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Fungal Diseases of Turfgrasses in California: their nature, factors influencing their development, and their control

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PLANT DISEASES AND FUNGI

1) What is a plant disease?

A disease includes most conditions that interfere with the normal condition or function of the plant.

2) What is a fungal disease?

A disease caused by a fungus. It causes disease by attacking living plant tissues. Some fungi multiply so rapidly that the infected tissues die; others produce poisons that kill the tissue; while others gradually weaken their hosts by stealing their food and interfering with normal growth.

3) What is a fungus?

A fungus is a very simple, usually microscopic plant which lacks leaves, stems, roots, flowers, and the green coloring matter, chlorophyll.

4) Where does a fungus obtain its food?

The absence of chlorophyll means that a fungus cannot manufacture its food, that it must obtain it ready made from dead or living plants or animals.

5) What is a saprophytic fungus?

It feeds on dead plants or animals. Fortunately, they are far more numerous than parasitic fungi.

6) What is a parasitic fungus?

It feeds on living plants or animals.

7) Are some fungi parasitic on both plants and animals?

No, either one or the other; not both.

8) Are there some fungi that can feed only on living plants?

Yes, they are called obligate parasites. Of the *10* different kinds of fungi attacking turfgrasses in California, only the fungi causing the rust diseases are obligate parasites.

9) Are there some kinds of fungi that are both parasitic and saprophytic?

Yes, such fungi are called facultative saprophytes or facultative parasites. Of the 10 kinds of fungi attacking turfgrasses in California, 9 of the 10 are facultative parasites.

10) Do facultative parasites cause more damage to turfgrasses than obligate pamsites?

No, not usually. As a group, they are rather weak parasites which cause more damage to weakened, stunted, slow growing plants than to vigorous, rapidly growing plants. This is because vigorous growing plants not only resist disease better but also make renewed growth more rapidly. Since turfgrass can be weakened by numerous factors, facultative parasites may cause severe damage to turf.

11) What does a fungus look like?

In its actively growing stage, a fungus "body" consists of delicate, microscopic threads called hyphae. The spiderweb-like threads may branch and rebranch but grow only in length.

12) What conditions favor continued growth of the fungal threads?

The presence of abundant moisture, favorable temperatures, and adequate nutrients. In the absence of moisture or nutrients, the threads cease growing and may dry up and die; in the absence of suitable temperatures, growth may be slowed appreciably or stopped completely.

13) How does a fungus "move about"?

a. By growth of the fungal threads through the soil and over plant surfaces.

b. By passive transportation (e.g., by mowers, by raking, water movement, insects, foor traffic, etc.) of the fungus, or materials carrying the fungus.

c. By wind or water dispersal of spores.

14) What are spores?

Asexual fungal spores are simple reproductive bodies that are comparable to seeds. Like seeds, spores may germinate in the presence of water and favorable temperatures. If spores happen to germinate on a susceptible grass plant, they may infect it by means of fungal threads.

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[1] *The authors are R. M. Endo, Associate Professor of Plant Pathology, University of California, Riverside, and A.H. McCain, Extension Plant Pathologist, Berkeley.*

15) When ore spores produced?

They are produced, usually under moist conditions, following an active period of growth of the fungal threads in the infected grass plant or in dead grass debris.

16) Are all spores spread by the wind?

No. Dry spores produced free above the soil surface are carried by the wind, but spores that are surrounded by a sticky matrix are not. They are spread by water or wind-blown rain. Also spores of the water mold fungus, *Pythium*, possess whip-like organs that propel the spores'through water.

17) How does fungal growth start?

By production of threads from asexual spores, infected plants, infested plant debris, or from resistant fungus structures such as chlamydospores, sexual spores, or sclerotia.

18) What are resistant fungal structures such as chlamydospores, sexual spores, and sclerotia?

Structures that are adapted to survive periods unfavorable for the fungus because of their thickened walls and abundant food reserves. They are usually produced by certain fungi during periods unfavorable for their growth. Because of their thick walls, they are usually resistant to the action of fungicides.

19) How does a fungus infect a plant?

Usually by fungus threads which may enter the plant through wounds, natural plant openings, or through intact plant surfaces.

20) Does the fungus grow and spread through the entire plant from a single infection?

No. Usually numerous infections are required to weaken and kill a grass plant. In general, seeds are extremely susceptible to invasion by facultative parasites, seedlings very susceptible, and plants several months old much more resistant. For example, a single *Helminthosporium* infection in a seedling may spread to involve the entire shoot; in a leaf several months old, the infected area may average only a few mm. in length. Plants with very young shoots and older leaves may therefore exhibit both large and small lesions.

21) Are certain kinds of fungal infections more damaging than others?

Yes, particularly infection of seedlings, infection of the very crucial crown area of the plant (where the stem and roots join), and infection by facultative parasites of stunted, weakened, plants.

FACTORS INFLUENCING FUNGAL DISEASES

22) What factors favor fungal disease development?

The same factors that favor fungal thread development, i.e.:

1) Occurrence of favorable temperatures. -Some fungi grow best and cause diseases at cool temperatures; others at warm temperatures (see table).

2) Presence of abundant food. – The parasitic fungi must compete not only with other fungi but with other microorganisms for available food (for example, grass clippings, and food materials leaking from healthy plants).

3) Presence of free moisture. – Water is required for prolonged periods, since all stages of fungal development require it, such as thread growth, spore production, spore germination, and plant infection. Normally, many such cycles of disease development are required for severe damage.

23) Which factor is most important in fungal disease development?

All 3 factors are of equal importance for the fungus. But from the grower's point of view, moisture is the most important, since it is the only factor which he can regulate to obtain some measure of disease control.

24) How should grass plants be watered to suppress fungal disease development?

1) Do not water daily if at all possible; water according to need.

2) Water to a depth of at least 1-2 inches.

3) The appearance of green scum (algae) on the soil surface, or the development of wet, ill-smelling soil indicate over-watering.

4) If the grass is watered in the morning, it will remain wet only for a few hours; if watered in early evening, it will remain wet for 14 or more hours.

25) Since dew forms on grass blades almost daily from spring to fall, is moisture reduction really so important in reducing fungal diseases?

Yes, we believe that it is, since the kind, amount, and distribution of moisture are important. A thin water film over the entire plant is much more favorable for fungus growth than a few, scattered drops of dew.

Fungi that spread only by threads require an almost continuous film of moisture, but with fungi that spread by spores, the spores may germinate and infect plants within drops of dew. However, increasing the amount of moisture, or the duration of the wet period usually increases both the incidence and severity of both kinds of fungal diseases.

This simple truth is easily demonstrated in 2 ways: 1) most fungal diseases appear first and are most severe and damaging in shaded areas, or in areas where moisture stands for long periods because of poor wind and/or soil drainage, and 2) fungal diseases of turfgrasses are severe and damaging in the humid, wet states of the North Central, northeastern and southeastern U.S., and within California, along the foggy, coastal areas.

26) What diseases are spread by wind-borne spores which

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are capable of germinating and infecting plants within droplets of dew?

The 2 most common and damaging turfgrass diseases in California: rust caused by *Puccinia* spp., and *Helminthosporium* leaf spot and foot rot caused by *Helminthosporium* spp. The spores of either can germinate in dew and infect plants in as short a time as 10 to 12 hours. This fact undoubtedly accounts for the prime importance of these 2 diseases in California.

27) Are weak, slow-growing plants damaged more severely by fungal pathogens than vigorous, rapidly-growing plants?

Yes, since most turfgrass diseases are caused by facultative parasites.

28) Does the type of fungal parasite make a difference?

Yes, it is generally believed that facultative parasites cause the most damage on weakened plants, the least on vigorous plants (see question 10). But this relationship is reversed in the case of obligate parasites.

29) How may grass plants be weakened?

In numerous ways but most common are the following:

1) Excess mat and thatch accumulation in the crown and root area of living plants reduces movement of water, air, and nutrients into the soil, results in loss of contact of roots with soil, and provides abundant plant debris for harboring facultative fungal parasites.

2) Too frequent mowing and/or excessive removal of foliage during periods unfavorable for plant growth probably results in a reduction of food reserves, and a sharp reduction in the number and depth of the root system.

3) Inadequate fertilization is undoubtedly the most common cause of weakened turf, yet one that is easily corrected.

30) Since accumulation of excess mat and thatch is harmful, can it be reduced or removed?

Yes, with the use of vertical mowers and other special machinery. Golf course superintendents also add soil, usually similar to the original, to restore contact of the roots with soil.

31) What diseases are most common and severe when plants are lacking in nitrogen?

Dollar spot caused by *Sclerotinia homeocarpa*, red thread caused by *Corticium fuciforme*, and rust caused by species of *Puccinia*.

32) Can these 3 diseases be controlled by adequate nitrogen fertilization?

Yes, controlled in the sense that the diseases are considerably reduced in incidence and severity.

33) How does nitrogen fertilization control these three diseases?

It is not known for sure how adequate nitrogen fertilization reduces dollar spot and red thread. We suspect that control is secured through improved plant growth since these fungi apparently require a food base in the form of dying or weakened grass blades in order to cause infection of healthy, young leaves. Rust is controlled because the rapid foliage growth resulting from nitrogen fertilization becomes only partially infected, and is rapidly removed by mowing. Since the fungus is an obligate parasite, its spores die out in the mowed leaves, and the plants thereby keep ahead of the rust. This method is not effective when plant growth slows down in winter.

34) What fungal disease is frequently associated with application of high rates of nitrogen (particularly of ammonium sulfate) which results in the rapid, soft growth of grass?

Brown patch – caused by *Rhizoctonia solani* – which commonly appears in the summer as very rapidly spreading, circular areas of affected turf (spread is by threads).

35) What is the common cause of the death of turfgrass in California?

Drought usually caused by: 1) water running off of compacted soil and usually aggravated by the too rapid application of water and, 2) water run-off due to failure of water to wet and penetrate dried-out grass debris (mat and thatch) which may be as difficult to wet as dry peat moss.

DIAGNOSIS OF FUNGAL DISEASES

36) How are known fungal diseases diagnosed by plant pathologists?

By noting 1) the distribution pattern of diseased plants in the field, 2) the kind of disease symptoms present on individual plants and the organs affected, and 3) the kind of fungus structures present in or on the infected cells as determined with a microscope.

37) What is meant by the disease distribution pattern?

Each fungus attacks plants in a field in a characteristic manner, depending primarily upon its method of spread. This results in a typical pattern of distribution of healthy and diseased plants or its disease distribution pattern. Turf-attacking fungi spread either by radial growth of fungal threads generally originating from a central starting point or by the wind dissemination of spores. The first type of disease spread results in gradually enlarging, circular areas of affected turf scattered among healthy areas. The second type results in the general, uniform distribution of diseased plants, with nearly all plants showing localized leaf infections, usually in the form of leaf spotting.

38) Give some examples of disease symptoms on individual plants.

The dollar spot fungus causes the death of small areas of the leaf which appear as bleached bands

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of tissue; the *Helminthosporium* fungi cause small brown or purplish leaf spots that are surrounded by a ring of darker colored tissue, and the *Pythium* fungi cause a brown, dry root rot (see table for other symptoms).

39) Give some examples of fungus structures found in or on infected plants.

In early morning it is sometimes possible to see a network of fungus threads growing in droplets of dew at the tips of infected grass blades. The "red thread" fungus forms reddish, dense, horn-like masses of fungal threads at the tips of affected grass blades; the "fairy ring" fungi form mushrooms at certain times of the year; and certain other fungi form characteristic asexual spores on characteristic spore-bearing stalks.

40) Why is diagnosis of turfgrass diseases difficult?

Since most parasitic fungi are very small and indistinguishable to the naked eye, positive identification requires confirmatory studies with the microscope. In addition, numerous saprophytic fungi occur on turfgrass plants and may be mistaken for parasites by the inexperienced.

CONTROL OF FUNGAL DISEASES

41) How are fungal diseases of turfgrasses controlled?

A) CONTROL METHODS WHICH MAY BE CONSIDERED BEFORE OR AT PLANTING TIME ARE:

1) Installing adequate water drainage facilities to prevent moisture retention, thereby minimizing the development of fungal diseases.

2) Chemical treatment of soil with gaseous toxicants such as methyl bromide to rid the soil of fungal parasites, nematodes, weed seeds, etc. This expensive procedure may be justified if the area has demonstrated a previous history of severe and chronic disease development. However, clean seed must be planted in treated soil. If dirty seed is used, fungal disease development may be more severe than if the soil had not been treated. This is because the soil microorganisms which normally compete with the fungal parasites on the seed have been killed by the soil treatment, permitting unrestricted growth of the fungal parasites on the seed.

3) Plant only fresh, clean (disease-free) seed of high viability at recommended rates of planting. Seeds and seedlings are extremely susceptible to disease and stunted, weak seedlings which result from overseeding remain very susceptible for many additional months after planting. Grass seeds grown in the far west are generally more disease-free than seed grown elsewhere in the U.S.

4) Cool season versus warm season grasses. Consider carefully whether you want to plant a cool season or a warm season grass. Cool season grasses are very susceptible to fungal parasites; warm season grasses are very resistant (e.g., bermuda grass, zoysia grass and St. Augustine grass). The cool season grasses are arranged in order of increasing disease resistance: Fescues, ryegrasses, bentgrasses, and bluegrasses.

5) If available and necessary, disease-resistant varieties of proven adaptability should be planted. This is the easiest way to control fungal diseases but very few resistant varieties of cool season grasses are available, and these are usually resistant to only a single disease.

B) CONTROL METHODS WHICH ARE APPLICABLE TO GROWING PLANTS ARE:

1) The application of protectant fungicides.

2) The use of certain cultural practices. These practices favor vigorous plant growth and are unfavorable for fungal disease development. Examples are given in question 29. These methods probably are more successful in California than elsewhere because of our very low relative humidity and low rainfall – which falls only in winter and early spring. In California these cultural methods may fail wherever low moisture distribution patterns are disturbed by the occurrence of frequent coastal fogs, by rainfall, by local topography, by the need for daily irrigations, by poor drainage situations, etc.

42) What is a protectant fungicide?

One which is applied to the external surfaces of plants to protect them from infection by fungal parasites. They are mainly effective in stopping further disease spread, not in curing infected plants of disease.

43) Is a fungicide more effective against a fungal disease spread primarily by spores or by fungal threads?

It is far more effective against fungal threads than spores. Threads are more exposed, and more readily damaged although they are far fewer numerically and less generally distributed. Poisoning of spores is more difficult primarily because of their very small size and their random distribution by wind over the host surfaces.

44) Why aren't fungicides curative rather than protective?

Because protectant fungicides are not taken up by the plant to kill the parasite inside.

45) How long does this external protection last?

Usually from 3 to 14 days depending upon the fungicide, the weather, etc. In addition, any new growth which occurs after fungicide application will be unprotected.

46) Is the lack of cumtive action the main reason why fungicides are sometimes applied every 7 to 14 days in a so-called preventative disease control program?

Yes, that plus the fact that the effectiveness of protectant fungicides is so short-lived and new growth is unprotected.

47) When is a preventative fungicide disease control schedule recommended?

Because of the expense, labor and time involved, it is not recommended for homeowners. It is recommended for turf areas receiving intensive care and play that must

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be maintained in as healthy a condition as possible (e.g., golf greens and bowling greens that are mowed from 3 to 6 times weekly and that receive daily play).

48) When should a preventative fungicide disease control program be started?

Sometime in early spring but the actual time will vary depending upon the area, the grass variety, weather conditions, diseases generally present, etc. In any case, applications must be started before disease development has progressed too far since fungicides are least effective when fungal populations are high, and most effective when fungal populations are low.

49) What method of disease control is recommended for the homeowner for established lawns?

Keep the grass growing in as vigorous a condition as possible as outlined in questions 22 to 35, and use fungicides whenever necessary to stop disease spread should diseases develop.

50) Why are different fungicides recommended for the control of different fungal pathogens?

Because fungicides are not equally effective against different parasitic fungi.

51) Since the exact identification of a fungal parasite requires microscopic examination, how can one be sure of what fungicide to use?

In most cases diagnosis is not difficult and a proper choice of fungicide can be made. If diagnosis is uncertain, use a mercurial-containing fungicide which possesses the widest spectrum of activity against fungal parasites, or use a fungicidal mixture.

52) What is a fungicidal mixture?

It consists of 2 or more fungicides mixed together to increase the number of fungal parasites that can be controlled, to increase fungicidal efficiency, or to increase the safety of fungicides to plants.

53) Are other chemical compounds sometimes added to fungicidal mixtures?

Yes. Commonly added chemicals are fertilizers, compounds containing iron, and insecticides.

54) Are fungicides harmful to plants?

Yes, if they are used ar higher than recommended rates.

55) Are some fungicides more damaging to plants at high temperatures?

Yes, mercurials, in particular, should not be applied when air temperatures are higher than 82° F, or when temperatures shortly after application are expected to rise above this temperature. Reduce the amount of mercury used by 1/4 to 1/2 or apply in late afternoon during hot weather.

56) Why do you recommend that certain fungicide mixtures or certain fungicides be used alternately in a preventative fungicide disease control schedule?

The alternate use of different fungicides or fungicide mixtures is recommended because development of fungi resistant to fungicides is less likely to occur and better protection is afforded against all the various fungi attacking turf.

57) What 2 groups of fungicides or fungicide mixtures are currently recommended?

Select one fungicide or fungicide mixture from each of the 2 groups. Apply one fungicide or fungicide mixture one week and the second fungicide or fungicide mixture 7 to 14 days later.

Group 1 (effective against dollar spot, brown patch, red thread, Fusarium patch and Helminthosporium-induced diseases). 1) Phenyl mercury acetate with tetramethylthiuram disulfide; 2) hydroxymercuri chlorophenol with tetramethylthiuram disulfide; 3) methyl mercuri dicyandiamide; 4) or folpet with cadmium carbonate and tetramethylthiuram disulfide.

Group 2 (effective against greasy spot caused by species of Pythium and rust caused by species of Puccinia). Zinc ethylene bisthiocarbamate, cyclohexamide, or cyclohexamide with tetramethylthiuram disulfide.

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UCLA TURF RESEARCH PROGRAM UNDER V. B. YOUNGNER TRANSFERRED TO RIVERSIDE CAMPUS

The turfgrass research activity centered at UCLA since 1948 will be located on the Riverside campus of the University of California after July 1, 1965. This move is part of the phasing out of agriculture from the Los Angeles campus which has been underway for the past several years.

After completion of the move, an expanded research effort at the new location will be effected. New facilities now under construction for the Department of Agronomy at Riverside will be used by the turfgrass research group according to Dr. V. B. Youngner, who heads the turfgrass program.

The work currently underway at the South Coast Field Station, Santa Ana, will also become an activity of the Department of Agronomy but will continue uninterrupted at the Field Station under the immediate direction of Mr. Stanley Spaulding, turfgrass technician.

Mr. Frank Nudge, laboratory technician, will remain at Los Angeles for part of the summer to complete the present work before joining the group at Riverside.

GENERAL INFORMATION ABOUT FUNGAL DISEASES OF TURFGRASSES AND THEIR CONTROL

DISEASE	SYMPTOMS	SUSCEPTIBLE GRASSES	CONDITIONS FAVORING DISEASE	CULTURAL CONTROL	FUNGICIDAL CONTROL*
BROWN PATCH ***Rhiroctonio solani*** is a soil-inhabiting fungus, active as fine fungus threads that survive in the soil, or in and on the turf. Hard masses of fungus threads (sclerotia) ore very resistant to fungicides.	Localized, irregular brown areas that start small, may spread to many feet in diameter. Leaves and leaf sheaths turn olive-green, wilt, become light brown, and die. Portions of leaves may be yellow. Stems, crowns and roots also may be infected. In light attacks, roots usually are not involved and plants recover.	Bentgrosses Bluegrasses Bermudas Ryegrasses Fescues Zoysia	Excess thatch and mat, high temperatures (75° to 95° F), high humidity, and soft, lush growth due to excess nitrogen favor brown patch. A cold-weather (40 to 60 F) form of the disease occurs infrequently. Disease is more common in warm inland areas.	Reduce shading and improve soil aeration and water drainage. Water when needed to a depth of 8 to 12 inches if possible. Avoid nitrogen fertilization that results in soft growth of foliage.	PCN B mercuriols thiram Dithane M-45
DOLLAR SPOT ***Sclerotinia homeocarpa*** fungus survives in the soil by means of sclerotia. Disease is common near or on the coast, essentially on bentgrass.	Small circular areas about 2 inches in diameter may merge to form large irregular areas. Spots usually are general over entire lawn; leaves are water-sooked at first, later brown and finally straw colored. Fine, white cob webby fungus threads may be seen in early morning.	Bentgrasses Bluegrasses Bermudas Ryegrasses Fescues	Moderate temperatures (60 to 80 F) and excess moisture, excess mot, and thatch fovor dollar spot. Turf deficient in nitrogen tends to develop more dollar spot than turf adequately fertilized with nitrogen.	Keep thatch at a minimum. Water only when needed to a depth of 8 to12 inches. Apply adequate nitrogen.	cadmium mercurials cycloheximide Dyrene Dithane M-45
FUSARIUM PATCH ***Fusarium nivale*** probably over-seasons as a network of fungus threads in grass residues.	Roughly circular patches of 1 to 2 inches may enlarge to 12 inches. Leaves first become water-soaked, then bleached. Minute, white or pinkish, gelatinous spore mosses occasionally are seen on dead leaves. Fungus threads, also white or pinkish, may be seen in early morning.	Bluegrasses Ryegrasses Fescues Zoysia Common on ***Poa annua*** and creeping bentgrass varieties.	Cool (40° to 60° F), moist conditions, such as prolonged rainy periods in winter, favor the disease. Usually appears first on shaded plants.	Reduce shade; improve soil aeration and water drainage. Avoid excess nitrogen fertilization.	merurials thiram cadmium Dyrene
MELTING OUT ***Helminthosporium*** vagans probably survives in infected bluegrass plants or debris os fungus threads and as spores. It may be seed. borne.	Symptoms include general thinning out of grass in scattered areas. Often general browning of lower leaves is evident on affected plants. Circular to elongate purplish or brown spots with straw-colored centers occur on leaf blades, leaf sheaths, and stems. General infection appears as leaf spots, indicating spread by windborne spores. Crown and roots frequently are attacked. Crown infections are especially damaging and such plants generally succumb in hot, windy weather.	Kentucky bluegrass. Improved selections, Merion and Newport, are resistant. Common Kentucky bluegrass is very susceptible.	Cool (50" to 70 F), moist conditions favor the disease. First appears on shaded plants. Most severe on closely clipped turf.	Reduce shade, improve soil aeration and water drainage. Do not mow grass lower than 1 1/2 inches.	captan folpet Dyrene cycloheximid Dithane M-45 Mercurials
H. sorokinianum probably survives in infected grass plants or grass debris as mycelium and spores. May be seedborne.	Same as for **Helminthosporiom** vagans, except leaf spots usually show brown rather than straw-colored centers, and borders of spots are purplish to dark brown.	Bentgrasses Bluegrasses Fescues Ryegrasses Bermudas	Warm temperatures (70° to 90° F) and high humidity favor the diseose. First appears on plants growing in shaded areas. Most damaging on closely clipped turf.		
LEAF BLOTCH ***H. cynodontis*** probably survives in infected bermudagrass plants and debris as my celium, and as spores. May be seedborne.	Tiny purplish to reddish spots occur on leaf blades and leaf sheaths. Seedlings are very susceptible but plants rapidly become resistant. Affected seedlings wither, die, and turn brown. Roots and crown may develop small lesions.	Bermuda-grasses	Leaf blotch damages young seedlings or adult plants weakened by factors such as excess thatch, deficient nitrogen, and unfavorable growing conditions.	Remove thatch at regular intervals. Apply adequate nitrogen.	As above

* USE AT RATES AND FREQUENCIES RECOMMENDED BY MANUFACTURER.

DISEASE	SYMPTONS	SUSCEPTIBLE GRASSES	CONDITIONS FAVORING DISEASE	CULTURAL CONTROL	FUNGICIDAL CONTROL *
RED THREAD *Corticium uciforme* over-seasons as pink-sh or red gela-inous crusts of ungus threads. Disease occurs commonlly along coast of northern and central Cali-ornia. It is rare n southern California.	Turf is killed in patches 2 to 15 inches in diameter. Pink web of fungus threads bind leaves together. Pink gelatinous, fungus crusts, 1/4 to 3/4 inch long, projecting from leaves, are characteristic.	Bentgrasses Bluegrasses Fescues Ryegrasses	Red thread usually appears on plants deficient in nitrogen, and during periods of prolonged cool, wet weather.	Apply adequate nitrogen and reduce shading.	cadmium mercurials Dithane M-45 Dyrene
GREASE SPOT Species of Pythium, mainly *P. aphanidermaum*, have thick. walled sexual spores that enable the fungi to survive in the soil for long periods. Infection by Zoospores (motile spores) in water or by fungus threads.	Turf is killed in small roughly circular spots (2-6 inches) which tend to run together. Blackened leaf blades wither rapidly and turn reddish brown. Leaf blades tend to lie flat, stick together and appear greasy. Roots may be brown.	All grasses	Grease spot usually appears in low spots that are wet for long periods. Disease depends upon excess moisture.	Reduce shading, improve soil aeration and water drainage. Water when needed to a depth of 8 to 12 inches,	zineb cycloheximide mercurials nabam Dexon
SEED ROT AND DAMPING OFF Disease as caused by several species of *Pythium, Rhizoctonia solani, Fusarium culmorum, ond Helminthosporium sorokinianum.*	Seed rot, pre- and postemergence damping off may occur. Seed rot is not mushy but rather dry. Hypocotyl area is particularly susceptible. At first, seedlings ore water-soaked, then they blacken, shrivel, and turn brown. Frequently, affected seedlings are not killed but are yellow and stunted with markedly reduced root systems.	All grasses	Seed rot and damping off are favored by excess water, sowing seeds of low viability, and sowing seeds above the recommended rates, especially during periods unfavorable for seed germination and growth.	Improve soil aeration and water droinoge. Do not overwater. Sow only fresh, healthy seed at recommended rates and seasons	Treat seed with thiram, chloronil, capan, or organic mercury. Spray seedlings with captan or thiram. Fumigate soil before planting with methyl bromide
RUST *Puccinia striiformis* and P. graminis overseason in infected grasses and as spores which are airborne.	Elongate, reddish pustules containing spores appear on stems, leaves, and leaf sheaths. Reddish spores adhere to fingers when pustules are rubbed.	Bluegrass Ryegrass	Moderately worm, moist weather favors rust development. Moisture in the form of dew for 10 to 12 hours is sufficient for spores to infect plants.	Keep plants growing rapidly by fertilization and irrigotion	zineb maneb cycloheximide
FAIRY RING Several species of mushrooms cause fairy rings. In northern and central California the predominant fungus is *Marasmius oreades;* in southern California, species of Lepiota.	A dark green band of turf develops in a circle or semi circle. Mushrooms may or may not be present. Frequently, just behind the dark green band is an area of sparse, brown, dying grass, caused by lack of water penetration. Weed invasion common.	All grasses	Fairy ring develops most frequently in soil high in undecomposed organic matter.	Apply adequate nitrogen. Aerate soil for better water penetration.	Complete soil sterilization. Applications of organic mercurials may suppress mushroom production.

* USE AT RATES AND FREQUENCIES RECOMMENDED BY MANUFACTURER.

WARNING: Pesticides are poisonous and always should be used with caution. Follow all precautions and safety rules on the label.

CAUTION: Chloropicrin and methyl bromide ore very hazardous materials. Anyone using them or planning to use them should become familiar with and strictly follow the warnings on the package label or any accompanying material furnished by the manufacturer.

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

TO SIMPLIFY INFORMATION. TRADENAMES OF PRODUCTS HAVE BEEN USED.NO ENDORSEMENT OFNAMEDPRODUCTS IS INTENDED. NOR IS CRITICISM IMPLIED OF SIMILAR PRODUCTS WHICH ARE NOT MENTIONED.

TURF FUNGICIDES

MERCURIALS

Organic

hydroxy mercury chlorophenol: Semesan Turf Fungicide
methyl mercury dicyandiamide: Panogen Turf Fungicide.
phenylmercury ethylenediamine: Lincks Lawn Fungicide
phenylmercury monoethanol ammonium lactate: Purta-turf 10
PMA – phenyl mercury acetate: PMAS, Tag Fungicide, Scutl, Tag-C-Lect, Phenmad, Liquiphene N-ethyl-mercuri - 1,2,3,6 tetrahydro-3, 6-endomethano 3,4,5,6,7,7-hexachlorophthamimide: Emmi, SEC

Inorganic

mercurous chloride (calomel) t mercuric chloride (corrosive sublimate): Calo-clor, Calogreen, Wood-Ridge Mixture 21, Fungchex, Calocure, Bi Cal, Velsicol 2-l Fungicide

CADMIUM

cadmium carbonate: Ortho Lawn and Turf Fungicide, Ortho Lawn Fungicide
cadmium chloride: Caddy, Cad-trete, Patterson's Liquid Turf Fungicide, Vi-cad
cadmium copper zinc sulfate chromate complex: Mico Turf Fungicide C
cadmium sebecate: Kromad
cadmium succinate: Cadminate
phenylamino cadmium dilacrate: Purtaturf 177

ORGANIC

captan = N-trichloromethylmercapto-4-cyclohexene 1,2-dicarboximide: Orthocide, Captan
chloranil = 2,3,5,6-tetrachloro - 1,4-benzoquinone: Spergon
cycloheximide: Acti-dione R Z , Acti-dione-Thiram, Acti-dione ferrated
dyrene = 2,4-dichloro-6-(O-chloranilino)-triazine: Dyrene, Turf-Tox D-50
folpet = N-(trichloromethylthio) phthalimide: Phaltan, Ortho Lawn and Turf Fungicide
maneb = manganese ethylene bisdithiocarbamate: Dithane M-22, Manzate
PCNB = pentachloronitrobenzene: Fungiclor, Terraclor, Best Turf Fungicide
polyethylenethiuramsulfide: Ethisul
thiram = tetramethylthiuramdisulfide: Tersan, Panoram, D and P Turf-Tox, Thiramad, Thiuram 75
zineb = zinc ethylene bisdithiocarbamate: Parzate, Dithane Z-78, Zineb

COMBINATIONS

Acti-dione RZ = cycloheximide + PCNB
Acti-dione-Thiram = cycloheximide t thiram
Bandini Turf Fungicide = PCNB + PMA
Cad-trete = thiram t cadmium chloride
Kromad = thiram + cadmium sebecate + potassium chromate t malachite green + auramine
Ortho Lawn Fungicide = captan + cadmium carbonate + insecticide and iron
Ortho Lawn and Turf Fungicide = folpet, cadmium carbonate, thiram
Scutl = PMA + thiram
Tersan OM = thiram + hydroxy mercury chlorophenol
Thimer = thiram + PMA
Micro Turf Fungicide = thiram + cadmium calcium copper zinc sulfate
Turf-Tox MC = thiram + mercuric chloride + mercurous chloride
Mercuram = thiram + phenyl mercury dimethyldithiocarbamate + malachite green
Thiuram M = thiram + mercurous chloride + mercuric chloride
Fung-0-Cide = cadmium chloride + methyl mercury dicyandiamide + fertilizer

SOIL FUMIGANTS

SMDC = sodium N-methyldithiocarbamate: Vapam, VPM
DMTT = 3,5-dimethyl-tetrahydro-1,3,5-2H-thiadiazine-2-thione: Mica-fume, Mylone, Soil Fumigant M methyl bromide: Bed Fume, Bromex, Dowfume MC-2, Isobrome, MBC Fumigant, Pano-Brome, Pestmaster Soil Fumigant, Tribrome, Weedfume
MIT = methylisothiocyanate: Vorlex (Vorlex is 20% MIT, 80% clorinated hydrocarbon)

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