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FUNGICIDAL CONTROL OF THE ANTHRACNOSE AND ALTERNARIA DISEASES OF DICHONDRA

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The anthracnose and Altemaria leafspot diseases of Dichondra cause leaf and petiole lesions, defoliation, decline in vigor and in some cases complete kill of plants. Both fungi produce spores; the anthracnose fungus spores are spread primarily by sprinkler irrigation and those of

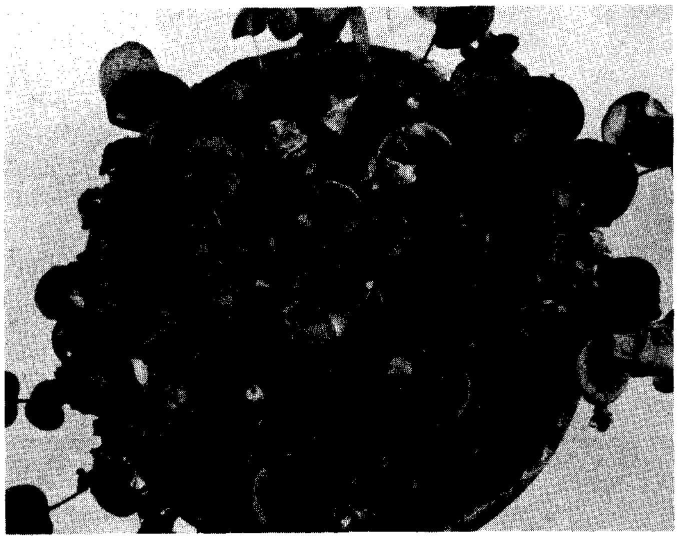

FIG. 1. Anthracnose leaf damage to dichondra.

the Altemaria fungus chiefly by wind. Surveys by B. L. Teviotdale and D. H. Hall, Plant Pathology Department, U.C., Davis, showed that anthracnose, caused by a species of Gloeosporium fungus, is a serious disease wherever Dichondra is grown in California. Anthracnose (Fig. 1) is mostly of concern during the warmer months of the year when flea beetles are also causing severe damage. Alternaria leafspot (Fig. 2) is favored by rainy, cool

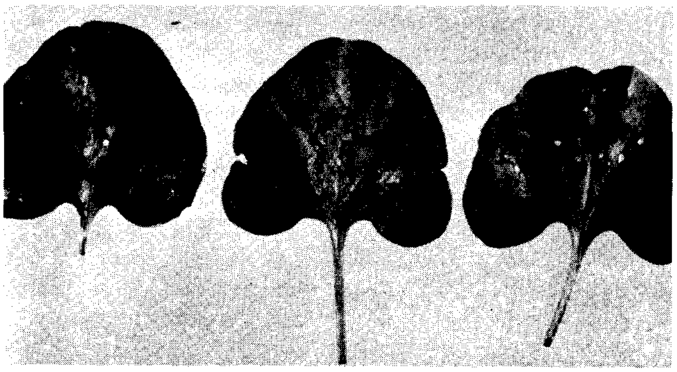

FIG. 2. Alternaria leaf damage to dichondra.

weather and consequently is most damaging during the winter and early spring. Alternaria leafspot usually disappears with the appearance of hot weather. Experiments were undertaken beginning in 1972 to compare various chemical sprays and timing of sprays for control of these two diseases.

Anthracnose Summer Trial-1972.

Preliminarv greenhouse trials at the Univeritv of California, Riverside, for the control of anthracnose indicated Manzate 200, Fore and Daconil 2787 showed promise. Consequently a field trial was initiated using these and other fungicide on Dichondra turf area near Paramount in Los Angeles county. Treatments were Tersan 1991 (benomyl) 5OW, 4 oz; Manzatc 200 8OW, 6 oz; Daconil 2787 75W, 4 oz; Captan 5OW, 6 oz; Thylate 75W, 6 oz; and an untreated check. Rates given are those per 1000 sq. ft. of turf. Plots were 10' by 10', replicated 4 times and two qts. of each fungicide mixture were applied per plot with a pressurized Hudson sprayer at 30 psi on an approximate 14-da\- spray schedule on June 23, July 7, and 21. All plots 'were fertilized with a 26-5-3 fertilizer to assure uniform plant growth. Disease ratings were made on a scale of 0 to 4; a "4" rating having severe leafspot and complete collapse of the Dichondra. Results are shown in Table 1.

Table 1. Anthracnose control with fungicides at Paramount, California, summer of 1972.

Treatment	OZ ./1000 sq. ft.	Disease Rating July 31
Tersan 1991 50 W	4	0.8 a*
Manzate 200 80W	6	1.1 a
Daconil 2787 75W	4	1.1 a
Captan 50W	6	1.9 b
Topsin M 70W	3	2.0 bc
Thylate 75W	6	2.3 cd
Check or no treatment	—	2.8 d

***Means followed by the same letter are not significantly different at the 1% level, using Duncan's multiple range test.**

'I'crsan 1991, Manzate 200 and Daconil 2787 provided an almost immediate control 14 days after the first spray application and were significantly better than all other treatments at the conclusion of the experiment. Captan and Topsin M provided intermediate control but Thylate was not significantly different from the check or no treatment. Plants responded to the best fungicide treatments by increased height of the foliage and a dark green color.

Summer-Fall Trial-1972.

Previous trials suggested that Tersan 1991 did not give effective control of anthracnose at a 2 oz. rate so a comparison was made between a 2 and 4 oz./1000 ft.2 rate. Topsin M 70W 3 oz. (Fungo) provided intermediate

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control in the previous experiment so the rate was increased to 8 oz. 50W Fungo. Daconil 2787 and Manzate 200 were included since they provided excellent control in the first trial.

Plots were 10’ by 10', replicated four times, and sprays were again applied with a pressurized Hudson spray as in the previous experiment. Spraying dates were July 21, August 4, 18, and September 1, 1972. Plots were fertilized with a 26-5-3 fertilizer. Disease ratings were made on a scale of 0 to 4; with a zero rating having no disease.

Results are shown in Table 2.

Table 2. Control of anthracnuse of Dichondra during the summer-fall, Paramount, California, 1972.

Treatment	Oz./1000 sq. ft	Disease Rating Sept. 9
Daconil 2787 75W	4	0.5 a*
Tersan 1991 50W	4	0.5 a
Manzate 200 80W	6	0.6 a
Tersan 1991 50W	2	0.9 a
Fungo 50W	8	2.0 b
Check or no treatment	—	3.3 c

*Significant 1% level. Treatments with same letter are not significantly different.

Daconil 2787, Manzate 200, Tersan 2 or 4 oz. gave excellent control of anthracnose of Dichondra. While 4 oz. of Tersan 1991 was not significantly different from 2 oz., a somewhat lower disease rating was noted with the higher dosage. Fungo at 8 oz. provided intermediate control but was still significantly better than the untreated check. The best. materials again showed an immediate response in disease control 14 days after the first application.

Spray Interval Necessary for Control of Anthracnose.

Growers frequently ask about the spraying interval necessary for control of anthracnose and how many sprays are needed during a season. To help answer this question Tersan 1991, Daconil 2787, Fore, Fungo and RH 3928 were applied in 14-day intervals two times to one-half of the plots on May 18 and June 1, and four times to the other half of the plots on May 18, June 1, 15 and 29. Plots were 10’ by lo’, replicated four times, and two gallons of the fungicidal mixtures were used per 400 sq. ft. Fungicides were applied with a pressurized Hudson sprayer and disease rating system used as in the previous experiments. Results are shown in Table 3.

Trials were further evaluated on July 16, and Tersan 1991, Fore and Daconil 2787 in the continuous 14 days plots were still providing adequate control 17 days after the last application. However, notes taken on August 10 showed disease control was inadequate in all plots and therefore should have been resprayed around August 1, 1973.

Alternaria Leafspot Control.

Since Alternaria leafspot may be a serious problem in Dichondra lawns of southern California during the winter and spring months, we decided to compare the materials used for anthracnose control in a plot with a high incidence of Alternaria leafspot. Materials used included Fore SOW, Daconil 2787 75W, Tersan 1991 5OW, FH 3928 SOW, Fungo 50W at rates listed below and the untreated check. Plot site was the Dichondra turf area surrounding the headquarters building of the University of California South Coast Field Station. Plots were 10’ by 10’ and replicated four times. Two gallons of each fungicide was applied per 400 sq. ft. with a pressurized Hudson sprayer at 30 psi. Materials were applied approximately every 14 days on March 7, 21, April 5 and 18, 1973. Disease ratings were taken on April 26, 1973. Plots were rated on a scale of “0” to “4” with “4” having numerous severe leafspots and extreme poor plant growth.

Table 3. Control of anthracnose on Dichondra with different spray schedules, spring, 1973.

Treatment	Oz./1000 sq. ft.	July 6,1973 Disease Rating
Every 14 days		
Tersan, 1991 50W	4 oz.	0.3 a*
Daconil 2787 75W	4 oz.	0.4 a
For 80W	4 oz.	[illegible] ab
2 sprays only		
Tersan. 1991 50W	4 oz.	1.6 c
Daconil 2787 75W	4 oz.	2.6 d
Fore 80W	4 oz.	2.6 d
Every 14 days		
Fungo 50W	4 oz.	3.0 de
RH 3928 50W	4 oz.	3.1 de
RH 3928 50W	4 oz.	3.3 de
Fungo 50W	4 oz.	3.4 e
Check or no treatment	—	3.5 e

*Significant 1% level. Treatments with the same letter are not significantly different.

Table 4. Control of Alternaria leafspot with fungicides at South Coast Field Station, Santa Ana, California, April, 1973.

Treatment	Oz./1000 sq. ft.	Disease Rating April 26
Fore 80W	4	0.8 a*
Daconil 2787 75W	4	1.1 a
Tersan 1991 50 W	2	2.8 b
Tersan 1991 50W	4	2.9 b
Fungo 50 W		3.1 bc
RH 3928 50W		3.4 bc
RH 3928 50W	4	3.4 bc
Check or no treatment	—	3.8 c

*Significant 1% level.

Fore and Daconil 2787 provided excellent control of Alternaria leafspot when sprays were applied at a 14 day interval. Appearance of foliage was excellent and plant heigh was at least twice that of the control plots. Benlate, Fungo and RH 3928 provided some relief from the disease but are not considered satisfactory by the authors.

ACKNOWLEDGEMENTS

Appreciation is extended to Paramount Gardens, Inc., Paramount, California, for the test site; O. M. Scotts for fertilizer; and the chemical companies for the materials evaluated.

THE SAFE USE OF PESTICIDES*

*By Andrew S. Deal’**

Everyone believes in pesticide safety. Many people become bored when you talk about pesticide safety, and not enough people practice it because we still have illnesses and deaths each year in the United States as a result of the misuse of pesticides. We use many kinds of pesticide chemicals in the production of turfgrasses and ornamental plants. These are insecticides, acaricides, fun-

*From: Proceedings of the 1973 Turf and Landscape Institute. p. 23-27.

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gicides, herbicides, nematicides, rodenticides and plant growth regulators. These materials range in toxicity from very high to low, but they are still all poisons and must be handled with caution.

Pesticides can be applied effectively and safely if the proper procedures are followed. The following are some do's and don'ts which are essential.

The Proper Selection of Pesticides

Where more than one pesticide is known to be effective against a particular pest, the least hazardous of these should be chosen. Information regarding the toxicity of perticides is available from a number of sources, but the pesticide label is a good place to start. Pesticide labeling laws require that certain information appears on the label for your use and protection. Before using any pesticide you should always read the label first. Certain key words on the label of the pesticide container indicate the general toxicity of the chemical contained therein. The word DANGER on a pesticide label indicates that the chemical is highly toxic. The word POISON and the skull and crossbones are also found on the label of highly toxic pesticides. The word WARNZNG indicates a moderately toxic pesticide. The word CAUTION indicates a material of fairly low toxicity.

Regardless of the toxicity of the pesticide, protective clothing and equipment should be worn to prevent inhalation of dusts, mists or vapors and skin contact by either liquids or dry materials. The maximum safety equipment necessary for use in applying pesticides to turfgrasses and ornamental plants in the landscape are moisture-resistant or moisture-proof coverall or other clothing which cover the entire body including the arms and legs to the wrists and ankles, a rainhat or other head covering, goggles, rubber gloves, rubber boots or galoshes and a respirator approved for use with pesticides. The necessity for the respirator and certain of the other items of equipment will depend on the toxicity of the pesticide to be applied and the conditions under which it is to be used. The pesticide label will indicate whether or not it is necessary to wear a respirator. In general a respirator should be worn for indoor applications of any pesticide or where applications are being made where there is a likelihood of drift of the material over the operator or inhalation of the vapors while mixing the materials and loading them into the spray tank. It is particularly important to wear rubber gloves when measuring or pouring liquid pesticide concentrates, even if the active ingredients are of low toxicity. Such materials readily penetrate the skin and repeated exposures of even materials of low toxicity may eventually result in symptoms of pesticide poisoning.

Any adjustments in spray nozzles or equipment should be made with plain water in the tank. If adjustments must be made after the pesticide is placed in the spray tank, then rubber gloves should be worn to avoid contact of the pesticide with the skin. The operator should not stand in the pesticide drift while either testing the equipment or making the actual application.

Follow Mixing Directions

The directions on the pesticide label for mixing should be followed exactly. Accurate measuring cup or scales should be used to be sure that the correct amount of pesticide is placed in the spray tank. If the amount used is too low, the pest may not be controlled. If the amount used is too high, there may be injury to the plants treated, to the person applying the material, to persons or beneficial species in the vicinity during application, or to persons handling the treated materials following application.

Proper Application

While applying pesticides be sure to avoid drift of the material to non-target areas. It is particularly important to cover or otherwise avoid contamination of feed and water containers for livestock and pets. Be careful about application of pesticides around swimming pools and fish ponds. Also be careful when using herbicides or insecticides which may be toxic to certain plants. If necessary, cover the plants with a tarp or other material to protect them from contact by the toxic material.

Careful Handling* of *Pesticides

Avoid trying to handle heavy pesticide containers alone. Always get help with such containers to avoid dropping, breaking, and spilling of the toxic materials. When transporting materials by truck or other vehicle, be sure the containers are secured so that they don't bounce around and break or fall out of the vehicle onto the road. Tightlv close paper containers so that the powdered materials are not blown about in the wind, and secure empty paper containers so that they do not blow out onto the highway.

Properly Clean Up All Accidental Pesticide Spills

If liquid pesticides are accidentally spilled on sidewalks. patios, streets, or other paved areas, the spill should be covered immediately with dry sawdust, lime, diatomaceous earth (such as used in swimming pool filters) or similar absorbent material. As soon as the liquid has been absorbed, the absorbent material should be scooped up with a square point shovel or scoop shovel and placed in a container which can be closed or covered tightly where it can be stored until disposal in an approved disposal site. The pavement in the area of the spill should then be further decontaminated by scrubbing with a stiff-bristle broom using the followmg solution:

1 cup household detergent
1 quart liquid chlorine bleach
2 gallons water

When liquid pesticides are spilled on bare soil, decontamination may be accomplished bv removing the soil to a depth of three inches and placing it in a tightly covered container and then filling the area with clean top soil. If liquid pesticides are spilled in a turfgrass area, the area may be decontaminated by carefully washing the pesticide into the soil with plain water from a hose. Be sure not to use so much water that the pesticide runs down the street or into other areas increasing the area of contamination.

Accidental spills of dry pesticides may be decontaminated by picking up as much of the material as possible with a shovel and placing it in a tightly closed container and then washing the small remainder of material into the soil with a small amount of water.

***Proper Storage* of Pesticides**

Pesticides should always be stored in a locked cabinet or cupboard or fenced area where they may not be reached by children or unauthorized persons. The storage area should be marked plainly with a sign including the appropriate warning signs and symbols. Pesticides should always be stored in the original containers with tight lids.

A large drum or garbage can with lid should be provided for storing empty pesticide bags and other paper containers. Pesticides should never be stored in areas where food is kept. Never store pesticides in beverage or food containers.

Final Disposal of Pesticides

Final disposal of excess pesticides and empty pesticide containers must be done in a manner which will prevent exposure of man, beneficial plants and animals, the air, soil, and underground water supply to the toxic materials. Suitable disposal sites are still under development. Contaminated pesticide containers may not be dumped in sanitary land fills. Pesticide containers which have been decontaminated by chemical incineration may be dumped in certain approved sanitary land fills. Excess pesticides and empty containers will be accepted at dumps which are designated as class 1 dumps. You should contact the Agricultural Commissioner or other county or city officials for information on approved dump sites in your area. Some commercial incineration facilities are now available which will accept empty pesticide containers for recycling.

Personal Decontamination

When finished apply pesticides and cleanup of equip ment and proper storage of pesticides is complete, then bathe and change to clean clothes. Place contaminated clothing into a washing machine immediately and wash it so that it will be clean and readv for use the next time you plan to apply pesticides.

Summary

The following four keys to safety sum up the procedures for the safe and effective use of pesticides:

1. Read the label completely
2. Use the right chemical in the right way
3. Store securely
4. Dispose of left-over chemicals and containers safely.

AN EVALUATION OF PERENNIAL RYEGRASS VARIETIES FOR WINTER OVERSEEDING

Final Report

Victor A. Gibeault and John Van Dam*

In the spring issue, 1972, of California Turfgrass Culture a report was presented on the performance and survival past the first overseeding season of eight varieties of perennial ryegrass used for overseeding a bermudagrass turf. The plots were established in October of 1970. The results indicated that the experimental cultivars K9-123, K9-124 and K9-125 and the commercially available varieties NK-100, Pelo, Manhattan, Pennfine and Common gave an acceptable turf appearance the first winter season following establishment. The varieties Manhattan and Pennfine were better able to uniformly survive the summer high temperature stress at Cal-Tech, Pasadena and thereby produce an acceptable winter appearance through the second season.

The test area was maintained in a normal manner through December of 1973. This included regular mowing at approximately 1¾ inches, three times-a-year fertilization with a complete fertilizer at the rate of 1 lb. N per 1000 sq. ft. per application, and irrigation common to bermudagrass lawn management.

The plots were observed periodically for general turf appearance and percent ryegrass remaining. Table 1 presents these observations for the second and third winter season following overseeding (February 16, 1972, as previously reported, and December 12, 1973 respectively). The turf score rating is a visual score based on appearance of the sward. A 0 represents a completely dead turf while 10 represents an ideal turf stand of uniform density, texture, color, etc., of the desired species mixture. Those plots considered dormant because of little or no rygrass present, were rated a 3.0.

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RESULTS

As can be noted in Table 1, there was a considerable decrease in the percent perennial ryegrass stand at the December 1973 observation date with the varieties K9-123, K9-124, K9-125, NK-100, Pelo, and Common. The response was attributed to the inability of these varieties to adequately compete with the common bermudagrass, under the conditions of this test, during the warm to hot summer months. The comparatively low percent ryegrass stand was reflected in the appearance (turf scores 12-12-73). K9-124 and K9-125 were considered dormant, as was the unseeded check, while K9-123, NK-100, Pelo and Common provided some green color in the third winter season following overseeding.

Table 1. The percent perennial ryegrass and turf scores of eight varieties at two observation *dates* following an October, 1970 overseeding.

	Percent Ryegrass		Turf Scores	
Cultivar	2-16-72	12-12-73	2-16-72	12-12-73
Kg-123	38a*	22.5 b	3.5ab	3.9
Kg-124	48 abc	2.5 a	5.0 bc	Dormant
Kg-125	60 bc	6.5 ab	6.2 c	Dormant
NK-100	50abc	la.5 ab	5.7 c	4.0
Pelo	44ab	16.2 ab	4.5abc	3.9
Manhattan	88c	79.0 c	9.0 d	7.1
Pennfine	a2 d	82.7 c	a.0 d	6.5
Common	64c	20.0 ab	5.0 bc	4.2
Check	—	—	Dormant	Dormant

*Values followed by the same letter(s) are not significantly different at the 5 percent level.

In comparison, the varieties Manhattan and Pennfine remained as a relatively uniform stand into the third winter following overseeding. Evidently they were able to continue to compete with the common bermudagrass during the summer months. This leads one to suspect the tolerance of Manhattan and Pennfine to high temperature conditions is greater than the other tested varieties. The higher turf scores of Manhattan and Pennfine reflect the superior appearance of plots overseeded with these varieties three years prior to the December 1973 observation date.

CONCLUSION

The perennial ryegrass varieties K9-123, K9-124, K9-125, NK-100, Pelo, Manhattan, Pcnnfine and Common were overseeded to a common bermudagrass lawn in October 1970. All varieties provided an acceptable appearance the first winter season. The varieties Manhattan and Pennfine continued to provide an acceptable appearance the second and third winters following overseeding.

ACKNOWLEDGEMENTS

Appreciation is extended to Germain's Inc. and Northrup King and Co. for supplying seed for this evaluation. The cooperation of Art Brown, Superintendent of Grounds, Cal-Tech, Pasadena is likewise appreciated for supplying and maintaining the test area.

SOME CLIMATIC REQUIREMENTS OF TURFGRASS"

Victor A. Gibeault *

The selection of a turfgrass species for a particular site is governed bv three considerations: the environment of the site, the use the area will receive, and the management that will be given to the established sward (3). Each must be considered a limiting factor in that each, if not carefullv evaluated, can limit the ultimate turf quality and possibly the survival of the chosen species.

Of the three, environment is the first to be considered in terms of-will the grass grow and develop at a given site? The term environment as used to determine turfgrass adaptation is actually a composite of numerous characteristics of a location. The most important characteristics can be considered as either climate factors or soil factors. Climate factors, such as temperature, moisture, light, humidity, wind and air pollution, to mention a few, are generally considered to be more important of the two but soil factors, such as texture, salinity, etc., also influence turfgrass adaptation. In this regard, it will be the objective of this paper to discuss the effects of three climatic factors, namely temperature, moisture and light, on the performance of the commonly used turfgrass species.

Temperature

The three temperature levels that will be mentioned include (5) :

Minimum temperature-lowest temperature for measurable growth.

Optimum temperature — greatest growth is recorded.

Maximum temperature-highest temperature for measurable growth.

The cool season grasses grow over a wide range of moderate temperature conditions, however, it has been shown that the most clcsirable turfgrass quality occurs when temperatures range between 60 and 75°F. (1). Above this range, shoot and root growth generally decrease, the latter doing so much sooner and at lower temperatures than the former since optimum root growth for cool season species is in the range 50-60°F. Optimum tillering for cool season species occurs at slightly lower temperatures than for optimum shoot growth while rhizome development is best at 50-60°F.

Warm season grasses make their best shoot and root growth at 80-85°F and 75-85°F respectively. They appear to be capable of making good growth, and giving excellent turfgrass quality, at much higher temperatures; in fact, I don't believe the maximum temperature for warm season turfgrass growth has been determined. Minimum temperatures for warm season species are between 50-60° F, expressed as average 24-hour temperatures (6). Growth ceases and chlorophyll destruction takes place, in the presence of light, at average temperatures below this range. Some root and rhizome growth has been rccorded in the 40-50°F. range (8). Bermudagrass has a lower minimum temperature than does zoyiagrass.

A comparative ranking of the commonly used turfgrasses in terms of temperature response would be as follows (7) :

High Temperature Tolerance

High
- Zoysia
- Improved bermuda
- Common bermuda
- St Augustine
- Tall fescue
- Kentucky bluegrass
- Colonial bentgrass
- Red fescue
- Ryegrass
- Creeping bentgrass

Low

Cool Temperature Tolerance (winter color)

High
- Perennial ryegrass
- Kentucky bluegrass
- Creeping bentgrass
- Colonial bentgrass
- Red fescue
- Tall fescue
- St. Augustine
- Improved bermuda
- **Zoysia**
- Common bermuda

Low

Moisture

Turfgrass plants are 85-95% water; water transports needed nutrients; water modifies both internal and the immediate external temperature; water is necessary for physiological processes; needless to say: the continued presence of adequate water is an important climate requirement of all turfgrass species if they are to make an attractive and functional swarcl. Some species are particularly sensitive to this climatic variable whereas others are "buffered" against extcndcd dry periods.

Sensitivity or tolerance to moisture stress, and conversely moisture requirement, is based on certain inherent

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plant characteristics. Does the plant have a deep root system that can forage the soil profile or does it have a shallow root system which necessitates the frequent replenishment of the soil-water reservoir? In this regard it can be noted that Kentucky bluegrass, creeping and colonial bentgrass, red fescue and the ryegrasses have a relatively shallow root system; tall fescue has a comparativelv deeper root system; and the warm season grasses are characterized bv an extensive root system, oftentimes penetrating six to kight feet deep (4). As an example of such characteristics under similar soil and climate conditions, a 25 days water supply for bermudagrass (root system 6' deep) may be only a one day water supply for creeping bentgrass (root system three inches deep).

Does the plant have the ability to reduce its transpiring leaf surface and thereby reduce water loss? Although red fescue does not have a deep root system, it does have the adaptive mechanism of a rolled leaf blade. The needle-like leaves reduce stomate exposure thereby reducing water loss.

These are but two examples that illustrate why turfgrass species can vary in their water requirement. To further point out the comparative drought tolerance of the commonly used turfgrasses, the following ranking can be given (7) :

Drought Tolerance

High
- Improved bermuda
- Zoysia
- Common bermuda
- Tall fescue
- Red fescue
- Kentucky bluegrass
- Perennial ryegrass
- Colonial bentgrass
- St. Augustine
- Creeping bentgrass

Low

Light

Turfgrasses can be considered as sun-loving plants in that they perform best where uninterrupted sunlight provides adequate light quality and quantity for a sufficient duration. Turfgrass is usually grown in a totally landscaped situation however, where light competition from trees and shrubs as well as light interception from buildings can cause light to become the limiting factor in a species performance. Tolerance of shaded conditions or conversely, light requirements of turfgrass, therefore becomes an important aspect relating to species selection.

Of the cool season grasses, red fescus is considered the most shade tolerant species. In shaded areas red fescue is usually seeded as a mix with Kentucky bluegrass or bentgrass. In very dense shade, where temperatures are cool and moisture present, rough bluegrass, which is not a commonly used turfgrass species in California, is often established.

Of the warm season grasses, St. Augustinegrass and zoysiagrass are quite tolerant of shaded conditions whereas both common and improved bermudagrass are notoriously poor performers under low light intensity. The inability of bermudagrass to survive shaded conditions was well illustrated (2) in a recent trial where common and improved bermudagrass were established as mixes with Kentucky bluegrass. Half the trial was in full sunlight and half was in shade during most of the day. It was noted after a several year period that the mixes located in full sunlight had a predominance of bermudagrass (60-80%) where the Kentucky bluegrass was most competitive under shade (100% bluegrass cover).

A comparative ranking of the turfgrass species in this regard would be as follows (7) :

Shade Tolerance

Shade
- Red Fescue
- Zoysia
- St. Augustine
- Colonial bentgrass
- Tall fescue
- Creeping bentgrass
- Kentucky bluegrass
- Perennial ryegrass
- Improved bermuda
- Common bermuda

Sun

Conclusions

Each turfgrass species has certain environmental requirements for its proper growth and development. Three of these requirements, temperature, moisture and light, were discussed in terms of the commonly used turfgrass species.

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NECESSARY NUTRIENTS FOR TURFGRASS*

Victor A. Gibeault**

Sixteen elements, in the correct amounts and proportions, are known to be essential for the growth and development of turfgrass plants. The elements carbon. hydrogen and oxygen have an air/water source. The remaining 13 have a soil source and these will be discussed in the framework of importance and function, normal amounts in plant, and deficiency symptoms.

*Adapted from: 1973 Proceedings, Golf Course Superintendents Institute :95-98.

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Nutrient	Importance - Function	Normal Amount In Plant	Deficiency Symptoms
Nitrogen	Found in chlorophyll molecule, amino acids and proteins, nucleic acids, enzymes and vitamins. Affects shoot growth, root growth, shoot density, color, disease proneness, heat, cold and drought tolerance	3 = 6%	Stunting→older→leaves turn pale green yellow →copper color.
Phosphorus	Energy transformations and constituent of genetic material. Influences establishment, maturation, rooting and reproduction.	0.2 - 0.40%+	Older leaves dark green →dull blue green→ purple along margins→ reddish tint on tip to base.
Potassium	Important as a catalyst in numerous reactions, carbohydrate synthesis and translocation, amino acid and protein synthesis, regulating transpiration, and etc. Influences rooting, drought, heat and cold tolerance, disease susceptibility and wear tolerance.	1 - 3% common; 4 - 5% luxury levels	"Soft" leaves→yellowing in interveinal areas→ rolling and burning of leaf tip→veins yellow and margins scorched.
Iron	Important in synthesis of chlorophyll and as part of cytochromes	0.20%	Interveinal yellowing of young leaves but no initial stunting growth →older leaves affected →stunting→white leaves in advanced stage.
Manganese	As a catalyst in several reactions.	Very small amounts	Seldom noticed in field Pale green between leaves very similar to initial iron deficiency→stripped or spotted appearance.
Zinc	Oxidation - reduction reactions	Very small amounts	Stunting of growth→ leaves thin and shrivelled →dark and appear dessicated→whitish in advanced stages.
Copper	Important in oxidase	Very small amounts	Not known on turf in field conditions. Toxicity does occur.
Calcium	Component of cell wall, required for meristematic growth and division, enhances root growth. Extremely important in affecting soil characteristics and availability of other nutrients.	0.2 - 0.5%+	New growth stunted, distorted. Young leaves ranging from pale green (bermuda) to reddish brown along margins depending on species.

Nutrient	Importance - Function	Normal Amount In Plant	Deficiency Symptoms
Magnesium	A constituent of chlorophyll, and several enzyme systems. Important in translocation of phosphorus.	0.1 - 0.25%	Pale green, especially between veins giving a stripped appearance.
Sulfur	Constituent of amino acids.	0.5% but variable	Paling of older leaves →overall yellowing of plant. Observed frequently on pure sand.
Molybdenum	Used in nitrate reduction	Very small amounts	Pale green in older leaves→stunting + withering of leaves. Seldom seen in field.
Boron	Not well defined	Very small amounts	Discoloration of shoots and stunting of growth. Chloratic streaks develop. Toxicity common as white tip burn.
Chlorine	Not well defined	Very small amounts	None observed.

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