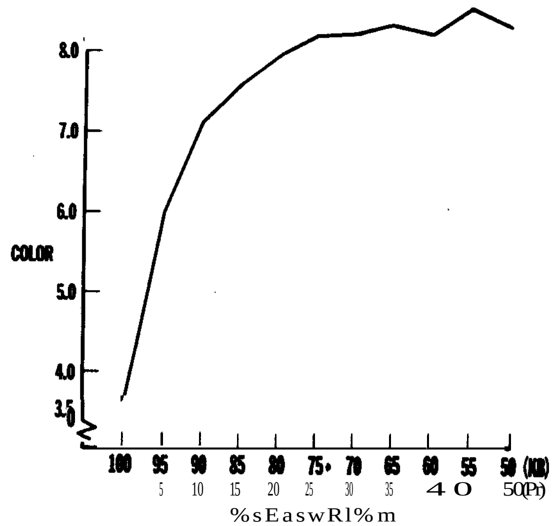

Fig. 2. Color intensity visual ratings for Kentucky bluegrass/perennial rye grass mixes. Scale from 0 to 10; 0 is turf sward without green color; 10 is deepest green.

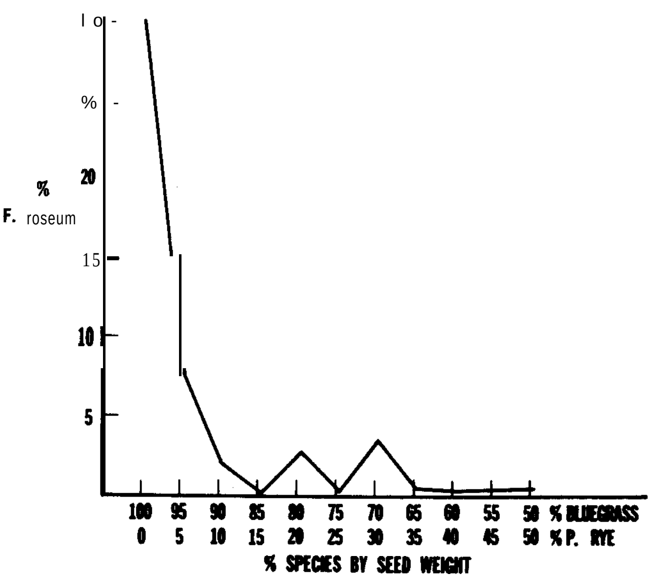

Fig. 3. Percentage of Fusarium roseum observed in Kentucky bluegrass/ perennial ryegrass mixes in August 1978.

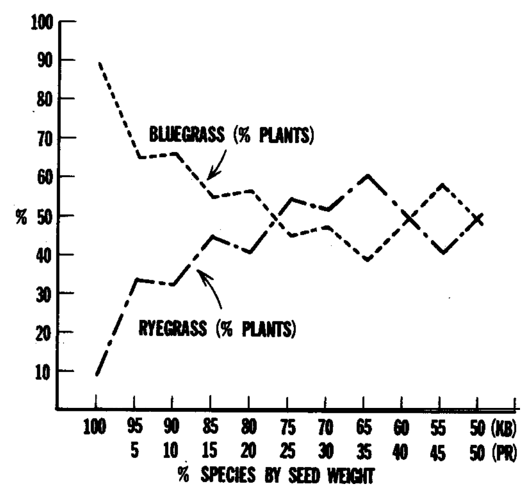

Fig. 4. Percentage of Kentucky bluegrass and perennial ryegrass plants 40 months after mixes were established.

TABLE 2. Turf Scores for 1977 to 1979 for Bluegrass/Ryegrass Mixes at Santa Ana

Mix (by weight)		
Kentucky bluegrass	Perennial ryegrass	Turf score*
%	%	
100	—	6.8 Z*
95	5	7.3 Y
90	10	7.5 XY
05	15	7.4 XY
80	20	7.7 x
75	25	7.7 x
70	30	7.7 x
65	35	7.6 XY
60	40	7.7 x
55	45	7.8 x
50	50	7.0 x

'Score is on a scale of 0 to 10, where 0 is dead turf, and 10 is an ideal turfgrass stand. Values followed by the same letter are not significantly different at the 5 percent level (Duncan's Multiple Range Test).

the mix. When the turf scores were combined and analyzed for the two-year period, we found that all mixes were given significantly higher appearance ratings than the straight bluegrass (table 2).

Even a small amount of ryegrass added to the Park Kentucky bluegrass improved turf color (fig. 2). Five percent perennial ryegrass gave significantly better color than 100 percent bluegrass, and the treatment with 10 percent ryegrass was significantly better than either the 5 percent or no ryegrass treatments. There were no further significant increases in color ratings when 15 percent or more ryegrass was used as part of the mix.

After the experimental area was subjected to moisture stress in the summer of 1978, Fusarium blight occurred that August. Fusarium blight on the 100 percent Park Kentucky bluegrass plot was devastating: about 30 percent of the plot area was killed (fig. 3). The amount of affected area decreased markedly in plots with only 5 percent ryegrass in the mix. The disease symptoms, in essence, were eliminated in all treatments containing 10 percent ryegrass or more, and there was no significant difference in Fusarium blight incidence among any treatments above 10 percent ryegrass. These results definitely show that mixing even small amounts of perennial ryegrass with Kentucky bluegrass can mask or control the disease symptoms. The amount of perennial ryegrass needed falls in the 10 to 15 percent range on a seed weight basis.

The count of bluegrass and ryegrass tillers in the 2-inch plugs showed that Kentucky bluegrass decreased very rapidly and perennial ryegrass increased when even a small percentage of ryegrass on a seed-weight basis was added to the mix (fig. 4). There was no significant difference in bluegrass/ryegrass plant counts in mixes containing more than 15 percent ryegrass on a seed-weight basis (85 percent or less bluegrass). The bluegrass/ryegrass balance assumed approximately a 50/50 plant count relationship with 15 percent ryegrass or more in the seed mix.

These results tend to support and explain the results on turf scores, color, and Fusarium blight activity. Evidently, the quick-germinating and rapid-growing perennial ryegrass was able to establish and remain competitive, even when very small seed numbers per unit area were seeded. The slower germinating and growing Kentucky bluegrass was able to fill in around the established ryegrass plants, and the species mix was maintained for the duration of this three-year test.

In conclusion, mixes of Kentucky bluegrass and perennial ryegrass practically eliminated Fusarium blight activity, whereas control plots of straight bluegrass were damaged. The mixture of the two species resulted in a better color and higher turf appearance ratings than the bluegrass alone. A seeding of 15 percent or more perennial ryegrass, and 85 percent Kentucky bluegrass or less, by weight, resulted in approximately a 50/50 bluegrass/ryegrass plant count after three years.

Acknowledgment

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Chemical Renovation of Turf

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"Turfgrass renovation" is an all-inclusive phrase that can cause considerable confusion unless clearly defined. For our purposes, renovation is defined as a turfgrass management practice for converting an existing stand of weeds or mixed grass species, or both, into a turf of acceptable species and quality. For example, it is sometimes desirable to remove bentgrass *(Agrostis sp.)*, bermudagrass *(Cynodon dactylon)*, tall fescue *(Festuca arundinacea)*, or kikuyugrass *(Pennisetum clandestinurn)* and replace these perenniai grasses with Kentucky bluegrass *(Poa pratensis)* or perennial ryegrass *(Lolium perenne)*. Similarly, a lawn with broadleaf weeds and mixed grasses can be converted by proper renovation methods to a uniform cover of a desired turf species.

Renovation may be accomplished in several ways. The best method usually depends on the plant species to be replaced. Nonchemical renovation usually is used where annual broadleaf weeds and grasses are a problem. In small locations, the sod can be removed and the area resodded or reseeded with a mixture comparable to the surrounding sod. In larger areas, most annual weeds can be controlled by cultivation when the soil is prepared for planting. Many types of equipment can be used for this type of renovation, depending on the size of the area to be treated. If perennial weeds are present, considerable effort will be necessary to alternately work the soil and dry out the surface to kill weed roots and stems (rhizomes and stolens). Even after this process is repeated several times, perennial weeds are seldom totally controlled.

Nonchemical renovation in a live turf stand also is difficult. A desirable species is seeded or plugged into an area that has been severely dethatched and scalped. After this process, the cultural practices required to favor the introduced species are extremely narrow, so that this kind of renovation is rarely successful.

Chemical renovation of many types of turf areas is still under investigation. One critical point to note is that any chemical method must be combined with good cultural practices following treatment to obtain optimum results.

Several postemergence herbicides are available for renovation (table 1). In each case, the weeds should be growing rapidly for optimum results. However, repeat applications of most of the materials will be required for any degree of control, especially of bermudagrass and kikuyugrass (table 2).

Recent research has focused on the use of glyphosate to renovate areas infested with bermudagrass, kikuyugrass, tall fescue, and other difficult-to-control perennial weeds. Glyphosate moves rapidly throughout most plants, although they may retain green color for some time after treatment. However, even when a material is translocated as well as glyphosate is, research data and use information indicate that the following specific conditions must be met for optimum activity of the herbicide.

TABLE 1. Postemergence Herbicides Available for Turf Renovation

Common name	Trade name
cacodylic acid	Germain's Fresh Start Grass and Weed Killer Phytar 560 Contact
dalapon	Dowpon Ortho Dowpon M Grass Killer Greenlight Dowpon M Grass Killer
amitrole	Amitrole T Amizol Cytrol
glyphosate	Roundup, Kleenup systemic weed and grass killer

TABLE 2. Turf Renovation — Optimum Weed Growth Stages and Other Conditions for Herbicide Application

Weeds	Cacodvlic acid	Dalaoon	Amitrole	glyphosate
Annual weeds	Young weeds (under 6 in.)	Young weeds (growing vigorously)	Young weeds (growing vigorously)	Young weeds (growing vigorously)
Bermudagrass	Closely mowed; spray regrowth	Moist soil, vigorous new growth; treat in spring or summer	Moist soil, vigorous growth; treat in late summer or fall	Moist soil, vigorous growth; treat in summer or fall
Perennial ryegrass	Closely mowed	Vigorous, new growth	....	Vigorous growth
Tall fescue	....	....	Treat clumps 6 to 8 inches tall	Vigorous growth

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Suggested steps to convert an unacceptable lawn to a cool-season grass lawn

The best time to start this procedure is July or August:

1. Keep turfgrass watered and fertilized before treatment.
2. Allow turf to grow 2 weeks without mowing.
3. Irrigate 1 or 2 days before treating with herbicides. Do not irrigate again until after replanting.
4. Treat with label rate of glyphosate in low volume of water (20 to 50 gallons per acre). Pay particular attention to edges (sidewalks, curbs, and the like) to make sure they are adequately sprayed.
5. After at least 7 days, rototill area well, or strip sod and rototill.
6. Allow area to dry completely.
7. Finish grade. Removing large clumps of rhizomes or drying them along edges is critical.
8. Plant cool-season varieties: Kentucky bluegrass, perennial ryegrass, or mixture.
9. Where warm-season grasses have been present, treat area with siduron (Tupersan) at highest label rate at planting time and the following year.

Data to support the glyphosate renovation steps are compiled from several trials. One trial showed significant improvement in control when bermudagrass was allowed to grow 2 weeks without mowing before treatment (table 3). Since this delay increases the leaf surface area, it should increase uptake of glyphosate.

TABLE 3. Bermudagrass Control with Glyphosate

Time of mowing before treatment	Control*
days	
0†	4.5
3	1.8
7	3.5
14	6.2
21	7.5

*Ratings on a scale of 0 to 10: 0 = no control; 10 = complete control of bermudagrass.
†Mowed 1 hour before treatment. Glyphosate applied 10/2 and rated 5/3

Another trial to evaluate the optimum time for sod removal after treating bermudagrass with glyphosate indicated that at least 7 days are required for control at the label rate of 4 pounds per acre (table 4).

Two other trials in Davis compared the effects of different glyphosate rates on bermudagrass control. At one location sod was removed dry, and the soil allowed to

TABLE 4. Bermudagrass Control

Herbicide	Rate	Control when sprayed sod removed the following days after treatment*: 2	7	14	21
	lb/acre				
Glyphosate	4	4.5	6.3	6.3	6.6
Glyphosate	6	7.0	7.8	8.0	7.3
Glyphosate	8	7.0	7.5	8.3	8.3
Control	–	3.5	2.0	2.3	2.0

*Ratings based on a scale of 0 to 10: 0 = no control; 10 = complete control of bermudagrass.

TABLE 5. Bermudagrass Control – Dry Soil*

Herbicide	Rate	Topkill† (fall)	Control the following months after treatment‡: 8	11
	lb/acre		%	%
Glyphosate	1	2.8	38	58
Glyphosate	2	6.0	70	78
Glyphosate	4	8.2	85	94
Control	–	0	12	53

*Soil allowed to dry completely before laying new sod.
†Ratings on a scale of 0 to 10: 0 = no topkill; 10 = complete topkill of bermudagrass.
‡Siduron applied at 10 pounds per acre after sodding.

TABLE 6. Bermudagrass Control - Wet Soil'

Herbicide	Rate	Topkill (fall)†	Control the following months after treatment*	
			7	10
	lb/acre		%	%
Glyphosate	2	8.0	40	16
Glyphosate	4	8.8	58	35
Glyphosate	6	10.0	86	55
Control	—	- -	18	12

'Soil still wet when new sod was laid.
†Ratings on a scale of 0 to 10: 0 = no topkill; 10 = complete topkill of bermudagrass.
‡Siduron applied at 10 pounds per acre after sodding.

TABLE 7. Tall Fescue Control

Herbicide	Rate	Control'	
		Treated 4/l 4	Treated 9/21
	lb/acre	%	%
Glyphosate	2	84	100
Glyphosate	4	95	99
Glyphosate	8	98	99
Control	—	3	42

*Evaluated 5/19

dry. At the second location the sod was removed wet, and new sod laid back on wet soil. Bermudagrass control was better where soil was allowed to dry out completely before replanting cool season sod (table 5) than on wet soil (table 6).

Information obtained in renovating tall fescue stands indicates that this grass is extremely susceptible to glyphosate, especially when treatments are applied in September (table 7). Data from several trials indicate that kikuyugrass is also easily controlled with glyphosate applications (table 8).

Probably the second most important factor in successful turf renovation is control of unwanted seedling regrowth. Particular attention should be paid to bermudagrass or kikuyugrass seedling germination and establishment, which can negate all previous renovation efforts in a very short time. Data indicate that siduron applications at planting time result in up to 20 percent added control of bermudagrass and kikuyugrass (data not available at time of publication). The siduron treatments will also control other grasses, such as crabgrass *(Digitaria sp.)* and barnyardgrass *(Echinochfoa crusgalli)*. This herbicide can be used safely only in cool-season turfgrasses, such as Kentucky bluegrass, perennial ryegrass, and tall fescue.

The final important type of renovation involves fumigation, which may be necessary when perennial grass

TABLE 6. Kikuyugrass Control'

Herbicide	Rate	Control†
	lb/acre	
Glyphosate	1	10.0
Glyphosate	2	9.8
Glyphosate	4	9.8
MSMA	4	8.8
Control	—	—

*Treated 2/27/76; evaluated 3/28/76
†Ratings on a scale of 0 to 10: 0 = no control; 10 = complete control

and broadleaf weeds are present that are not easily controlled with postemergence herbicides. Fumigant materials available are methyl bromide' (Dowfume MC-2, Bromo-O-Gas, Tribrom), metham (Vapam), calcium cyanamid (Tag Line Cyanamid), and dazomet (Mylone). Again, successful fumigation depends on following a specified set of conditions, which may include tarping of the treated areas to prevent escape of the fumigant and to enhance control.

'Restricted material; permit for purchase and use must be obtained from County Agricultural Commissioner.

In following any of the aforementioned renovation procedures, an important set of cultural practices plays a significant part in the continuing success of the project. These practices include, but are not limited to:

☐ Selecting the right variety of turf for the area to be renovated. Sowing at the proper rate. (Drill seed, preferably, or sod.)

☐ Mowing at regular intervals and at the prescribed height for the variety planted.

Cl Fertilizing to keep the stand vigorously competitive with weeds.

❑ Irrigating with the proper amount and at a frequency to promote growth.

❑ Recognizing and treating potentially damaging insects, diseases or other pest problems.

❑ Managing thatch development to limit its effect on healthy turf growth.

Reference

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Germination and Establishment of Prostrate Spotted Spurge

Robert Krueger and Dale Shaner*

Prostrate spotted spurge *(Euphorbia supina Raf.),* a low-growing summer annual, is a weed in several cultivated areas, including turf. Spurge lives from about March or April until September or October. Each plant produces several thousand seeds, which largely accounts for the success of the species as a weed. To further understand the characteristics of spurge, studies were undertaken at University of California, Riverside, and elsewhere in southern California.

One very important characteristic was found to be that spurge seed produced at different times of the year vary in amount of dormancy. About 50 percent of seed produced in August germinates, but this declines to about 5 to 10 percent germination for seed produced in November. Thus, even if all the emerged spurge plants were killed before they could produce seed, ungerminated weed seeds would remain in the soil for future site contamination.

Germination of spurge seeds increases after stratification. “Stratification” involves keeping the seeds cool and moist-conditions similar to those encountered during winter. This characteristic, when combined with the dormancy phenomenon, prevents seeds from germinating during unfavorable winter conditions. The seeds are stimulated to germinate the next spring, when conditions are favorable.

Temperature is the most important factor controlling spurge germination. The temperature must be between 60° and 110° F; about 85° F is the optimum. Alternating temperatures (if they are within the 60° to 110° F range) increase germination; the best conditions are when the upper temperature is 85° to 95° and the lower 60° to 80° F.

If spurge seeds are moist and kept at temperatures too low for germination (but too high for stratification), germination immediately afterwards at favorable temperatures is inhibited. This inhibition can be removed by stratification. This observed response prevents a brief warm spell in the fall from promoting a large amount of germination, which would expose seedlings to possible death from subsequent frost or cold.

Total lack of light decreases spurge germination and inhibits subsequent germination in the light. This prevents spurge from germinating in dark conditions, such as a dense plant canopy, and from germinating after plants forming the canopy die.

Even though complete darkness is inhibitory, spurge is able to establish under very low light levels. Even at regimes as low as 12.5 percent of full sunlight, all seedlings establish, although those growing with higher light intensities are larger and more vigorous.

Germination and initial seedling growth were observed under day-lengths of 8 and 16 hours. The two photoperiods did not influence germination differently. Once emerged, however, seedlings grew more quickly and vigorously under the longer photoperiod.

The amount of soil covering the seed also affects spurge establishment. Emergence is best from a depth of about 4 inches and declines somewhat at the surface and at 1/2-inch depth. At depths greater than 1/2 inch, emergence is virtually eliminated. This appears to result from a lack of germination, because no germinated but un-

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emerged seedlings were found. Factors preventing emergence from lower depths appear to be darkness and soil impedance. Lack of emergence from very shallow depths appears to be due to exposure of the seed to adverse environmental conditions. In addition, seeds brought to the soil surface from lower depths by a disturbance do not germinate, even after stratification, so a seed may die if buried too deeply or for too long.

It was shown that soil pH affects spurge germination. In test conditions, as pH was increased above 6.0, the germination of spotted spurge decreased. Similarly, reduced germination was noted as the seeds were stressed for water.

The results indicate that germination is prevented when environmental conditions are unfavorable and stimulated when conditions are favorable. This characteristic results in the preservation and increase of seed reserves, which in turn result in a more severe spurge infestation. It is therefore important to combat spurge before it produces seed. Spurge must be detected early in its life cycle, when it is still quite small, because it can set seed within a month of germination. However, spurge is capable of germinating throughout the summer, although high temperatures may slightly decrease germination. It is apparent that control must be maintained throughout the growing season to keep the weed from getting completely out of hand, and that preemergence as well as postemergence herbicides are needed when chemical controls are used.

Progress Report: Control of Spotted Spurge in Bermudagrass Turf

*Victor A. Gibeault Richard Autio, and Clyde Elmore**

Prostrate spotted spurge *(Euphorbia supina)* is commonly found in turf swards, especially in areas of high summer temperature. It is considered a weed in turf because of its short life cycle, and because it colonizes the desired turf by rapid growth in July and August, only to turn an objectionable red-orange color and die shortly thereafter. Spotted spurge is a prolific seed producer, even under close clipping, so can spread rapidly once it is established. Usually associated with an inadequately fertilized sward with resulting poor density, spotted spurge is a low-nitrogen-requiring plant that can compete very well in a soil of poor nutritional status.

Because of the increasing prevalence of this weed in California turf sites, a series of trials was conducted to evaluate chemical methods of controlling spurge.

The trials reported here were conducted at the Eisenhower Medical Center, Palm Desert, California, unless otherwise stated. The site had a common bermudagrass *(Cynodon dactylon)* turf that was overseeded each year with annual ryegrass *(Lolium multiforum)* and had a history of a heavy spurge infestation during the summer. As the annual ryegrass died during the late spring-early summer, the spurge proliferated, and by July dominated the bermudagrass. By later summer-early autumn, the spurge growth slowed, the plants took on a reddish hue, and they remained in a static growth stage until the area was again overseeded with annual ryegrass in October.

The area was maintained at a l-inch cutting height, fertilized primarily in the autumn, winter, and spring for ryegrass growth and color, and irrigated as needed throughout the year to ensure good growth and appearance. No other primary or secondary management practices were performed.

The soil was a loamy sand with a pH of 6.8 and a low electrical conductivity reading (EC, 0.79). Phosphorus and potassium levels were adequate for turfgrass growth.

For more information on the germination characteristics of spotted spurge, the site was examined weekly during the winter of 1977 to determine the time of spurge germination. Each time, the turf in several areas was pushed aside, and the soil surface examined for germinating spurge seedlings. The temperature at the l-inch soil depth was recorded at each observation time (9:00 a.m. recording).

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Preemergence trials

Preemergence control studies for spotted spurge had been conducted at this location since 1975. Materials evaluated included the following:

Common name	Chemical name
benefin	N-butyl-N-ethyl-a, d, d,-trifluoro-2, b-dinitro-p-toluidine
bensulide	o,o-diisopropyl phosphorodithioate S-ester with N-(2-mercaptoethyl) benzenesulfonamide
bifenox	methyl 5-(2, 4-dichlorophenoxy)-2-nitrobenzoate
DCPA	dimethyl tetrachloroterephthalate
methazole	2-(3, 4-dichlorophenyl)-4-methyl-l, 2, 4-oxydiazolidine-3, 5-dione
ozadiazon	2-ter-butyl-4-(2, 4-dichloro-5-isopropoxyphenyl)-2- 1, 3, 4-oxadiazolin-5-one
–	El 131 (experimental material)
–	RH2915 (experimental material)

In all preemergence studies, the appropriate herbicides, with water carrier, were applied during calm weather using a pressurized sprayer operated at 40 psi with 80 GPA water carrier, and a TeeJet 8004 nozzle. The granular herbicide formulations were applied to the research plots by salt-shaker method or with a calibrated Gandy 5-foot drop spreader. Treatments in each trial were randomized, replicated, and analyzed statistically.

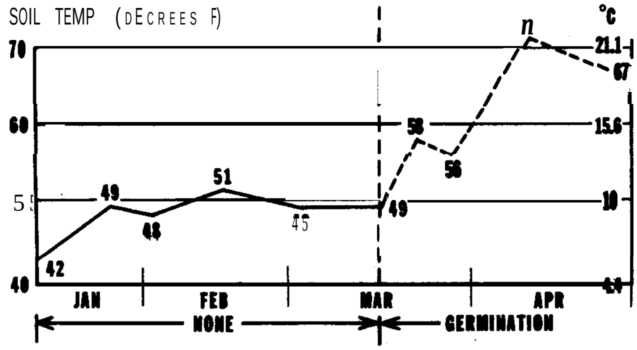


Fig. 1. Presence or absence of spurge seedlings, by month and soil temperature, at Palm Desert, California.

Postemergence trials

A number of postemergence herbicides were also screened over a period of several years at the Eisenhower Medical Center site.

Common name	Chemical name
bifenox	methyl 5-(2, 4-dichlorophenoxy)-2-nitrobenzoate
bromoxynil	3, 5-dibromo&hydroxybenzonitrile
dicamba	3, 6-dichloro-o-anisic acid
diuron	3-(3, 4-dichlorophenyl)-1, l-dimethylurea
–	El 13 1 (experimental material)
MCPA	[(4-chloro-o-toly)oxy] acetic acid
methazole	2-(3, 4-dichlorophenyl)-4-methyl-l, 2, 4-oxydiozolidine-3, 5-dione
–	RH2915 (experimental material)
–	Velsicol 4207 (experimental material)
2, 4, 5-TP	2-(2, 4, 5-trichlorophenoxy) propionic acid
2, 4-DB	4-(2, 4-dichlorophenoxy) butyric acid
2, 4-D	(2, 4-dichlorophenoxy) acetic acid .

Herbicides were applied as previously discussed; the trials were randomized and replicated, and significant difference determined.

Results

Germination of spotted spurge was noted when the surface soil temperature increased from 49° to 58° F in a one-week period in mid-March (fig. 1). At that time, the spurge was in the two-leaf stage, and it stayed at that growth stage until mid to late April. Thereafter, growth proceeded quite quickly with small rosettes noted in early May.

From this visual inspection and the information previously presented by Krueger and Shaner, it appears that spotted spurge germinates when soil temperatures rise to and are maintained at or above the 55° to 60° F range. If preemergence herbicides are an anticipated control method, such materials must be applied before temperatures are favorable for spurge germination.

Among the numerous preemergence herbicides field-tested for several years, the only consistent control of spurge was noted with DCPA. The best results were obtained when DCPA was applied three times with 60 days between treatments, each time at the recommended label rate. If only one or two applications were made, dormant spurge seed would germinate in the late spring or summer, following the breakdown of the herbicide.

It was concluded from these studies that DCPA, to be effective, must be present and active over a long period to control the almost continuous germination of spurge well into the summer season. Making at least three applications per season is both costly and potentially phytotoxic to the desired species, if applied over several seasons, thus raising the question of feasibility of relying completely on preemergence control as the only chemical control method.

Of the postemergence herbicides and herbicide combinations tested, bromoxynil was the most effective chemical. However, higher than label rates and repeat treatments were needed for good control. Table 1 clearly shows that the 2-pound-per-acre rate of bromoxynil active ingredient gave the best control. Control was not achieved without temporary phytotoxicity to the bermudagrass, which appeared as a tip burn that was mowed off within 2 weeks after treatment. As the summer progressed, surviving spurge plants and younger expanding plants were able to grow and reinvade the turf, necessitating two bromoxynil applications.

Table 2 presents the results of a trial where two applications of bromoxynil were made at the rate of 2 pounds active per acre. Two applications separated by four weeks between treatments gave the best spurge control. Other trials and observations showed similar results. Phytotoxicity to bermudagrass was again temporary tip burning that followed each herbicide treatment; the desired

TABLE 1. Spotted Spurge Control and Phytotoxicity to Bermudagrass with Various Bromoxynil Rates, Applied June 14, 1977

Treatment	(ai/a)*	Bermudagrass phytotoxicity† 6/16	6/22	6/29	Spurge control 6/29
	lb				%
Bromoxynil	1/2	0.75	0.5	0.0	14
	3/4	2.0	1.25	0.1	21
	1	3.25	1.50	0.4	52
	1 1/2	4.25	2.0	0.4	59
	2	5.25	3.25	0.9	77
Untreated check		0	0	0	0

* ai/a = active ingredient per acre.
†Phytotoxicity rated on a scale of 0 to 10: 0 = no injury; 10 = severe injury.

TABLE 2. Spotted Spurge Control and Bermudagrass Phytotoxicity after Various Reapplication Schedules with Bromoxynil

Treatment*	Reapplication	Spurge control†	Phytotoxicity‡ 8/16	8/23	8/30	9/7	9/15	9/20
		%						
Bromoxynil	. . .	51	3.25	0	0	0	0	0
	after 1 wk	74	3.25	3.5	0	0	0	0
	after 2 wk	77	2.75	0.5	2.5	0	0	0
	after 3 wk	78	3.25	0.5	0	0.1	0	0
	after 4 wk	100	2.75	0.5	0	0	1.25	0
Check		0	0	0	0	0	0	0

*Bromoxynil applied at 2 pounds active ingredient per acre, each application; first applied on August 5.
†Percent spurge control rated September 20.
‡Phytotoxicity rated on a scale of 0 to 10: 0 = no injury; 10 = severe injury.

grass recovered within 7 to 14 days after treatment.

To study phytotoxicity with the bromoxynil rate of 2 pounds active ingredient per acre on cool-season grass, two trials were conducted at the U. C. South Coast Field Station in Santa Ana, one on Kentucky bluegrass cv. Park and one on tall fescue cv. Alta. The initial treatment of bromoxynil was made on August 24, 1976.

As is shown in table 3, Kentucky bluegrass performed similarly to common bermudagrass in tolerating the 2-pound rate of bromoxynil. A tip burn was noted, which was reduced following mowing and disappeared a few weeks after treatment. More serious, long-lasting injury was noted on tall fescue, especially when bromoxynil was reapplied one week after the initial application. From the results, it appears that tall fescue is quite susceptible to bromoxynil; however, recovery from herbicide injury does occur.

To determine the influence of very high rates of bromoxynil for spurge control and the effect of potential overlap on bermudagrass phytotoxicity, a trial was conducted to evaluate the herbicide at 1, 2, 4, and 8 pounds active ingredient per acre. The rates were

TABLE 3. Phytotoxicity on Two Grasses after One or Two Bromoxynil Applications

Treatment*	Reapplication	Phytotoxicityt					
		8/31	9/8	3/1 4	9/21	9/28	10113
Kentucky bluegrass							
Bromoxynil	.	2.75	0.9	0.5	0	0	0
	after 1 wk	2.25	2.25	1.75	0.75	0.5	0
	after 2 wk	2.75	1.0	2.25	0.25	0	0
	after 3 wk	2.0	1.1	0.25	1.0	0.5	0
	after 4 wk	2.0	0.75	0.5	0	1.0	0
Check	------------	0	0	0	0	0	0
Tall fescue							
Bromoxynil		3.0	1.5	0.5	0	0	0
	after 1 wk	3.5	7.0	5.0	3.5	2.75	1.0
	after 2 wk	3.25	1.5	3.5	1.75	1.25	0.25
	after 3 wk	3.5	1.5	0.5	2.5	1.0	0.25
	after 4 wk	3.25	2.0	1.0	0.5	2.5	0.25
Check	....	0	0	0	0	0	0

*Bromoxynil applied at 2 pounds active ingredient per acre. First treatment on August 24, 1976.
†Phytotoxicity rated on a scale of 0 to 10: 0 = no injury; 10 = severe injury.

TABLE 4. Phytotoxicity to Bermudagrass after Two Bromoxynil Applications Four Weeks Apart

Treatment	(aila)*	Phytotoxicityt					
		7/13	7/19	7/25	7/31	8/10	8/17
	lb						
Bromoxynil	1	1.0	0	0	0	1.25	0
	2	2.5	0.75	0	0	3.0	0
	4	3.75	1.25	0	0	3.5	0
	8	5.75	3.0	0.25	0	6.25	0
Untreated check		0	0	0	0	0	0

‘ai/a = active ingredient per acre.
†Phytotoxicity rated on a scale of 0 to 10: 0 = no injury; 10 = severe injury.

applied on July 4, 1979, and again four weeks later on July 31.

It was found that 2, 4 and 8 pounds controlled spotted spurge equally, and the three rates gave significantly better control than the l-pound rate (fig. 2). For optimum control, there is no reason to go above the 2-pound rate.

As the rates increase, so does the bermudagrass injury (table 4). The highest herbicide rate, 8 pounds active ingredient per acre, was especially injurious, but essentially complete recovery was noted two weeks after treatment. These data indicate that an overlap from a 2-pound application would result in more phytotoxicity; however, the increased injury would be temporary.

In conclusion, it was determined that germination of spotted spurge began when soil temperature at the l-inch depth increased and remained at or above 55° to 60° F. Initial preemergence control of spurge was achieved with DCPA applied according to label directions. Repeat DCPA treatments were necessary for control. For spurge that escaped preemergence control or for swards not treated before emergence, bromoxynil at 2 pounds active ingredient per acre applied twice with four weeks between treatments gave excellent control.

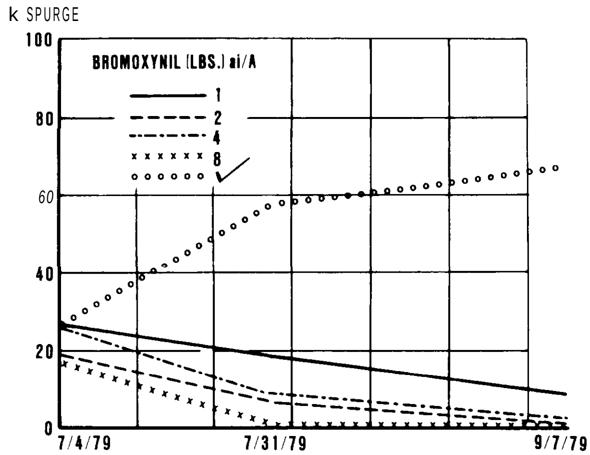
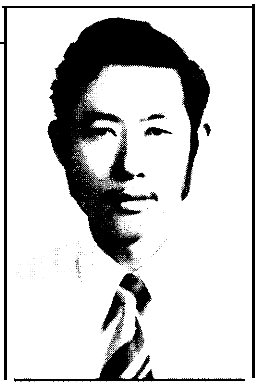


Fig. 2. Spotted spurge control at various bromoxynil herbicide rates, as compared with untreated control (check).

Temporary, acceptable tip-burn discoloration was noted on common bermudagrass and Kentucky bluegrass. Quite severe leaf injury was noted on tall fescue.

The 2-pound rate is above label guidelines, so this information must be treated as a research progress report and should not be construed as a recommendation.

Dr. Lin Wu Joins U. C. Davis



Dr. Lin Wu has joined the Environmental Horticulture Department, University of California, Davis, as Assistant Professor with a specialty in turfgrass research. He is taking the position vacated by the partial retirement of Dr. John Madison.

Dr. Wu, a native of Taiwan, did his graduate work at the University of Liverpool in England. His research projects in England concerned heavy metal tolerance in creeping bentgrass.

At Davis, Dr. Wu's research will focus on genetic and physiological studies related to stress resistance of turfgrass. The objective of his breeding program will be the evaluation and introduction of grasses that perform better under environmental and heavy use stress.

New turfgrass pest manual

For anyone concerned with turfgrass and the pests that invade it, the newly revised edition of *Turfgrass Pests,* Priced Publication 4053 (formerly Manual 41), is a ready source of information on prevention and control of insects, nematodes, weeds, diseases and rodents.

Over 80 photos, many new and in color, help to identify the various pests of turfgrass. The calendar of pest activity together with tables noting pest life cycles, susceptible plants, methods of detection, and activity and treatment periods for pests provide quick, useful references, New tables of metric and customary equivalents are particularly handy with the increasing use of International System Units (IS).

Up-to-date '"how-to" chapters include the safe and effective use of pesticides - from how they work to bow to store them as well. as how to calculate the size of the turf area to be treated, the amount of chemical needed, and bow to prepare the sprayer.

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Rust on Kentucky Bluegrass and Perennial Ryegrass Cultivars

*M. Ali Harivandi and Victor A. Gibeault **

Rust fungi *(Puccinia striiformis)* attack many turfgrasses but are a more serious problem on Kentucky bluegrass *(Poa pratensis L.)* and perennial ryegrass *(Lolium perenne L.)* in the Central Coast and northern California. Moderately warm, moist spring and fall weather in this region favors rust development. Symptoms are elongated yellow-orange or reddish brown powdery pustules that develop on leaves and stems. Reddish spores adhere to fingers or cloth rubbed across affected leaves.

Several labeled chemical pesticides control or prevent reinfection of rust. And, at times, repeated applications might be necessary to see some results. Keeping grass growing rapidly by proper mowing, fertilizing, and watering has been the most effective control measure against rust so far. The best weapon against the disease could be selection of turfgrass species and cultivars that are not susceptible to this disease.

Fifty-seven cultivars of Kentucky bluegrass and 37 cultivars of perennial ryegrass established at the U. C. Deciduous Fruit Field Station, San Jose, were evaluated for fall rust susceptibility in mid-October 1980. These grasses had been seeded in October 1978. The plots had been fertilized at the rate of 4 pounds nitrogen per 1,000 square feet per year, mowed at a height of 2 inches with a reel mower with clippings returned, and irrigated at the rate of water evaporated from an above-ground class A evaporation pan installed adjacent to the plots. Results of this evaluation are summarized in tables 1 and 2.

TABLE 1. Kentucky Bluegrass Cultivars Evaluated for Fall Rust Susceptibility*

Severe rust	Moderate rust	No rust	
Cello	Aquila	Adelphi	Harmony
Enoble	A-20-8	A-34	Hekla
Kimono	Cheri	Baron	Holiday
Merion	Entroper	BFB-35	ISI 28
Oblisk	H-7	Berka	ISI 154
Plush	Scenic	Bluebell	Majestic
P-184	Touchdown	Bonnieblue	Merit
		Bristol	Mosa
		Brunswick	Ornce
		Charlotter	Parade
		Cleopatra	Pion
		Columbia	Ram 1
		Dormi	Rugby
		Durmier	Sherpa
		Enaldo	Swing
		Emmundi	Sydsport
		Fylking	Trenton
		Geronimo	Vanesa
		Glade	Victa
		Golden west	Welcome
		Haga	WW Ag-480

“Cultivars evaluated on October 15, 1980.

TABLE 2. Perennial Ryegrass Cultivars Evaluated for Fall Rust Susceptibility*

Moderate rust	No rust	
Bellatri	Acclaim	Mom LP20
Citation	Aristocrat	Pennfine
Derby	Arno	Pippin
Diplomat	Birdie	Player
Hunter	Blayer	Score
K5-92	Carvalle	Servo
Manhattan	Campus	Sportiva
Omega	Common	Sprinter
Pennant	Elka	Venlona
Regal	Ensporta	Yorktown II
Runner	Fiesta	2W 42-80
Yorktown	Linn	2W 42-81
	Loretta	

● Cultivars evaluated on October 15, 1980.

*Farm Advisor, Cooperative Extension, Alameda County; Environmental Horticulturist, Cooperative Extension, University of California, Riverside, respectively.

UC TURF CORNER

Victor A. Gibeault and Forrest D. Cress*

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.

Annual Bluegrass Control in Bermudagrass: Progress Report

A 3-year study was conducted at the Virginia Polytechnic Institute and State University to determine the effectiveness of different herbicide programs for annual bluegrass control and improvement of bermudagrass groundcover for golf fairways.

Treatments were applied in April for large crabgrass, in May or June for goosegrass, and in late August for annual bluegrass.

Oxadiazon applied in August gave complete control of annual bluegrass. Although oxadiazon has a long residual life in the soil, annual bluegrass was poorly controlled with treatments made in June, according to the Virginia researchers who conducted the study. Fall applications of benefin, prosulfalin, and butralin adequately controlled annual bluegrass with only a few exceptions during the experiment. Bensulide gave variable control of annual bluegrass. However, this was improved in programs with oxadiazon which provide goosegrass control during summer.

In the Virginia study, DCPA, even with three applications a year, gave very little control of annual bluegrass. When oxadiazon was used in rotation with DCPA, adequate control was obtained, the Virginia scientists report.

(See "Effectiveness of Herbicide Programs for Annual Bluegrass *[Poa annua]* Control in Bermudagrass *[Cynodon dactylon]*,* by S. W. Bingham and R. L. Shaver, *Weed Science*, Vol. 27, No. 4, July 1979.)

Effects of Postemergence Herbicides on Disease of Kentucky Bluegrass

Researchers at Iowa State University have come up with several interesting findings on how postemergence herbicides influence *Helminthosporium sorokinianum* and the severity of leaf spot that this pathogen causes on Kentucky bluegrass.

The Iowa scientists have been studying the effects of 2,4-D, 2,4,5-T, 2,4,5-TP, MCPP, and dicamba on the life processes of both *H. sorokinianum* and the bluegrass. They say that these postemergence herbicides show various stimulatory and inhibitory effects on germination of the pathogen's conidia, growth of its germ tubes and mycelium, and conidia production.

Results from their work to date suggest that concentrations of 2,4-D, MCPP, and dicamba currently used for weed control in turf neither inhibit nor stimulate the germination of *H. sorokinianum* conidia.

The most dramatic effect of the herbicides on *H. sorokinianum*, according to the Iowa findings, is stimulation of the growth of conidia germ tubes after germination. Such growth may increase two to three times in response to various concentrations of each herbicide. Only 2,4,5-TP shows some inhibition of germ-tube growth at higher concentrations, the Iowa researchers say. What this means in terms of germ-tube stimulation relative to infection of leaves and disease development is not clear.

Recent studies in the Iowa laboratory have established that herbicide stimulation of *H. sorokinianum* leaf spot on Kentucky bluegrass is associated with the aging process of the leaves. Leaf spot normally becomes more severe on each older leaf of the shoot. When a shoot is exposed to 2,4,5-T, MCPP, or dicamba and infected, the increase in disease is least severe on the youngest leaves and most severe on the older ones.

The Iowa observations have been made in greenhouse studies; no experimental evidence has been obtained yet from field studies. However, the Iowa researchers report that the leaf spot symptoms produced in response to herbicides in greenhouse studies are similar to those observed in the field during late spring, summer (with irrigation), and fall to early winter. Herbicide stimulation of leaf spot therefore may occur in the field. Such stimulation probably would occur erratically. Early spring herbicide applications might have little effect on leaf spot development because of the lush, youthful condition of the leaves. However, with normal senescence in late spring and early summer, the herbicides may be a factor in increasing leaf spot severity, especially with irrigation or during a wet season.

Preliminary studies at Iowa suggest that raising temperatures from 72° to 86° F will increase the yellowing

*Environmental Horticulturist and Communications Specialist, respectively, Cooperative Extension, University of California, Riverside.

and blighting caused by leaf spots exposed to herbicides. Thus, auxin-like herbicides could have a substantial effect on promoting leaf spot damage on irrigated bluegrass during warm weather. Also, auxin-like herbicides might promote leaf spot the most in fall and early winter, when they may contribute, along with shorter day length, to the rate at which leaves age and subsequently predispose them to develop more severe leaf spot.

(See "Greenhouse Research Explores Herbicide/Turf Disease Relationship," by C. F. Hodges, *Weeds Trees & Turf*, September 1980.)

Minimum Temperatures for Turfgrass See6 Germination

Although a basic principle of establishing turfgrass from seed is to plant when soil temperatures are optimum, vegetative soil stablization is often required of the professional turfman or landscaper when unfavorable temperatures prevail. Residential and building construction in which the project is completed during the winter, when bermudagrass or St. Augustinegrass cannot be planted is an example. In such a situation, a temporary grass must be planted to stabilize the area from soil erosion and to minimize mud and dust problems. Similar situations also arise in winter overseeding of cool-season grasses into warm-season species.

Studies have been conducted at the Texas Agricultural Station, College Park, to investigate the comparative ability of a range of cool-season turfgrass species to germinate at minimal temperatures. Five perennial grasses were featured in the study: Chewings fescue, creeping bentgrass, perennial ryegrass, rough bluegrass, and tall fescue. Seven more cultivars of perennial ryegrass also were evaluated. The annual grass species included cereal rye, Italian ryegrass, winter oats, and winter wheat.

Results to date indicate that the four annual grasses are capable of germinating at slightly lower temperatures than the perennial ryegrasses. Benel cereal rye performed the best, followed by winter wheat, Italian ryegrass and winter oats.

The second grouping of perennial grasses consisted of seven perennial ryegrasses plus Chewings fescue. Linn was the best of the second grouping, and Manhattan ranked the lowest of the perennial ryegrasses in minimum germination temperature requirement. Following the perennial ryegrasses, in order, were rough bluegrass, creeping bentgrass, and tall fescue; the latter two required substantially higher minimum temperature for seed germination.

Although a 1 to 2" F difference at first may not appear significant, it can be very important during the late fall-early winter period of declining soil temperatures. Soil temperature is the critical controlling factor. Researchers at the Texas station have observed over the years that a temperature difference of only a few degrees can delay the establishment rate by as much as 1 to 2 weeks.

In the first of two articles referred to below, minimum temperature required for seed germination of 11 perennial and 4 annual grasses are presented. The Texas investigators who conducted the studies emphasize that seed germination is only one phase of grass establishment. Seedling vigor, they explain, including root and shoot growth rate plus tillering, can be equally significant. Thus, they say, with grasses with comparable minimum temperature requirements for seed germination, the seedling vigor is another factor to consider in selecting the most appropriate grass.

(See "Minimum Temperature Requirements for Seed Germination of Turfgrasses," by J. B. Beard and A. Almodares, *Texas Turfgrass Research--1978-79*, Consolidated PR-3667-3678, February 1980, and "Miniplanted, is an example. In such a situation, a temporary by J. B. Beard, *Grounds Maintenance*, February 1980.)

Use of Activated Charcoal to Deactivate Herbicides

Activated charcoal can absorb and deactivate most of the herbicides used for weed control on golf courses, according to a University of Rhode Island researcher. In soils contaminated with harmful chemical residues, improved grass stands can be obtained by using charcoal in the seedbed. Use of charcoal in contaminated soils where sod is to be transplanted can improve rooting and reduce grass injury.

Where chemical spills, overapplication, or misuse takes place, he says, damage to turfgrass from some chemicals can be alleviated with the use of charcoal. Also, most pesticides can be expected to perform well in turf areas where charcoal has been used earlier.

(See "Charcoal's Neutralizing Powers," by J. A. Jagschitz, *Golf Course Management*, November/December 1979.)

Use of an Instron Universal Testing Instrument to Measure Sod Strength

Using the Instron Universal Testing Instrument, researchers at the University of Georgia have developed a method to aid in determining sod strength accurately.

The pull is in a controlled direction, and the force applied is recorded on a chart that yields the force required to break the sod, the amount the sod stretched before breaking, and the pattern of breaking. The equipment, other than the Instron tester, is reasonable in cost and can be constructed in most shops.

(See "Measuring Sod Strength with an Instron Universal Testing Instrument," by R. E. Burns and J. G. Futral, *Agronomy Journal* 72 [3], May-June 1980.)

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