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Matching Irrigation to Turfgrass Root Depth

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The depth of turfgrass roots determines the volume of soil that serves as a water reservoir which is available for the plant use. Therefore, a deeply rooted turf requires relatively less frequent irrigation than the shallow rooted turf. The word "rootzone" denotes that portion of soil in which roots may grow and turfgrasses are anchored. The soil profile of the rootzone may range from the soil surface to the depth of soil where the roots may reach. In a limited soil depth, the drainage or the underline substrate which may affect the root growth is included. For example, in putting greens the depth for drainage potential from the putting surface to the tile is approximately 16 inches. For an unlimited condition, tall fescue roots may reach a depth of 60 inches or more.

Management practices and the kinds of turfgrass species directly affect the nature of the rootzone of turfgrass. For example. poor soil aeration due to compaction. close mowing. excessive fertilization or irrigation, and cool season or summer heat stresses tend to reduce turfgrass root growth. Among the different turfgrass species, the rooting potential may be quite different between species. A generalized root depth of different turfgrass species is given in Table 1. It may serve as a reference for turf management.

Little information is available concerning the relationship between the available water, turf quality and turfgrass root density distribution. At the UC Davis campus. the relationship between root density distribution and the degree of turf qualtity degradation of tall fescue turf under drought stress was studied.

An "Olympic" tall fescue turf was mowed weekly at 2 inches. In September 1983 and May 1984 the root densities of the turf were measured in increments of 6 inches to a total depth of 36 inches. The highest root density (about 45 cm per one cubic cm soil) was found in the first 6 inches from the soil surface. The root density dropped to about 20 cm/cm3 of soil between 6 to 12 inches. The root density was decreased to about 10 cm/cm3 of soil at the soil depth of 12 to 18 inches, and the density remained constant down to 30 inches. The root density was only 4 cm /cm3 of soil between 30 and 36 inches.

Prior to drought treatment. tensiometers were installed in the tall fescue turf plots at different soil depths. Irrigation was terminated on May 15. 1984. The pressure gauges of the tensiometers were checked daily. When the pressure gauge read-out of the tensiometer at different depths indicated over 90 centibars or became collapsed. three pieces of a 4 inch diameter area of turf were collected and the proportion of fresh leaf area was measured as an indication of turf quality degradation.

The results of root density and root dry weight measurements showed that when the soil moisture depletion reached 90 centibars at 6 to 12 inches deep. the fresh turf leaf area reduced to about 60 percent (Figure 1). This was over the period of 15 days since the termination of irrigation. The turf fresh leaf area was further reduced to 50 percent when the soil moisture depletion reached 18 inches. 30 days after the irrigation was terminated. The fresh turf leaf area was reduced to 30 percent when the soil moisture depletion reached 24 inches. Thereafter. the turf leaf areas remained constant until the soil moisture depletion reached 36 inches and the leaf area further reduced to 20 percent and the turf appearance became stressful. Irrigation was restored after six weeks drought stress. The "Olympic" tall fescue recovered in three weeks after the restoration of irrigation.

Three conclusions may be drawn from observations presented here. First, it was shown that when irrigation was stopped, moisture was depleted starting at the surface then sequentially progressing through the profile from top to bottom. Second, it was shown that a positive relationship may exist between the root density distribution and the appearance of tall fescue under moisture stress. And third, it was observed that tall fescue recovered from severe moisture stress when irrigation was resumed.

Under field management conditions, these findings would indicate that tall fescue, because of its deep root system, water use and appearance characteristics, can withstand considerable periods of lack of irrigation. This may be important to turf managers who are faced with water shortages caused by unavailable water or financial limitations.

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Table 1. Potential root depth of turfgrass species.

Shallow 1 - 8 inches	Medium 8 - 18 inches	Deep 18 - 60 inches
Poa annua	Kentucky bluegrass	Zoysiagrass
Creeping bentgrass	Red fescue	Bermudagrass
Colonial bentgrass	Ryegrass	Tall fescue
	St. Augustinegrass	

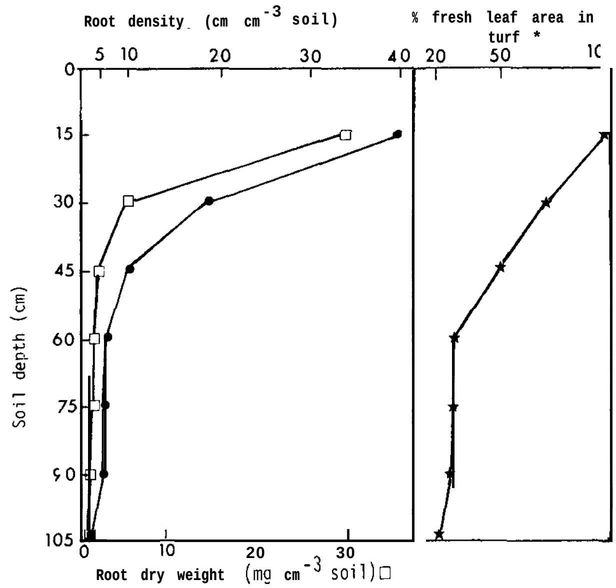

Fig. 1. Root density and dry weight distribution of "Olympic" tall fescue turf and the proportion of fresh leaf area remained in the turf while soil moisture was depleted at different soil depth

Spring Dead Spot, A Destructive Disease of Bermudagrass New to California

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Spring dead spot (SDS), a destructive fungal disease affecting bermudagrass, has occurred in California for the past 7 8 years. We have recently demonstrated that the cause of SDS is the fungus Leptosphaeria korrae. The disease has been mainly a problem on Tifgreen bermudagrass home lawns in the San Joaquin Valley from Fresno to Bakersfield, but recently the disease has appeared on several golf courses in southern California. Although the SDS disease has been spreading slowly, it has been very destructive wherever it has occurred. It is the first disease affecting bermudagrass in California that kills plants.

SDS appears in the spring, after the breaking of winter dormancy, as circular patches of dead and dying bermudagrass plants (Fig. 1):Affected areas vary from a few inches to a foot or more in diameter. Diseased areas are depressed because the upper leaf blades, upper leaf sheaths, and upper stems of the diseased bermudagrass plants are dead, bleached and desiccated as a result of a black-to-brown rot affecting the stolons, roots and basal portions of the stems.

The disease usually does not appear until the bermudagrass plants are two years old or more, but in subsequent years the disease usually reappears in or near the same spots. By summer, the dead patches usually have filled in with new growth spreading in from the sides and/or with new growth arising from surviving plants within the patches.

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The disease is easy to diagnose based on the characteristic signs and symptoms of the disease which are as follows. The disease appears only in the spring as circular patches of dead and dying bermudagrass plants that fail to recover from winter dormancy (Figure 1). If the affected plants are dug up with the roots still attached and the soil washed off, the affected roots and stolons will appear black or brown rather than the normal white or green color (Figure 2). Next, examine with a 10x hand lens the brown stolons and the brown lower stems for the presence of tiny, brown-to-black, round, cushion-shaped sclerotia (Figures 2 & 3) which are aggregations of fungal threads or hyphae. These sclerotia are located on the surfaces of diseased lower stems and stolons and can be easily scraped off with a knife. They commonly occur. The sclerotia are survival structures of the causal fungus which is named *Leptosphaeria korrae.* Now, with a hand lens, examine the diseased roots for the presence of a second type of sclerotia. They are longer than broad, black-to-brown in color and appear to be formed on the surface of the roots (Figure 4). In actual fact, the sclerotia are formed inside of the cortex of the roots (Figure 5). In contrast to the first type of sclerotia, which are abundant, the root sclerotia are rarely formed. Finding them is unlikely. If all of the above characteristics of the disease and signs of the fungus can be observed, your diseased bermudagrass plants are affected with spring dead spot disease. If you are uncertain of your diagnosis, send a 2- to 4-inch diameter sample of the diseased bermudagrass to R. M. Endo, Department of a Plant Pathology, University of California, Riverside, CA 92521.

As far as susceptibility of bermudagrasses is concerned, the fungus, *L. korrae,* has been found attacking the following varieties: Common, Santa Ana and Tifgreen. The disease has also been found in kikuyugrass. The susceptibility of other turfgrasses to the SDS disease is unknown.

Why is the disease expressed only in the spring following the emergence of bermudagrass plants from winter dormancy? There appear to be three reasons: 1) the fungus is more active at cool temperatures than at warm temperatures; 2) bermudagrass plants are either more susceptible than normal at cool temperatures; or 3) growth of bermudagrass plants ceases during winter so that replacement of diseased tissues by healthy tissues does not occur. When inoculated, Tifgreen bermudagrass plants were grown in growth chambers controlled at 54 or 74°F the causal fungus L. korrae killed plants grown at 54 but not at 74 (Figure 6). This means that if effective fungicides can be found to control the disease, they should be applied in early fall when the fungus is most active.

How does the fungus spread? Plant-to-plant spread to adjacent plants occurs by means of fungal threads or hyphae which grow over the surfaces of the roots, stolons, and lower portions of the aerial plant surfaces. Unlike the delicate hyphae of most fungal pathogens of turfgrass, the hyphae of the SDS pathogen are resistant to desiccation; as a result, the hyphae do not dry up and die when free moisture disappears. Instead, they persist for long periods on the surfaces of the subterranean parts of bermudagrass plants, spread, grow and infect plants whenever moisture conditions are favorable. This method of localized spread explains the appearance of the SDS disease in circular patches since the fungus spreads out as threads from a central point.

Spread of the fungus from area to area probably occurs by movement of pathogen-infected plant parts on shoes, rakes, mowers, aerifiers, renovators, golf carts and golf bags. It may also occur by planting infected sod. Aerial spread of the fungus by means of spores probably does not occur or occurs only rarely because the pathogen does not form asexual, wind-disseminated spores. Certain isolates of the fungus, however, occasionally form sexual spores called ascospores, in pear-shaped fruiting bodies called pseudothecia, but it is not known if the ascospores are capable of causing infection.

The fungus readily survives unfavorable periods by means of its persistent fungal threads or hyphae and by means of its two types of sclerotia. Infection probably occurs by means of the free fungal threads and by fungal threads arising from the two types of sclerotia.

Since the disease first starts as a few circular patches, homeowners have frequently asked if the disease can be controlled by digging up and removing the disease patches and transplanting healthy sod back into these areas. Our answer is; "Probably not, because it is not known how deep in the soil the pathogen occurs as hyphae on the roots of bermudagrass and how far the fungus spreads laterally as hyphae into apparently healthy-looking areas of bermudagrass'.' Thus, removal of only the obviously diseased areas most probably will fail to remove all of the causal fungus, and this is necessary for control.

In Australia, the SDS disease is controlled by monthly applications of the fungicides tetra-methyl thiuram disulfide or disodium ethylenebisdithiocarbamate applied as a soil drench for nine consecutive months beginning in the fall. Unfortunately, these fungicides are no longer readily available in the United States. Therefore, we are presently evaluating in the laboratory and field some of the more promising fungicides for their ability to control the fungus and disease with fewer applications. No fungicide is presently registered for control of SDS disease in the United States.

The effects of watering frequency and duration, and fertilization (type and frequence) are not known on the development of the SDS disease. Infrequent, deep watering, during the fall when the fungus is most active will probably help to slow down the spread and development of the disease. This is because abundant, free moisture usually favors the development, growth, and parasitic activities of most parasitic fungi.

In conclusion, a disease with the same name and symptoms on bermudagrass occurs in the southeastern United States, but the cause of the disease has not yet been determined. Therefore, control measures developed for the SDS disease in the southeastern United States may not be effective in California.

Fig. 1. Tifgreen bermudagrass lawn affected with spring dead spot (SDS).

Fig. 2. Stolons and roots affected with dry brown rot typical of SDS. Note tiny, round sclerotia on the stolon surfaces.

Fig. 3. Close-up of the external type of sclerotia that are formed on the stolon and lower stem bases.

Fig. 4. A second type of sclerotia that is formed within the cortex of the infected roots.

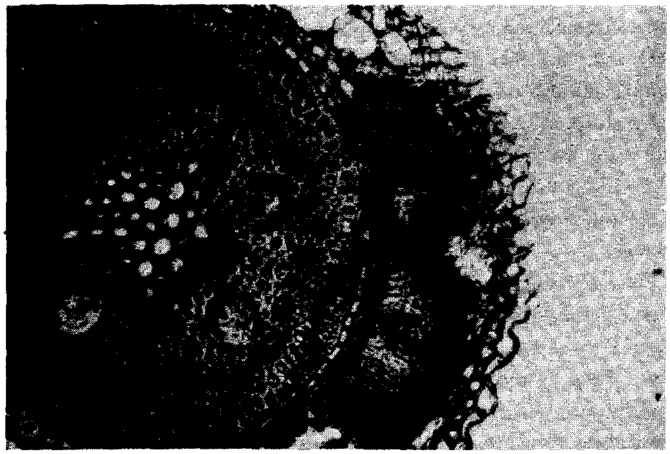

Fig. 5. Close-up of two sclerotia that were formed within the cortex of the infected root.

Fig. 6. Effect of temperature on SDS development. The plants on the left in each pair were the healthy, uninoculated control and the plants on the right were inoculated. The pair of plants on the left was grown at 74° F and the pair on the right was grown at 54° F.

Paspalum Vaginaturn Winter Color Management Study

J. Michael Henry, Victor A. Gibeault[1]

The winter color of *Paspalum vaginatum* (common name, Seashore Paspalum; trade names, "Adalayd" and "Excalibre") is generally poor when compared with cool-season turfgrasses. However, the Southern California winter climate is such that with special care most warm-season lawns, including Seashore Paspalum, can be managed to yield some greenness during most winters. This study sought to determine the adaptability of Seashore Paspalum to winter color enhancing practices and to rate the quality of the turf during the winter and the following growing season.

This study began on October 22, 1981 at the University of California South Coast Field Station, Irvine, California. The Paspalum plot used was five years old and had never been verticut or dethatched. Although the plot had been subjected to previous management studies, the total plot received normal management for six months prior to the start of this study. The entire plot had received nitrogen fertilization in early August and September (1 pound actual nitrogen per 1,000 square feet each month using ammonium sulfate.)

The most common and successful practices to enhance green color on warm-season grasses were selected as treatments. They were as follows:

Treatment 1 -Ammonium sulfate, 1/2 lb actual nitrogen/ 1,000 sq ft/2 weeks (first and fifteenth of each month).

Treatment 2-Ammonium sulfate, 1 lb actual nitrogen/ 1,000 sq ft/month (first of each month).

Treatment 3 - Overseed with annual ryegrass, fertilize with 1/2 lb actual nitrogen / 1,000 sq ft (first of each month).

Treatment 4 - Overseed with perennial ryegrass, fertilize with 1/2 lb actual nitrogen/l,000 sq ft (first of each month).

Treatment 5-Apply turf colorant to dormant grass, no fertilization.

Treatment 6 -CHECK. (No treatment other than mowing and irrigation).

All fertilizer was weighed out in individual quantities for each 4' x 10' plot and uniformly applied by hand for the nitrogen fertilization treatments and the overseeding treatments. A moderate irrigation followed each application to dissolve the material and carry it into the root zone.

The overseeded plots were first verticut and close-mowed to a height of 1/2 inch. Twelve passes with the vertical mower and three passes with a front-throw reel mower were required to open up the turf for overseeding. The perennial rye overseed blend consisted of 1/3 "Derby:' 1/3 "Pennant" and 1/3 "Pennfine" varieties of perennial ryegrass seeded at the rate of six pounds per 1,000 square feet. The annual rye overseeding rate also was six pounds per 1,000 square feet.

The turf colorant was a commercially available product, Cal-Verde, applied at the label rate of one quart per 400 square feet with a 1.5 gallon tank sprayer. The colorant was not applied until complete dormancy occurred (February 1, 1982). The overall plot was irrigated, as needed, based on tensiometer readings and evaporation pan data collected on an adjacent Paspalum plot.

Mowing was done weekly at 1-1/4 inches during the winter. In the spring, mowing was changed to 3/4-inch height twice weekly as the Seashore Paspalum growth began. A front-throw reel mower was used for the low cut; a rotary mower was used for the higher cut.

The plot design was a randomized complete block with three replications. Each individual subplot was 4' x 10'.

The plots were rated visually for turf quality monthly by two researchers, when possible. The rating scale used was from 1 to 9 with 1 indicating totally dead turf and 9 indicating perfect quality (excellent color, density, uniformity, plus freedom from pest, weed problems, etc.). Figure 1 shows one replication of the treatments, taken in March. 1982.

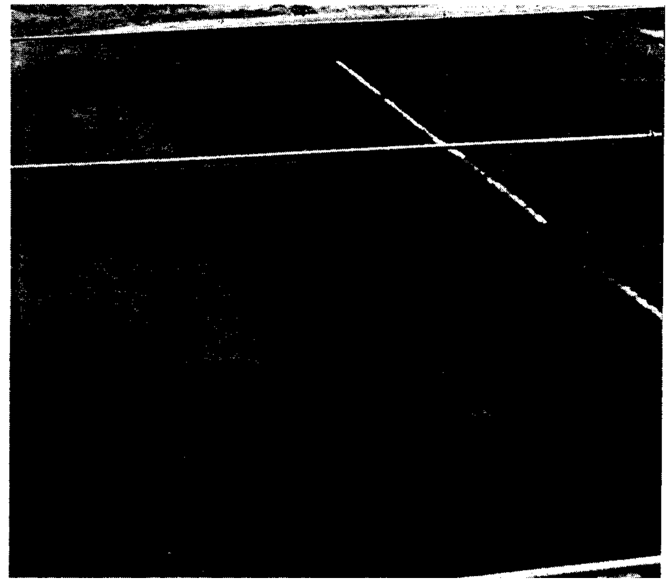

Figure l-Close-up of six treatments taken March 9, 1982 (approximately six months after start of study). (Photo by Max Clover, UCR)

RESULTS

All statistically analyzed data is significant to the five percent level unless otherwise indicated. Each treatment will be discussed individually based on the information presented in the graph in Figure 2. The turf score of the experimental area was just below 7 at the time the study began in mid-October, 1981.

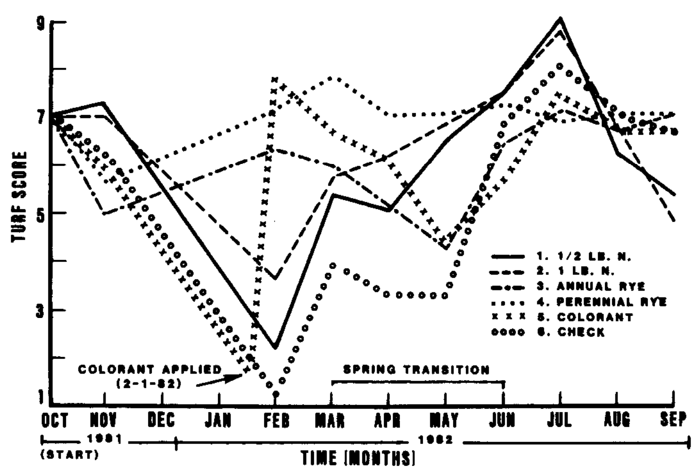

Figure 2 -Turf scores for six treatments to enhance winter color on *Paspalum vaginatum* "Adalayd" (Excalibre) .

NITROGEN TREATMENTS

The two nitrogen treatments at the 1/2 pound and one pound rates showed a significant color enhancement over the unfertilized check through the winter months into spring. There was no significant difference between the two nitrogen treatments during much of the study in spite of the fact that the one pound treatment appeared to give slightly better turf quality during the winter. Neither nitrogen fertilizer treatment produced turf scores high enough during the winter months to yield an acceptable turf quality rating (7 or higher). The final nitrogen treatment was May 6, 1982.

Continued observation and rating of the plots through the following summer and fall yielded information that substantiated previous findings regarding the association between nitrogen application and scalping injury on *Paspolum vaginatum* High nitrogen during the warm months stimulated already vigorous, upright stem and leaf growth. Unless mowed at a higher height and more frequently, the green turf was removed, leaving brown stems which would not resprout green growth. Table 1 gives the comparison of the turf score data and the scalping injury rating taken one year after the start of the study (November 1982).

Table 1. Comparison of mean turf quality scores one year after "start of study. Scalping percent on a 0 to 10 scale with zero indicating no scalping injury. Turf quality scores on a 1 to 9 scale with 9 indicating excellent quality. Means followed by the same letter are not significanty different at the 5 percent level, Duncans Multiple Range Test.

Treatment	Scalping 11/23/82	Turf Qual. 11/30/82
1/2 lb N	4.7 Y	4.0 Y
1 lb N	5.3 Y	3.7 Y
Annual rye	1.0 z	4.7 z
Perennial rye	1.0 z	5.7 z
Colorant	1.0 z	5.3 z
Check	1.3 z	5.3 z

These data clearly show a direct relationship between scalping and nitrogen application even six months after the last fertilizer application. The two nitrogen treatments showed significantly lower turf scores and significanty greater scalping injury when compared with the four other treatments. The fact that the overseeded plots received the same amount of nitrogen as the 1/2 pound nitrogen treatment and yet were not scalped may indicate that the verticutting practice played a significant role in reducing the degree of scalping. Work currently under way to further investigate the scalping/management interaction initially shows an increase in turf quality on verticut plots.

The presence of the very competitive ryegrass may explain the difference in degree of scalping under the same nitrogen regimes.

OVERSEEDING TREATMENTS

Annual ryegrass - It gave acceptable winter color during the late fall and winter months. The turf quality began to fall off in March with the beginning of the spring warming period. The coarse, yellow-green annual rye started to decline long before the Paspalum started to green up. This decline continued into May, at which time the greening of the Paspalum overshadowed the negative effects of the declining annual rye. This poor transition period performance strongly detracts from the overall acceptability of this species as a management tool for winter color improvement on Seashore Paspalum. This treatment is less than satisfactory for situations that demand high quality during the spring transition period as well as the winter months.

Perennial ryegrass - It gave the highest overall turf quality and and consistency of any treatment during the study period. Not only did it give significantly better turf quality over the annual rye overseeded plots during the winter months, but it greatly outperformed the annual rye in the spring transition period. The texture and color of the perennial ryegrass closely matched that of the Seashore Paspalum resulting in slightly noticeable transition period, turf quality decline.

In addition to the rating of the plots during and immediately after the treatment period, the plots were observed and rated for one year following the last treatment in May 1982. This permitted evaluation of long-term effects of the six treatments. No cultural practices other than mowing and irrigation were imposed on the study area during this observation period.

The main point of interest in this extended observation period was the degree of persistence of the perennial ryegrass after a summer period. Table 2 shows the data collected for January 25, 1983 (15 months after initial overseeding). The turf quality scores show that the perennial rye which persisted was enough to significantly increase the rating over the other five treatments. It should be noted that the level of color and turf quality was almost three points below the score for the perennial rye treatment in January of the previous year (Figure 2). This level of quality is far below the acceptable level for high quality turf, but it does give marked and visibly noticeable green color. The photograph (Figure 3) was taken the year following this rating period, 27 months after overseeding, and the perennial rye is still distinctly evident among the dormant *Paspalum vaginaum* "Adalayd" plots.

Table 2. Turf quality scores 15 months after start of study. Means followed by the same letter are not significantly different at the 5 percent level, Duncans Multiple Range Test.

Treatment	Turf Qual. 1/25/83
Perennial rye	3.3 Y
1/2 lb N	1.3 z
1 lb N	1.3 z
Colorant	1.3 z
Check	1.3 z
Annual rye	1.0 z

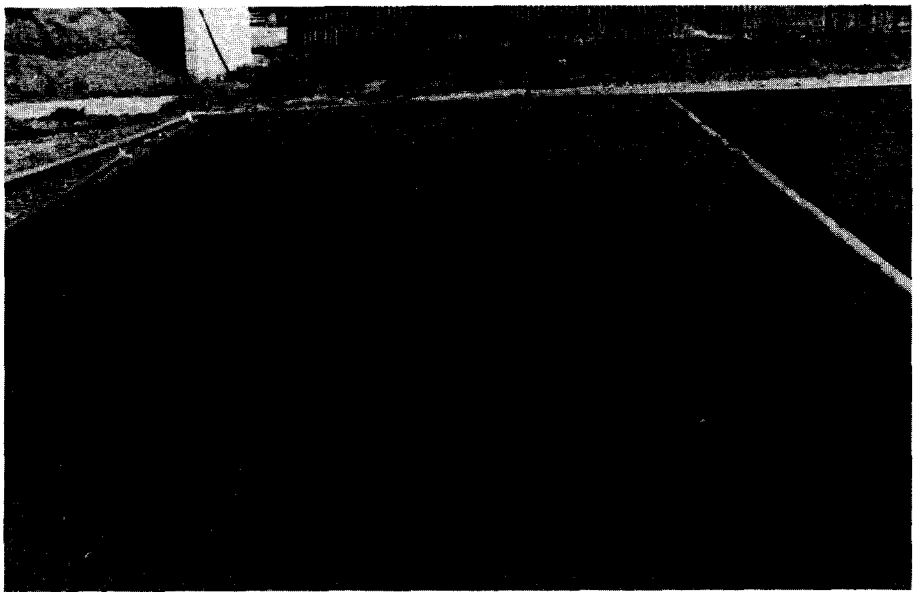

Figure S-Perennial ryegrass overseeded plots 27 months after overseeding. Photo taken February, 1984 (photo by Max Clover, UCR).

Turf Colorant - It gave high turf color ratings immediately after application February 1, 1982. The turf scores declined steadily as the colorant faded over the four-month period until spring greening of the Seashore Paspalum reversed the downward trend. The lowest turf score recorded in May was 4.3, clearly in the unacceptable turf quality range for most turf situations. One could overcome this problem by respraying when the colorant intensity reached an unacceptable level. The fact that the turf score in July is significantly lower and showed slower recovery than the check and the two nitrogen treatments, may indicate a negative effect on growth due to the colorant product used, or the application in general.

Check -This treatment showed the expected drastic fluctuation in turf quality rating over the period of the study. The turf quality extended below the acceptable range (7 or above) for eight months. Clearly all of the color enhancing treatments gave a degree of winter color improvement over the no treatment check. It should be noted that the check reached acceptable turf quality in June.

SUMMARY

The five treatments studied gave improved winter turf scores over the untreated check. If we look only at winter performance, the two overseeding treatments and the colorant treatment gave acceptable turf quality, whereas the two nitrogen treatments and the check yielded poor turf quality. When we take the spring transition period performance into account, the colorant treatment and the annual rye fall out of the acceptable turf quality range during that period. This leaves the perennial rye treatment as the single treatment that gave acceptable turf quality over the period of the study, from fall through the spring transition period into summer. Even a year after the start of the study, the perennial rye treatment was the only one that showed lingering beneficial effects the following winter. Plots that received the nitrogen treatments gave some indication that increased scalping resulted during summer, four months after the treatments ended. The other possible negative trend was that of slightly delayed spring greenup in the plots treated with the turf colorant.

The question of the cause of the delay in spring greenup of the plots treated with the colorant should give some pause to those considering use of the particular material on a regular basis. Further investigation of this question and comparison of currently available colorant products for this effect on spring recovery of warm-season turfgrasses may be warranted.

The poor response to light and moderate nitrogen fertilization rates would logically lead to the conclusion that higher rates during the fall and winter might force a greening of the turf in all but our coldest years. This, in fact, may be true, but this work indicated that the direct effect of the nitrogen treatments was increased growth and resultant scalping the following summer and fall. Previous studies with nitrogen fertilizer treatments on *Paspalum vaginatum* also showed a direct effect between high nitrogen rates (8 lb. /M/yr.) and scalping. (See California Turfgrass Culture, Vol. 27, pp. 9- 12.) For this reason, pushing this species with nitrogen for winter color may lead to serious summer/fall scalping problems and is not a recommended management alternative.

Clearly, the outstanding treatment for enhancing winter turf quality of a *Paspalum vaginatum* lawn was the perennial ryegrass overseeding. The compatibility of these two species and the resultant effect of the overseeding during the winter and the spring transition period yielded a high quality turf under the management and climatic conditions of this study. The price of this quality is another question that was not addressed in this study, but it should be considered by managers before embarking on a large-scale overseeding effort. The physical difficulty in preparing a seed bed for the ryegrass was considerable in the mature Seashore Paspalum stand used for this study.

ACKNOWLEDGEMENTS

The authors wish to express appreciation for partial funding of this project from the Southern California Turfgrass Council.

WARNING ON THE USE OF CHEMICALS

Pesticides ere poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in their original labeled containers in a locked cabinet or shed. away from food or feeds. and out of the reach of children, unauthorized persons. pets. and livestock.

Recommendations are based on the best information currently available. and treatments based on them should not leave residues exceeding the toleranceestablished for any particular chemical. Confine chemicals to the area being treated. THE GROWER ISLEGALLY RESPONISBLE for residues on his crops as well as for problems caused by drift from his property to other properties or crops.

Consult your County Agricultural Commissioner for correct methods of disposing of leftover spray material and empty containers. Never burn pesticide containers.

PHYTOTOXICITY: Certain chemicals may cause plant injury if used at the wrong stage of plant development or when temperatures are too high. Injury may also result from excessive amounts or the wrong formulation or from mixing incompatible materials. Inert ingredients, such es wetters, spreaders, emulsifiers, diluents, and solvents, can cause plant injury. Since formulations are often changed by manufacturers. it is possiblethat plant injury may occur, even though no injury was noted in previous seasons.

NOTE: Progress reports give experimental data that should not be considered as recommendations for use. Until the products and the uses given appear on a registered pesticide label or other legal, supplementary direction for use, it is illegal to use the chemicals as described.

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