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FUNGUS DISEASES OF TURFGRASS AND THEIR CONTROL

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The damaging diseases of lawn grass and turf are caused by parasitic fungi; no bacterial or viral diseases of importance have been found. The following table includes diseases that definitely have been shown to cause damage to turf in California. Continuing research undoubtedly will disclose additional diseases of importance.

The key to successful turf disease control as well as to successful turf culture is proper management. Vigorous growing grass plants in contrast to weak spindly plants are not only better able to withstand disease attacks, but also recover more rapidly. Thus good management is very important, as every patch of turf will at some time or another be attacked by pathogenic fungi. Good management, which includes proper fertilization, watering, mowing, raking, periodic aerification, and regular removal of mat and thatch, will do more to keep turf diseases down to a minimum than all the expensive fungicides on the shelves of your local garden dealer.

Parasitic fungi require water, favorable temperatures, and a susceptible host to cause disease. In addition, disease-producing fungi usually must be present in considerable numbers to cause extensive damage. On the basis of the foregoing facts, management practices should be modified whenever possible so as to suppress disease development, and at the same time favor plant growth. Let us consider the previously recommended management practices with these latter two objectives in mind:

(1) Proper fertilization. Apply sufficient fertilizer to maintain the grass in a vigorous growing condition. See California Turfgrass Culture, volume 8, number 4 and volume 10, number 2. Do not overfertilite with nitrogen as "lush" soft grass is very susceptible to brown patch and to rust.

(2) Proper watering. Stop watering daily and water according to need. Water to a depth of 8 to 12 inches. If water runs off, aerify, and apply water slowly. Shallow, daily waterings result in weak plants with a shallow root system and hastens compaction, thereby reducing much needed aeration. Daily watering also permits pathogenic fungi to develop to the high populations necessary for most turf diseases. Weekly warerings not only tend to develop vigorous-growing turf with deep root systems, but also allows the turf to dry out and stops fungus growth. Early morning watering is preferred since it washes off the fine drops of dew that are ideal for fungus infection. The dew is replaced by a film of moisture which dries off quickly. Watering during the day and particularly during the evening tends to prolong the period that the grass remains wet. This is very important since rust fungi and species of *Helminthosporium* may cause infection in less than 10 hours at favorable temperatures.

(3) Proper mowing is also very important. Different grasses should be clipped at the recommended heights and frequencies. Clipping turf shorter than recommended is harmful as root growth is stopped and plants are weakened. The leaf spot and foot rot diseases caused by species of *Helminthosporium* are very damaging to bluegrass clipped shorter than 1¾ inches.

(4) Raking. Turf should be kept free of heavy clippings. Warm, moist air is trapped beneath, and provides ideal conditions for parasitic fungi to develop. Disease organisms also may be spread in clippings.

(5) Aerification. All turf is compacted to some degree but the problem is particularly acute with turf growing in heavy clay and adobe soils that are over-watered and receive heavy traffic and play. Dead turf in compacted areas look as though they had died from disease. Although diseases are often present, they usually are not the main cause of death. We need to remember that cultural practices that break up the soil and restore favorable levels of aeration and water infiltration are standard practices in agriculture. To correct compacted turf, aerification should be practiced whenever necessary.

(6) Mat and thatch removal. The accumulation of grass refuse in the crown and root areas of turf is harmful because it reduces the movement of air and water into the soil, and results in the loss of contact of roots with the soil. As a result the roots of plants growing in thatch are usually very short. The plants are subject to sudden changes in water stress due to the tendency of thatch to dry out quickly during periods of hot, dry, windy weather. Many parasitic fungi are capable of surviving and growing

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in the thatch, and when over-watered, thatch provides an ideal environment for pathogenic fungi to develop. Since thatch accumulation is harmful, every effort should he made to remove excess thatch at regular intervals throughout the year.

Proper lawn construction and seedbed preparation is also essential and every consideration should be given to constructing a lawn or green properly when first planted. This will reduce many of the cultural problems and diseases that plague the homeowner. Heavy soils that compact readily may be improved by incorporating organic matter such as peat, redwood sawdust, rice hulls, etc. into the soil. Every effort should be made to improve the grading, and to level and prepare the soil and subsoil properly so as to ensure good drainage. Use only fresh, healthy seed, seed only at the recommended rates, and only during the recommended seasons. Use disease-resistant varieties whenever possible.

Finally, a word about fungicides. Fungicides have been used to control turf diseases on golf and bowling greens for over 35 years. For many years fungicides were used only after the diseases made their appearance. Although fungicides usually stopped further disease spread, severely diseased plants usually died. This is because fungicides rarely cure plants of disease; they are mainly preventative in action, that is, fungicides are applied to the surfaces of plants where they form a poisonous barrier against fungus attacks.

Because golf course superintendents are interested in eliminating all losses from disease, they have in recent years used a preventative fungicide schedule, i.e., fungicides are applied at 7 to 14-day intervals during the time of year that diseases are normally active. To be effective such a program must be initiated when pathogenic fungi are present in low populations because fungicides are mainly preventative and not curative in action. An additional difficulty is that most fungicides are specific and are effective only against certain fungal pathogens. Because turf diseases are difficult to identify a preventative schedule necessitates the use of fungicide mixtures, which contain several fungicides that are theoretically effective against different groups of fungal pathogens. It is hoped that such a mixture will be effective against the broad group of fungal pathogens that commonly attack turf. A few fungicidal mixtures are available and appear to have performed satisfactorily. Because no single mixture is effective against all the major fungal pathogens attacking turf in California, it is recommended that at least two different fungicide mixtures be used. This should increase the effectiveness of the preventative schedule and decrease the possibility that fungus strains resistant to fungicides will develop. The first group of mixed fungicides recommended consists of a mixture of a mercury fungicide (either phenyl mercury acetate or hydroxy mercuric chlorophenol) with tetramethylthiuram disulfide (tersan, thiram). The second group of mixed fungicides recommended consists of a mixture of cycloheximide (Actidione) with tetramethylthiuram disulfide, or a mixture of captan (N-trichloromethyl-thio-4-cyclohexene-2 dicarboximide), cadmium carbonate, benzene hexachloride, and ferrous ammonium sulfate. Select one mixture from each of two groups. Apply one fungicidal mixture one week, and apply the second mixture 7 to 14 days later. Start the alternate application in early spring and continue until late fall.

The use of a preventative fungicide schedule is not recommended for homeowners because of the expense, labor, and time involved. The best control of lawn diseases for homeowners can be obtained by proper lawn construction and planting, selecting only adapted grasses, good management, and occasional use of fungicides to stop disease should it develop.

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4-H TURFGRASS PROJECT

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With the general decline of students entering the plant Science fields at our colleges and universities, qualified personnel are not being trained to fulfill the needs of the growing turfgrass industry.

This is the situation the Southern California Turfgrass Council found in the spring of 1960. In an effort to meet this problem they requested the University of California Agricultural Extension Service in Los Angeles County to develop a project in their 4-H program that would interest and help prepare young people for a career in plant science fields.

The author, together with farm advisor Richard G. Maire who specializes in nurseries and ornamentals for the University of California Agricultural Extension Service in Los Angeles county, and 4-H farm advisors Bernard C. Downing and Carl B. Downing of the same office, worked out a tentative outline for a turfgrass project. This project outline covers a four-year period and provides for a year-to-year progression. The basic sciences will be taught along with turfgrass culture. It is hoped that the youngsters' interest will be captured and maintained by educating them with some “learns” and "dos".

Literature covering the first-year program is partially completed. Information has been written covering soil texture, soil moisture characteristics, and how to measure water application. By the use of a glass front box and also by examining soil after an irrigation, the 4-H members will be taught how water infiltrates different textured soils.

Principles of fertilization requirements and mowing heights will be shown from a demonstration experiment on the home lawn. A turf grass area will be divided into approximately four equal areas.

A	B
C	D

In one direction there will be two different fertilization rates. AC will receive 6 pounds of nitrogen per 1000 sq. ft. per year. BD will receive 12 pounds of nitrogen per 1000 sq. ft. per year. Cutting across each fertilization rate will be two different mowing heights. The mowing heights will be 1- 2 inches versus 1/2 - 3/4 inch depending upon the grass species being grown. Information will be included also in this section on how to measure areas, how to adjust and sharpen a mower, and how to determine fertilizer percentages.

Other parts of the first year program include information about correct turfgrass fertilization, irrigation, and mowing. Each youngster who participates in the turfgrass project will be required to improve and maintain existing lawns. To assist them in this, a description of recommended use and cultural practices for the major turfgrass species and varieties will be written.

After completing the first year's work, the turfgrass project members study the following units:

Planting a new lawn and rejuvenating an existing one.

Turfgrass diseases, insects and weeds and their control.

Use of turfgrasses and ground covers in landscape design.

More will be taught through demonstrations about the importance of soil aeration, structure, profile, compaction, soil deflocculation, water quality, salinity and drainage.

The youngsters will be taught propagation by seed, stolon, and plugs. Each year they will grow specified numbers of the various turfgrass species and varieties. These will be presented for display.

It is believed by the author that all the material for the first year unit will be completed by mid-May. University research and extension specialists and farm advisors in our counties have contributed generously to developing this project, with their suggestions, articles, and editing of the information presented.

It is estimated about fifteen to twenty 4-H members are registered for the turfgrass project. This project will be tried at first only in Los Angeles County. The 4-H project year begins in October. Due to the lateness of this project being developed, there has not been a great attempt made yet to interest young people in the project. Nevertheless, there has been gratifying interest displayed in the program by the 4-H members and leaders who have heard about it.

The Southern California Turfgrass Council is sponsoring this program. An educational trust fund has been established by them to provide recognition and achievement awards. Scholarships will be provided where it is deemed advisable. Members of the Council have volunteered to serve as 4-H leader-trainers and to help when problems arise. Council members will travel to the youngsters' homes to inspect and judge the projects.

Offers of part-time and summer employment for qualified 4-H members who complete the turfgrass project have been made by the Southern California Turfgrass Council.

FUNGUS DISEASES OF TURFGRASS

DISEASE	CAUSE	SYMPTOMS
Brown Patch	A soil-inhabiting fungus, *Rhizoctonia solani,* consisting of many strains, produces small compact masses (sclerotia) of fungus threads that survive for long periods in the soil.	Localized, irregular brown areas that start small, may spread to many feet in diameter. Leaves and leaf sheaths turn olive-green, wilt, assume a light brown color and die. Portions of leaves may be yellow. Stems, crowns and roots may also be infected. In light attacks, roots usually not involved and plants recover.
Dollar Spot	*Sclerotinia homeocarpa,* a fungus which produces sclerotia that live for long periods in soil. Disease occurs most commonly along the coast of California.	Small circular areas about 2 inches in diameter which may merge to form large irregular areas. Spots usually appear throughout whole lawn; leaves water-soaked at first, later brown and finally straw colored. Fine, white, cobwebby fungus threads may be seen in early morning.
Fusarium Patch	*Fusarium nivale,* or pink snow mold, probably overseasons as loose aggregations of fungus threads in plant residues. Disease not seen in southern California.	Roughly circular patches, 1 to 2 inches, may enlarge to 12 inches. Leaves first water-soaked, then bleached. Fine, white or pinkish, heaped, gelatinous spore masses occasionally seen on dead leaves. Fungus threads may be seen in early morning; also white or pinkish.
Melting out	*Helminthosporium vagans.* Probably survives in infected plants as mycelium (fungus threads) in crop debris and as spores. May be seed borne.	A general thinning out of grass in scattered areas. General browning of lower leaves evident. On leaf blades and leaf sheaths, circular to elongate purplish or brown spots occur with straw colored centers. When disease appears, a few spots can be observed on almost all plants indicating spread by wind-borne spores. Crowns and roots (light brown to black) frequently are attacked. Plants may be killed in the summer.
Melting out	*H. sorokinianum.* Probably survives in infected plants or other grass hosts, as mycelium in crop debris and as spores. May be seed borne.	As above, except that spots on leaves usually show a brown center rather than straw-colored centers, and borders of spots are purplish to dark brown.
Leaf Blotch	*H. cynodontis.* Probably survives in infected plants as mycelium in crop debris and as spores. May be seed borne.	Small, purplish to reddish spots occur on leaf blades and leaf sheaths. Young shoots very susceptible. Affected shoots wither, die, and turn brown. Roots and crown may also be infected.
Red Thread	*Corticium fuciforme,* a fungus overseasoning in the form of pinkish or red gelatinous crusts of fungus threads. Disease occurs commonly along coast of northern and central California. Rare in southern California.	Turf killed in distinct isolated patches, 2 to 15 inches in diameter. Pinkish web of fungus threads bind leaves and sheaths together. Pink, gelatinous, branched bundles of fungus threads, 1/4 – 3/4" long, projecting from leaves, are diagnostic.
Grease spot	Caused by several species of *Pythium,* mainly *P. aphanidermatum,* which produce thick-walled sexual spores, (oospores) that survive for long periods in the soil.	Turf killed in small, roughly circular spots about 2 inches in diameter. Spots tend to run together. Blackened leaf blades wither rapidly and become reddish brown. Leaf blades tend to lie flat, and appear greasy. Cottony growth of fungus threads may be seen in early morning.
Seed Rot and Damping Off	Caused by several species of *Pythium, Rhizoctonia solani, Fusarium culmorum,* and *Helminthosporium sorokinianum.*	Seed rot, pre- and post-emergence damping off may occur. Seed rot is not mushy but rather dry. Hypocotyl area is particularly susceptible. Seedlings at first water-soaked, then blacken, shrivel and turn brown.
Rust	*Puccinia graminis f. poae,* produces two types of spores that survive unfavorable periods.	Elongate, reddish or black pustules on stems, leaves, and leaf sheath. Reddish spores adhere to fingers when affected leaves are rubbed.
Mushroom Fairy Rings	Many species of mushrooms cause fairy rings.	A dark green band of turf develops in a circle or semicircle. Musrooms may, or may not be present. Frequently, just behind the dark green band is an area of sparse, brown, dying grass. Weed invasion frequently takes place.

'"RN PAGE FOR FOOTNOTES

AND RECOMMENDATIONS FOR CONTROL

USCEPTIBLE GRASSE!	CONDITIONS FAVORING DISEASE	CULTURAL CONTROL	FUNGICIDAL CONTROL
Bents Bluegrasses Bermudas Ryegrasses Fescues Zoysia	Excess thatch and mat, high temperatures* (75-90° F) and high humidity. Soft lush growth due to excess nitrogen favors brown patch.	Keep down thatch. Improve aeration and water drainage. Water only when needed and to a depth of 8-12 inches. Avoid excess nitrogen.	Mercury-containing fungicides, or mixtures containing mercury and thiram. Try pentachloro nitrobezene (PCNB).
Bents Bluegrasses Bermudas Ryegrasses Fescues	Moderate temperature (60-80 F.) and excess moisture, excess mat, thatch. Turf deficient in nitrogen tends to show more dollar spot than turf adequately fertilized with nitrogen.	Keep down thatch. Water only when needed and to a depth of 8 – 12 inches. Apply adequate nitrogen.	Cadmium or mercury, or Actidione - containing fungicides or mixtures of mercury and thiram. Cadmium fungicides best.
Bents, Bluegrasses, Ryegrasse Fescues, Zoysia. Common on Poa annua and creeping bent varieties.	Cool (40 – 60 F.), moist conditions favor the disease. Usually first appears on plants growing in shaded areas, and in winter during rainy periods.	Improve aeration and water drainage. Avoid excess nitrogen.	Mercury or cadmium-containing fungicides ot mixtures of mercury and thiram.
Kentucky bluegrass. Improved selections Merion[3] and Newport are resistant.	Cool (50 – 70 F.) moist conditions favor the disease. First appears on plants growing in shaded areas and is most severe on closely clipped turf.	Improve aeration and water drainage. Mow grass no lower than 134 inches.	Captan, Phaltan, mercurials, mixtures of mercury and thiram Zineb, Kromad, or Actidione-containing fungicides.
Bents, Bluegrasses Fescues, Ryegrasses, Bermudas	Warm temperatures (70 -85 °F.) and high humidity favor the disease. First appears on plants growing in shaded areas and is most severe on closely clipped turf.	As above.	As above.
Bermudagrasses	Appears most commonly on plants weakened by such factors as excess thatch, deficient nitrogen, and unfavorable growing conditions	Remove thatch at regular intervals. Apply adequate nitrogen.	As above.
Bents, Bluegrasses, Fescues, Ryegrasses	Usually appears on plants deficient in nitrogen, and during periods of prolonged cool, wet weather.	Apply adequate nitrogen.	Cadmium or mercury-containing fungicides.
All grasses	Usually appears in low spots that are wet for long periods. Disease favored by cool to high (*P. aphanidermatum*) temperatures (80 – 95° F.) and excess moisture.	Improve aeration and water drainage. Water only when needed and to a depth of 8 – 12 inches. Keep dry.	Zineb, Actidione-Thiram, or nabam drenches.
All grasses	Seed rot and damping off are favored by excess water, sowing of seeds of low viability, or above recommended rates, or during periods unfavorable for seed germination and growth.	Improve aeration and water drainage. Do not overwater. Sow only fresh, healthy seed at recommended rates and time	Try treating seed with Arasan, Ceresan M. captan, or Panogen. Try spraying seedlings with captan or thiram. Treat soil, before planting, with methvl bromide*.
Kentucky Bluegrass, Merion bluegrass is very susceptible; Newport is resistant	Moderately warm, moist weather favors rust development. Moisture in the form of dew is sufficient.	Apply adequate nitrogen.	Zineb, Maneb, Actidione-containing fungicides.
All grasses	Develops most frequently on weakened turf lacking nutrients, and in soil high in undecomposed organic matter.	Apply adequate nitrogen. Avoid application of organic fertilizers high in organic matter.	Suppress with phenyl mercuric acetate3 drenches. Apply in 2-inch holes spaced 2" apart, including area 2' beyond area of fairy ring. Eliminate by treating with Methyl bromide*.

1. Use at rates and frequencies recommended by manfacturer. Use mercury-containing-fungicides with caution since they tend to burn grass at temperatures above 80° F .

2. Cool temperature-adapted strains of *Rhizoctonia solani* sobeen isolated from bluegrass from central and southern California that are capable of attacking grass at temperatures as low as 40° F

3. Merion bluegrass is very sensitive to fungicides containing phenyl mercuric acetate, and should not be used.

4. Methyl bromide is toxic to humans, difficult to handle, and should be handled only by experienced personnel; it should not be used by homeowners.

MERCURY FUNGICIDES

PMA = Phenyl mercury acetate:
"PMAS" "Tag Fungicide" "Scutl" "Tag-C-Lect"
Hydroxy mercuri chlorophenol: "Semesan Turf Fungicide"
Methyl mercuri dicyandiamide: "Panogen Turf Spray"
Phenyl mercuri monoethanol ammonium lactate: "Puraturf 10"
Mercurous chloride (calomel) + mercuric chloride (corrosice sublimate):
"Calo-Clor" -"Calogreen" – "Wood-Ridge Mixture 21"
"Fungchex" – "Calocure" – "Bi Cal"

CADMIUM-CONTAINING FUNGICIDES

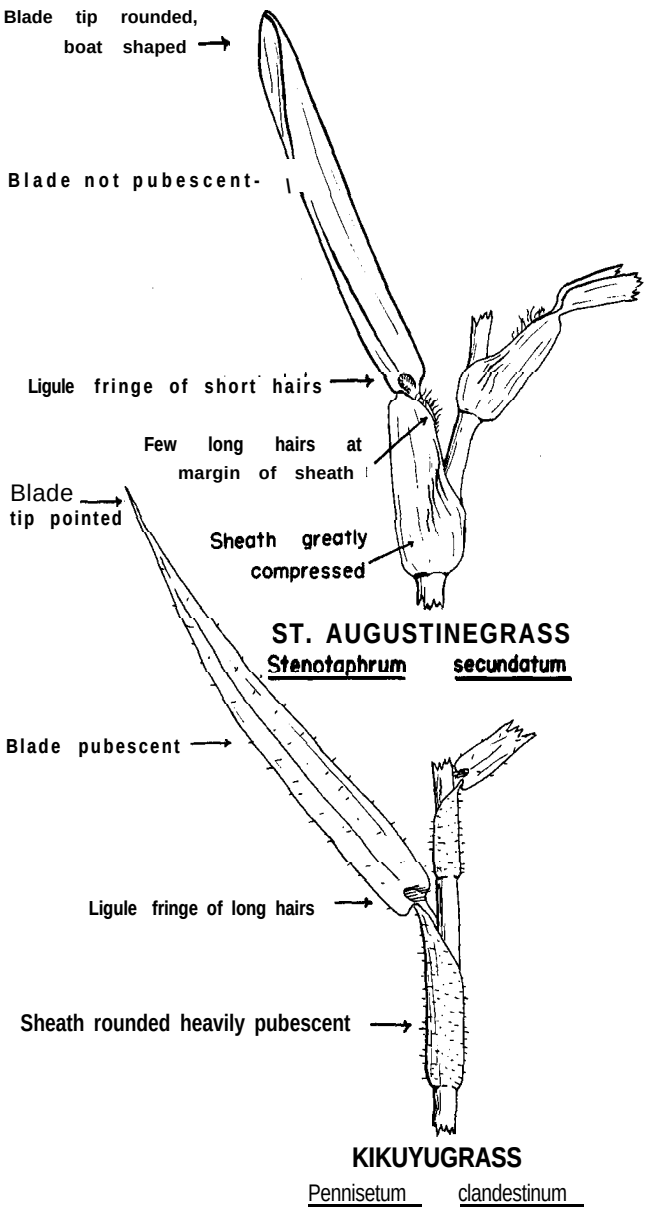
Cadmium succinate: "Cadminate"
Cadmium chloride: "Caddy"
Phenyl amino cadmium dilactate: "Puraturf 177"
"Cad-Trete" = Thiram + Cadmium chloride
"Kromad" = Cadmium sebacate + Potassium chromate, + Malachite green + Thiram
"Ortho Lawn Fungicide" = Captan + Cadmuim carbonate t insecticide and ferrous ammonium sulfate

OTHER FUNGICIDES

PCNB = Pentachloronitrobenzene: "Terraclor"
Thiram = Tetramethyl thiuram disulfide:
"Tersan" – "Panoram"
Acti-dione: cycloheximide
Captan = N-trichloro methyl mercapto-4-cyclohexene-1, 2-dicarboximide: "Orthocide" Captan
Zineb = Zinc ethylene bisdithiocarbamate: "Parzate" "Dithane Z-78"
PhaItan = N-(trichloro methylthio) phtalimide
Chloranil =2,3, 5, 6-tetrachloro-1, 4-benzoquinone: "Spergon"

MERCURY t THIRAM COMBINATIONS

"Tersan OM" = Thiram + Hydroxy mercuri chlorophenol
"Thimer" = Thiram + Phenyl mercury acetate



ST. AUGUSTINEGRASS OR KIKUYUGRASS?

Because of the superficial similarity between St. Augustinegrass and kikuyugrass, the latter species is often planted in turf by mistake. Nurseries have actually sold kikuyugrass in flats, labeled as St. Augustine. As kikuyu is a noxious weed, extremely difficult to eradicate, it is important that St. Augustine is positively identified before planting. To help anyone concerned with this problem, Mr. Charles Bretz of the Department of Floriculture and Ornamental Horticulture, U.C.L.A., has illustrated the principal differentiating characteristics.

A GREENHOUSE FOR WARM SEASON GRASSES

Wesley A. Humphrey

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Plastics are coming into their own in turfgrass culture. Work done in Texas using plastic sheeting has indicated its value in aiding in the establishment of seeded turf areas. This work spurred consideration of plastic in protecting the warm season grasses during low-temperature periods. If plastic sheeting could be used to maintain the normal green color of the warm season grasses during low-temperature periods in the wintertime, it would indicate its value in aiding in establishing warm season grasses during the cool seasons. With warm season grasses a loss of color due to low temperatures has held back their wider use. Cold periods in the fall, winter and early spring limit the time when these grasses may be established.

In December a trial was laid out to test the response of certain of the warm season grasses to a covering with plastic sheeting in cooperation with Mr. Joe Williams, Golf Course Superintendent. The Santa Ana Country Club at Costa Mesa, where Mr. Williams is superintendent, has a turfgrass nursery including several of the improved bermudagrasses. The bermudas had been established for two years and had approximately a two-inch thatch at the time of the tests.

On December 2, 1960, an area 4 feet by 5 feet of each of four strains of bermuda - - Sunturf, Tifgreen, Ormond and UCLA 15 -- was covered with translucent polyethylene plastic sheeting of a two millimeter thickness. One side of the plastic sheet was left open, while the other sides were held in place with wood strips. Leaving one side open permitting improved air exchange while still holding moisture, the plastic was left in place both day and night.

At the time the plastic was laid over the bermudagrass, all of it had its normal green color, both under and outside the covering. Following this period several cold spells occurred, some as low as 24° F., at the country club nursery area. By December 20, the bermudas under the areas covered with plastic retained approximately 80 per cent of their green color, while those not covered with polyethylene had lost all color.

January 10, 1961, the bermudas under the plastic still had much of their green color, while the areas not covered with plastic were straw colored. This is despite the fact that on approximately January 3 the covering had blown off and remained off one night when the temperature had dropped to below 32°.

An additional trial was started to determine the response of an area which had lost its green color to plastic sheeting placed over it. On January 10, 1961, an area 11 feet by 10 feet of Tifgreen, completely discolored due to low temperature, was covered with a two millimeter layer of translucent plastic. This area was in a large Tifgreen bermuda planting in the nursery. Within one week's time the area covered with polyethylene had regained its green color while the surrounding area remained straw colored. At the end of January all plastic covering was removed as those areas not covered had regained their green color.

Apparently, the plastic covering over the bermudagrasses was acting much like a greenhouse. The sun's rays penetrated through the covering during the daytime periods and warmed the soil, even penetrating through the thatch.At night, the clear polyethylene also helped reduce the heat loss to the air. The warmer daytime temperatures under the plastic would aid growth also. Moisture conservation resulted. In newly-planted areas, plastic sheeting reduces need for frequent irrigations. Disease was no problem under the plastic.

This trial indicates that translucent plastic sheeting can be used to protect the improved bermudagrasses and possibly other warm season grasses, including zoysiagrasses, and keep them growing during the wintertime in areas where winter low temperatures are not extreme. Also, under this covering the bermudas will continue to grow and can be brought back rapidly to an active growing state if dormant.

It can be assumed with a covering of plastic sheeting certain of the bermudas could be kept growing throughout the wintertime. If a person had a new planting of the improved bermudas in the fall or early spring, covering it with polyethylene sheeting could markedly increase its rate of establishment while reducing management time in establishing it. Flexibility of planting season is gained.

Plastic could be used in turfgrass nurseries to keep the warm season grasses growing during cool periods for earlier spring production of stolons and, possibly, production of stolons during winter months.

On golf course areas, such as tees and putting greens, in anticipation of a very low temperature at night, the polyethylene sheeting might be used to preserve the grass from color loss.

TURFGRASS SEED MIXTURES FOR FAIRWAY AND PARK TURF

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Turfgrass seed mixtures should be carefully planned so that each component of the mixture will have a purpose in the resulting turf. The practice, often seen, of indiscriminately throwing a number of varieties together with the hope that something will survive is not recommended. Simple mixtures of two or three varieties are usually the most satisfactory. These should be selected so that they blend with each other in color, texture and growth habit as much as possible.

Since park and fairway turf must be planted with the expectation of a long life, a large portion of the mixture should consist of a variety or varieties known to be adapted and permanent in the climatic region under consideration. This means bluegrasses and fescues for the cool, temperate climates of Northern California and bermudagrass for Southern California and the Central Valley.

Another factor which should be considered is the ability of the varieties to tolerate traffic. The choice of grasses may be different for a park area to be used primarily for its esthetic effect and one on which games are to be played.

The type of management to be used must also be taken into account when planning a mixture. If the mixture is to be used on a fairway to be mowed at one-half inch, bluegrasses cannot be expected to survive long. Bermudagrass in the warm areas and bentgrass in the cool areas would be the best choices as permanent grasses for this management practice. Other grasses in a mixture for this situation would be temporary.

Soil types, exposure (sun or shade), fertilization practices and irrigation are also factors effecting the choice of grasses.

In theory, mixtures of grasses are used to provide protection from failure caused by disease, variations in soil, variations in water supply, degree of shade and other factors which may not be readily controlled at all times. However, many times careful evaluation of a problem may show that a simple variety will do everything which might be expected from a mixture and produce a better appearing turf at the same time.

Vegetatively propagated bermuda and zoysia grasses, when planted later in the season, may be overseeded with a temperate climate grass such as Kentucky bluegrass or red fescue. However, when this is done, the warm season grass may require a longer time to cover because of the competitive effect of the overseeded grass.

The following mixtures are suggested as examples but should not be considered as recommendations for every situation:

General purpose mixture for temperate climate regions.

Kentucky bluegrass – 60%
Creeping red fescue – 40%
Sow at 3 lbs. per 1000 sq. ft. of area.

General purpose mixture for subtropical climate regions. May also be used for fairways.

Kentucky bluegrass – 75%
Hulled bermudagrass – 25%
Sowed at 3 lbs. per 1000 sq. ft. of area.

Close cut fairway mixture for temperate climate regions.

Merion Kentucky bluegrass – 40%
Creeping red fescue – 40%
Highland bentgrass – 20%
Sow at 3 lbs. per 1000 sq. ft. of area.

Shade mixture for temperate climate regions.

Red fescue – 60%
Highland bentgrass – 10%
Poa trivialis – 30%
Sow at 4 Ibs. per 1000 sq. ft. of area. This mixture may be used in subtropical regions also but will not be permanent. Zoysia and St. Augustinegrass are the only permanent shade grasses for these regions.

Playing fields and heavy use areas in subtropical regions.

Alta tall fescue – 60%
Pensacola bahiagrass – 40%
Sow at 6 to 8 lbs. per 1000 sq. ft. of area. Bermudagrasses and zoysia are also good and will be finer textured.

All bluegrass mixture for temperate climate regions.

Common Kentucky bluegrass – 30%
Merion Kentucky bluegrass – 30%
Newport Kentucky bluegrass – 40%
Sow at 3 lbs. per 1000 sq. ft. of area.

Quick growing turf for coastal areas only - not for areas of warm summer temperatures. May not be permanent.

Perennial ryegrass – 60%
Kentucky bluegrass – 40%
Sow at 4 lbs. per 1000 sq. ft. of area.

Quick growing turf for warm summer areas. May not be permanent.

Meadow fescue – 60%
Kentucky bluegrass – 20%
Red top – 20%
Sow at 4 lbs. per 1000 sq. ft. of area. For permanent turf substitute at least 10% hulled bermuda for part of one of the above components.