Turfgrass Diseases

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I. Introduction

Plant diseases are a normal part of nature. They are one of the many checks that help keep the many hundreds of thousands of living organisms in balance with each other in undisturbed nature. When man selects and cultivates plants, he must recognize that diseases are one of the expected hazards. In fact, cultivated plants are usually more susceptible to diseases than their wild cousins, partly because large numbers of the same kind are grown closely together. In addition, cultivation constantly disturbs nature and the normal checks and balances. Where else can one find more of a mono-culture than in our cultivated turf areas?

Diseases have become increasingly important in turf management as our knowledge of turf culture is expanded. The grasses grown on greens, fairways, lawns, road parkways, athletic fields, parks, cemeteries and around industrial sites are attacked by over one hundred different infectious diseases. Nearly all of these infectious diseases are caused by fungi, although diseases caused by viruses, nematodes and bacteria are known. Fortunately, most of these diseases can be controlled by fungicides and good cultural practices.

Correct disease identification is essential to the intelligent use of proper control measures. Some basic knowledge of plant diseases is also important; therefore, a few basic principles are given. This is followed by a description of the more commonly found turfgrass diseases in the midwest along with some cultural and chemical control suggestions.

II. What is a Diseased Plant?

It is difficult to precisely define a diseased plant. Most definitions contain the word "normal", and, to date, no one has accurately defined a "normal plant". However, for our purposes, we will use the word "normal" advisedly in the following definition. A plant is said to be diseased when its normal functioning and growth are disturbed by an injurious physiological activity caused by the continued irritation of a primary causal agent. The term "continued irritation" is used to differentiate between a disease and injury caused by the chewing of insects, or animals, mechanical damage caused by equipment, and damage from ice, hail or wind.

III. Classification of Plant Diseases

1. Non-infectious.
2. Infectious.

Non-infectious diseases are characterized by the fact that the causal agent can not be transmitted from affected to healthy plants.

Infectious diseases are characterized by the fact that the causal agent can be transmitted from affected to healthy plants causing the same symptoms to appear in the healthy plants as in the affected plants.
IV. Causes of Non-Infectious Diseases

1. Excessive temperatures.
2. Improper soil-water relationships.
3. Injurious impurities in air, soil or water.
4. Mineral deficiencies, excesses or imbalance.
5. Improper oxygen relationships.
6. Extreme alkalinity or acidity of growing medium.
7. Genetic factors.

V. Causes of Infectious Diseases

1. Bacteria
2. Fungi
3. Nematodes
4. Viruses
5. Parasitic Phanerogams.

VI. Requirements for the Development of an Infectious Disease

1. Inoculum
2. Susceptible Host
3. Proper Environmental Conditions.

Inoculum is that portion of a pathogen that is capable of causing an infection when transferred to a susceptible host; spores or mycelial fragments, bacterial cells, nematodes or nematode cysts, virus particles, and seeds of parasitic plants are the inoculum for the causal agents of infectious diseases.

In order for an infectious plant disease to develop, the first requirement is that suitable inoculum be disseminated to a host. Inoculum may be disseminated from infected to healthy plants by wind, rain, surface or soil water, insects, animals, man or machinery.

The second requirement for development of an infectious disease is that a suitable host must be present. Inoculum of a pathogen may be disseminated to a plant, but unless that plant is susceptible to infection and development by the pathogen, no disease will develop. A host plant may be susceptible to a given pathogen during certain stages of growth and resistant during other stages. Plant vigor as influenced by nutrition, water, soil factors, cultural practices and environmental conditions may increase or reduce the resistance of a plant to a given pathogen, or alter the severity of any given disease.

The third requirement for disease development is proper environmental conditions. Both the host and pathogen are influenced by environmental conditions. Pathogens are generally more sensitive than hosts. Temperature and humidity are two critical environmental factors for pathogens, while temperature, moisture, light, nutrition and soil factors are critical factors for host plants. Generally, a plant is more susceptible to a disease when the environmental conditions favor growth of the pathogen and are unfavorable for plant development.

In addition, diseases incited by certain viruses are influenced by all conditions that affect the population or activity of their insect vectors.
VII. Effect of Cultural Practices on the Development of an Infectious Disease

Proper cultural practices may be beneficial in the protection, eradication, elimination or severity of a disease.

1. Nutrition - Proper nutrition will help any grass to maintain its highest resistance to a pathogen. While nitrogen is the single most important element for growth, excessive use of this element may increase the susceptibility of a turfgrass to several pathogenic organisms. This is especially true when nitrogen is high in relation to potash and phosphorus. Research indicates that many variables exist between different elements and disease resistance; however, one trend remains clear; plants generally have their highest degree of resistance when available nutrients are maintained in balance.

2. Cutting - Grass mowed at the proper height for the species will have more resistance to disease than grass mowed too closely or allowed to grow too high. Scalped grass does not have enough leaf surface to produce sufficient carbohydrates for the production of new leaves, roots or stolons. Excessively tall grass reduces air movement and provides an excellent incubation chamber for the development of pathogenic organisms.

3. Watering - Excessive watering causes soil aeration problems, and roots are suffocated from a lack of oxygen. Poor surface or subsoil drainage will cause similar problems, and will increase the damage caused by overwatering. If grass blades, including thatch, could be kept dry while maintaining sufficient water in the root zone, foliar disease problems would be nonexistent. Soil kept near the saturation point prevents normal root growth and favors growth of pathogenic organisms like Pythium. Proper water control is the single, biggest environmental and cultural factor in disease control in turf areas.

4. Thatch - Pathogenic organisms thrive on the dying, dead and decaying organic matter found in the thatch layer. Thatch absorbs excess moisture and acts as an incubation chamber. With the removal of thatch, the pathogenic organisms are forced to compete with the multitude of non-pathogenic bacteria, fungi and other organisms found in the soil. Many of the non-pathogenic organisms found in the soil produce substances which are toxic to pathogenic organisms. The antagonistic effects of these organisms helps to reduce the inoculum potential of the pathogenic organisms.

5. Prevention of injury to the grass - Careless use of pesticides, fertilizers, using improperly set mowers, leaving the cut too long in one spot, using machinery on turf that is soggy, removing half or more of the grass blade at one mowing, etc. may weaken grass plants. Any condition that weakens or puts a plant under a stress reduces the natural resistance of that plant to pathogenic organisms.

6. Promote rapid drying of leaf blades - Fungi, with the exception of the powdery mildews, require free moisture on the grass blade for 3 to 12 hours in order to infect a plant. Rapid drying of dew and guttated water is an important disease control measure, especially on golf course greens. Poling or brushing greens may be used to facilitate drying of greens. Removal of trees, shrubs or brush from near greens may aid in air circulation and drying. Problem greens are often improved by increasing air circulation. Guttation fluids contain the amino acid glutamine, and this amino acid has been shown to increase the virulence of certain fungi.

7. Maintain proper soil conditions - A well drained, fertile soil with proper control of fertilization, water and pH promotes healthy, vigorous plant growth. Healthy, vigorous growing plants are more resistant to pathogenic organisms than weakened plants.
VIII. Chemical Control of Infectious Diseases

Chemical disease controls may be necessary to maintain prestigious turf areas relatively free from infectious diseases. No grass variety is resistant to all major grass diseases, and even the best cultural practices will not prevent disease development under some environmental conditions.

There are generally two types of chemical disease control - preventive and curative. Preventive sprays are applied at scheduled intervals before a disease strikes. Many prestigious turf areas receive scheduled preventive fungicide sprays throughout the growing season. Curative disease controls are applied after disease development has started. The same fungicides may be used as with the preventive schedule, but dosages are increased and the interval between sprays reduced. In order for curative spray programs to prevent further spread of the disease, it is necessary to start fungicide applications at the first appearance of symptoms. Even then curative programs are not always effective in stopping disease development.

Correct diagnosis of a disease is extremely important. There is no single chemical that is effective against all pathogenic organisms. In fact, some chemicals are quite specific for a small group of pathogenic organisms. Always read label directions and use chemicals accordingly.

Use at least 5 to 10 gallons of spray per 1,000 square feet to adequately wet the grass blades, thatch, and top quarter inch or more of soil. Use five gallons of spray against such diseases as powdery mildew and rust, which attack only the grass blades. Other diseases, such as dollar spot, brown patch, Pythium, melting-out, and snow molds, attack the crown and root area before growing on and over the grass surface. Here 10 gallons per 1,000 square feet is barely adequate. For diseases like brown patch, where the causal fungus is known to survive in the form of sclerotia buried in the soil, 15 gallons would probably do a better job. See special instructions under stripe and flag smut for gallonages needed to move the newer systemic chemicals into the active root zone.

High pressures are not necessary. It is much more important that the fungicide be applied evenly. Use a multi-nozzle boom and apply the chemical equally in two directions. The time interval between spray applications should vary with temperature, expected disease occurrence, grass condition, chemicals used, the amount of rainfall or artificial watering. The spray interval may be as short as two or three days in hot, wet weather or stretch out to two weeks or more in dry weather. Some fungicides give some protection for a week or 10 days even when four to six inches of water has fallen as rain or from a sprinkler. Another chemical may last only two or three days under similar conditions. The problem is complex and is a further reason to read and follow label directions.

Soil fumigants such as methyl bromide, chloropicrin, Vorlex, Vapam, V.P.M. Soil Fumigant, etc. may be applied to soil before seeding to kill fungi, nematodes, insects and weeds. These chemical control methods are specialized and should not be attempted until the applicator has become thoroughly familiar with the application methods, uses and hazards. Some of the chemicals are highly toxic and should be handled only by qualified applicators. The expense is fairly high, but more and more of this type of control is being used before seeding or sodding greens, tees, stadium turf, and even home lawns. Generally a polyethylene cover is placed over the treated area to retain
the fumes of the fumigant. The only problem is that disease and nematode problems may become more severe later because of lack of competitive fungi, bacteria, and nematodes in the treated area. Once a disease-producing organism is introduced (blown, washed, or tracked) into a treated area, there is no "biological check and balance."

Following are the more common turf grass diseases found in Indiana. The causal organism, symptoms, occurrence, cultural controls, chemical controls and varietal differences are given for each of the diseases.

IX. Common Infectious Turfgrass Diseases in the Midwest

1. Pink Snow Mold (Fusarium Patch)
   a. Causal organism: *Fusarium nivale*
   
   b. Symptoms: Somewhat circular patches of dead, bleached grass from 1 inch to several feet in diameter. Patches may coalesce. Affected grass may be first covered with a dense white or pinkish mold growth. Under a snow cover or during prolonged cool, wet weather, minute heaps of gelatinous, salmon-pink spore masses may appear on dying leaves.
   
   c. Occurrence: Affects most turfgrasses. Disease symptoms appear in late fall, winter or early spring in shaded, wet areas where snow melts slowly. Disease promoted by damp autumn, snow falling on unfrozen ground, deep snow, prolonged wet spring, high nitrogen fertilization in late fall, and tall matted grass. Fungus unable to attack vigorously growing tissues under good growing conditions. Mycelium can withstand temperatures as low as -4°F makes definite growth at 32°F, grows most vigorously at 60 to 69°F and ceases growth at 90 to 91°F.
   
   d. Cultural control: Avoid late fall fertilization. Grass should not go into winter growing at a fast rate. Mow at proper height till all growth ceases in fall. Provide good surface drainage. Control thatch accumulation.
   
   e. Chemical control: Apply recommended chemicals before first heavy snow fall or cold drizzly weather. Repeat during midwinter thaw. Use Demesan, Tersan SP, Dyrene, Ortho Lawn & Turf Fungicide, etc.
   

2. Grey Snow Mold (Typhula Blight, Winter Scald)
   a. Causal organisms: *Typhula itoana, T. idahoensis*
   
   b. Symptoms: Similar to pink snow mold. Under a snow cover or during prolonged cool wet weather patches may be bordered by band of white, blue-grey or almost black mycelium. Pathogens produce yellowish to brown sclerotia imbedded in dead leaves. The sclerotia are used to differentiate Grey and Pink snow molds.
   
   c. Occurrence: Affects most turfgrasses. Disease symptoms appear in winter or early spring in shaded, wet areas where snow melts slowly. Disease promoted by factors similar to those promoting pink snow mold. Mycelium grows at -9°F, most vigorously at 32 to 40°F, and ceases growth at 64°F. Sclerotia may remain
viable for two or more years. In spring, fungus becomes inactive as soil warms.

d. Cultural control: Same as pink snow mold.

e. Chemical control: Same as pink snow mold.


3. Helminthosporium Leaf Spot and Melting out


b. Symptoms - leaf spot phase: Scattered circular to elongate leaf lesions with prominent reddish-brown to dark purple borders. At first, centers of lesions are dark but becomes straw colored later. Infected leaves may turn yellow and die.

Symptoms - melting-out phase: Turf areas become thinned or killed out in circular to irregular areas. Areas enlarge during summer months. Leaf sheaths, stems, crowns, roots and rhizomes turn reddish-brown to black and rot. Symptoms of melting-out are easily confused with symptoms of drought, insect damage or chemical injury.

c. Occurrence: Affects most turfgrasses. Leaf spots may occur during wet, cool weather of spring and fall. Melting-out appears in dry hot periods of summer. Leaf spot phase does not cause extreme damage to turf areas; however, disease causing organisms may move down into leaf sheaths, crown, roots or rhizomes causing death of the entire plant-the latter damage resulting in the melting-out phase.

d. Cultural control: Avoid early spring nitrogen fertilization of highly susceptible varieties. Avoid frequent sprinkling and overstimulation with nitrogen fertilizer. Mow at proper height and collect clippings, if practical. Maintain growth in summer by proper watering and fertilization.

e. Chemical control: Apply recommend chemical at 7 to 14 day intervals in spring during wet weather. Soil drenches may be required to control melting-out. Use Daconil 2787, Dyrene, Acti-dione-thiram, Fore, Tersan LSR, mane, etc.

f. Varieties: Fylking, Merion, Sodco, Warren's A-20 and Windsor have a high degree of resistance to most species of Helminthosporium. Prato has some resistance. The varieties Park, Delta and Kenblue are highly susceptible.

4. Brown Patch

a. Causal organism: *Rhizoctonia solani*

b. Symptoms: Somewhat circular brown patches up to several feet in diameter. Leaves are first water-soaked and dark, but soon wither and turn light brown in color. A typical "smoke ring" of grayish-black mycelium from $\frac{1}{2}$ to 1 inch wide delimits the patch when the fungus is actively growing.
c. Occurrence: Affects most turfgrasses. Two stages of fungus development are required for severe outbreak of brown patch. First, short germ tubes are produced by the sclerotia (fungus resting bodies) at 64 to 68°F with high humidity. The germ tubes are dependent upon the sclerotia for food and are relatively short-lived unless environmental conditions for development of parasitic mycelia occur within a few hours after germination. The fungus mycelia become pathogenic at 73°F with high humidity. Thus, when the temperature is rapidly lowered to 64 to 68°F by sudden cooling wind or rainstorm, the sclerotia rapidly germinate, and infection of grass blades occurs when the temperature increases to 73 to 90°F within a few hours.

d. Cultural control: Avoid overwatering and frequent sprinkling in late afternoon or evening. Prune dense trees and shrubs to increase air circulation. Provide good surface drainage. Avoid overfertilization with nitrogen during hot weather. Remove clippings if practical.

e. Chemical control: Apply recommended chemicals weekly during hot humid weather. Use Daconil 2787, Benlate (Tersan 1991), Acti-dione RZ, PCNB, Fore, maneB, etc.

f. Varieties: Bentgrasses are injured more seriously than the courser bluegrasses. The Creeping bentgrasses are generally more resistant than the Colonial bentgrasses.

5. Dollar Spot
a. Causal organism: Sclerotinia homoeocarpa

b. Symptoms: Round, brown or bleached spots about the size of a silver dollar. If disease left unchecked, the spots coalesce forming large, irregular, straw-colored, sunken areas in turf. When fungus is active and leaves are being killed, a fine, white cobwebby growth of mycelium may be observed in early morning while dew is still present. Spots may persist, if uncontrolled, for many months. Dollar spot lesions on individual leaves are characteristic; yellow green to brown blotches girdle the leaf with distinct reddish margins at upper and lower margins of lesions.

c. Occurrence: Affects most turfgrasses; most severe on bentgrasses. Disease symptoms may appear when soil temperature reaches a minimum of 60°F. Maximum injury occurs at about 80°F. Disease promoted by low soil moisture with sufficient surface moisture from dew fog, sprinkling, etc. Several strains of the fungus have been found.

d. Cultural control: During periods of high incidence of dollar spot, use high nitrogen fertility program and irrigation practices to hold soil near field capacity. Prune dense trees and shrubs to increase air circulation. Provide good surface drainage.

e. Chemical control: A preventive spray program is usually required for bentgrasses. Use Benlate (Tersan 1991), Acti-dione-thiram, Dyrene, Fore, Ortho Lawn and Turf Fungicide, etc.

f. Varieties: Most bentgrasses are susceptible. Most bluegrasses have more resistance than bentgrasses, but may be attacked.

6. Fusarium Blight
a. Causal organism: Fusarium roseum f. sp. cerealis, F. tricinctum f. sp. poae.
There appears to be some question as to how many species and strains of Fusarium are involved.
b. Symptoms: Disease symptoms are similar to dollar spot. Fusarium blight begins a scattered, circular light green patches 2 to 6 inches in diameter. The grass in the patches turns reddish brown, then tan and finally becomes straw colored. The patches increase in size to 1 to 3 ft. in diameter. The patches may coalesce causing irregular killed areas. Centers of the patches may remain green giving the characteristic "frog-eye" or doughnut symptom. Fusarium blight may produce individual leaf lesions similar to dollar spot, except Fusarium blight lesions are not bordered by the dark reddish-brown band found in dollar spot lesions.

c. Occurrence: Affects bentgrasses, bluegrasses and red fescue; most severe on Merion Kentucky bluegrass. Disease symptoms appear when temperatures are 90°F and above with corresponding high humidity. Disease is most severe when plants are under stress from drought or high temperature. Disease usually appears in sunny areas near sidewalks, driveways, etc., where temperatures and light intensities are highest.

d. Cultural control: Maintain growth with balanced fertilization and proper watering. Plants grown in low calcium imbalanced soil are more susceptible to Fusarium blight than in nutritionally balanced soils. Collect clippings if practical. Control thatch accumulation.

e. Chemical control: Since Fusarium blight is a relatively new disease, much research remains to be completed. Control measures have not been completely developed. To date Benlate (Tersan 1991) and Fore appear to offer the best control possibilities. Once disease becomes well developed, control is very difficult.

f. Varieties: Merion bluegrass appears to be the most susceptible variety. Other bluegrass varieties as well as bentgrass, fescue and ryegrass varieties may be susceptible but damage is not as severe as with Merion bluegrass. Warren's A-10 Kentucky Bluegrass has been reported to have some resistance.

7. Pythium Blight (Greasy Spot, Cottony Blight)


b. Symptoms: First seen as circular or irregular reddish-brown to light brown patches from ½ to 4 inches in diameter. Infected blades at border of patches are first dark, almost black, and have a "greasy" appearance. In early morning, diseased areas may be covered with a white, cottony growth of fungus mycelium. Patches may coalesce; often merging to form streaks. Disease may spread rapidly, killing large areas of turf grass.

c. Occurrence: Affects most turfgrasses; especially severe on bent grasses. Disease development favored by high temperatures (80 to 110°F) and high humidity. More severe on heavy, poorly drained soils and in areas of poor air circulation. Disease spread by mowing and flowing water.

e. Chemical control: Apply recommended chemicals 1 to 3 times weekly during hot, humid weather. Use Koban, Dexon, Dyrene-Dexon, Fore, etc.

f. Varieties: Bentgrasses most susceptible. Young plantings of bluegrass, ryegrass, etc. also may be susceptible.

8. Rust

a. Causal organism: *Puccinia* spp.; *Uromyces* spp.; *Puccinia graminis* f. sp. *agrostis* is probably the most important single species since it parasitizes Merion Kentucky bluegrass.

b. Symptoms: The first symptoms seen are light yellow flecks or individual leaves. A few days later yellow-orange; reddish-brown, or black powdery pustules develop on leaves or leaf sheaths. Infected leaves may yellow and die. Turf may be thinned, weakened and more susceptible to drought, winter injury and other diseases.

c. Occurrence: Affects most turf grasses. Disease symptoms appear during summer and early fall when plant growth is slowed.

d. Cultural control: Maintain plant growth during summer and early fall with proper fertilization and watering. Collect clippings if practical; this is especially important if disease appears. Cultural practices alone may not be sufficient to prevent an outbreak of rust on Merion Kentucky bluegrass.

e. Chemical control: Apply recommended chemicals at 7 to 10 day intervals when disease appears. Continue until the disease is controlled. Use acti-dione, acti-dione-thiram or zineb.

f. Varieties: Merion Kentucky bluegrass appears to be the most severely affected variety. Windsor bluegrass has some resistance.

9. Powdery Mildew

a. Causal organism: *Erysiphe graminis*

b. Symptoms: Leaves appear yellowish or chlorotic. White, grayish-white, or cream—colored powdery fungus growth appears on leaves. Heavily infected turf looks as if it were dusted with flour.

c. Occurrence: Affects all turf grasses. Most serious on new plantings. Disease symptoms appear in spring or fall when nights are cool and days are warm. May occur at any time in shaded or poorly drained areas.

d. Cultural control: Avoid overwatering or frequent late afternoon or evening sprinkling. Avoid overfertilization, especially with nitrogen. Mow at recommended height; rank growth produces an environment around leaves conducive to disease development. Provide good surface drainage. Prune dense trees and shrubs to reduce shade and improve air circulation.

e. Chemical control: If needed, apply recommended chemicals at 7 to 14 day intervals, use Karathane WD, acti-dione-thiram or wettable sulfur.

f. Varieties: All grasses are susceptible. Newport and Prato Kentucky bluegrasses have some resistance.
10. Stirpe Smut
   a. Causal organisms and Flag Smut: *Ustilago striiformis* and *Urocystis agropyri*
   
   b. Symptoms: These are two separate diseases with similar symptoms and control. Infected plants are first noticeable singly or in small patches. Infected plants are pale green to slightly yellowed and stunted. Individual leaf blades are curled and have linear black stripes running parallel with the veins. A black, soot-like dust is formed in the black stripes. The dust is actually the fruiting structures (teliospores) of the fungus. Affected turf may die out in patches during July and August.
   
   c. Occurrence: Affects most turfgrasses, but Merion Kentucky bluegrass is the most susceptible. Disease symptoms usually appear in the spring or fall when temperatures are around 70°F. Infected plants usually die in hot, dry weather. However in turf areas receiving extremely good care, infected plants may not die. For this reason, stripe smut appears to be more severe in the intensively cared for turf areas.
   
   d. Cultural control: Use resistant varieties. (Merion Kentucky bluegrass is most susceptible; some clones of common Kentucky bluegrass are highly resistant or immune to infection.)
   
   e. Chemical control: Treat affected areas in spring or fall with Benlate (Tersan 1991). It may be necessary to repeat treatments. Control of this disease with the systemic chemical benomyl (Benlate®) requires that the chemical be placed in the active root zone. Soil must be thoroughly wet for a depth of two to three inches or more at time of fungicide application. Apply fungicide, then before spray residue dries, drench chemical into soil with about 1/2 inch of water (300 to 400 gallons/1000 square feet).
   
   f. Varieties: The Kentucky Bluegrass varieties Fylking, Warrens A-20 and Sodco have been reported to have some resistance. Merion Kentucky bluegrass is highly susceptible. Windsor bluegrass is susceptible. Bentgrasses, fescue and ryegrasses are somewhat susceptible, but damage is rarely severe.

11. Fairy Rings, Mushrooms, Puffballs
   
   b. Symptoms: Fairy ring fungi produce a circular ring of fast-growing, dark green grass surrounding a ring of thin or dead grass. The rings may not always be complete forming an arc or horseshoe. Mushrooms appear in the dark green ring, usually in spring or fall. Mushrooms and puffballs, not fairy ring fungi, may appear in turf areas from time to time.
   
   c. Occurrence: May occur in any turf area. The fungi are soil inhabiting living on dead organic material. They are not pathogenic or the roots of grass plants, but produce disease-like symptoms through depletion of soil nutrients, the exudation of substances toxic to plants, or the formation of an impervious layer through which sufficient water can not penetrate.
d. Cultural control: Pump large amounts of water into the darkgreen and dead rings with a lance or root feeder. Water should be placed 16 to 24 inches deep. Maintain proper fertilization. Before planting new turf area, remove large roots, stumps, construction lumber and other large pieces of organic matter. When mushrooms appear consistently year after year in one location, usually a large stump, root or other organic matter may be found buried beneath the turf. Often, mushrooms will disappear if these objects are removed. Fairy rings fungi, on the other hand, had there inception in buried organic material, but continue on outward yearly spread from the central starting point and can not be controlled by removing the buried organic debris.

e. Chemical control: There are no good chemical control measures for fairy ring or other mushroom producing fungi. Before planting, soil may be sterilized with methyl bromide, chloropicrin or formaldehyde. Sod also may be removed and soil sterilized with one of the above chemicals.

f. Varieties: No varietal differences. May affect all turfgrasses.

12. Slime Molds
a. Causal organism: *Mucilago spongiosa*, *Physarum cinereum*, etc.

b. Symptoms: Small white, grey, yellow or brownish heaped, slimy masses grow over the grass in round or irregular patches. The slimy masses dry to produce powdery, bluish-grey, gray, black or white masses that easily rub free from the grass blades.

c. Occurrence: May occur anywhere, appearing mainly in the spring during cool wet periods; may appear any time if sufficient moisture. Slime molds are not parasitic on living plants. They are soil-inhabiting fungi which feed on decaying organic matter in the soil. In humid or wet weather the slime molds grow out of the soil onto whatever is available for support and produce spores.

d. Cultural control: If left alone, slime molds soon disappear. If unsightly, hose down or rake to spread out spore masses.

e. Chemical control: None necessary since slime molds cause damage only through the shading of leaves; cultural control measures given above are sufficient.

f. Varieties: No varietal differences.

13. Nematodes

b. Symptoms: Turf declines, lacks vigor and does not respond normally to water and fertilizer. Turf often appears stunted and yellowed with dead and dying areas. Injury easily confused with fertilizer burn, soil deficiency, poor soil aeration, drought, compaction, insect damage. Parasitic nematodes can be identified only by taking plugs of suspected turf to a competent nematologist for analysis.
c. Occurrence: Nematode damage may occur on most turfgrasses at any time of the growing season.

d. Cultural control: Maintaining steady growth with proper fertilization and watering.

e. Chemical control: After definite diagnosis of nematode problem, apply recommended chemicals according to manufacturer's directions. Use Nemagon EC-2, Fumazone 70-E, VC-13, Diazinon, Zinophos or Sarolex.

14. Chlorosis, yellowing
a. Not an infectious disease. Usually associated with highly acid or alkaline soils. Caused by nutrient deficiency such as iron, magnesium, manganese, etc.

b. Symptoms: Turf areas become yellow-green or yellow and stunted in irregular patches. Individual leaves chlorotic; tissues near veins usually greener than interveinal tissues.

c. Occurrence: May affect any turfgrass at any time of the growing season.

d. Cultural control: Have soil tested for pH. Follow directions in report. Lime will be required for acid soils; sulfur, ammonium sulfate or other acid-forming fertilizers for alkaline soils. Optimum pH for most turfgrasses is 6.0-7.0.

15. General Recommendations
a. Use fungicides and other pesticides properly. Read and follow manufacturer's directions. Observe all safety precautions listed by manufacturer.

b. Use a wetting agent (surfactant) to reduce surface tension of spray in order to obtain uniform coverage of chemical. Some wetting agents are: Triton B-1956, Surfactant WK, DuPont Spreader-Sticker, etc. Do not use household detergents, unless there is no possible chance for a chemical reaction to occur.

c. Do not use less than 5 gallons of spray per 1000 sq. ft. to control foliar disease such as powdery mildew and rust and not less than 10 gallons to control other disease.

d. Do not allow children or pets on sprayed areas until the spray has completely dried or has been watered in.