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Turfgrass Disease Management[1]

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Introduction

Turfgrass diseases are difficult to understand because the biological organisms (plant pathogens) causing the problems are rarely observed. Fortunately, grasses maintained using proper cultural practices (water, mowing, fertility) are not as likely to become diseased or be as severely damaged as grasses not receiving proper care. The following section discusses turfgrass diseases, their causal agents, diagnosis and management.

What is a disease?

Observing spots and patches of yellow or brown turfgrass does not automatically mean the turfgrass has a disease. While turfgrass injuries or disorders may look like diseases, they are not diseases and should be treated differently. Because diseases are difficult to diagnose, it is often faster to rule out involvement of *other* factors than to verify the presence of disease. Diseases are the exception and not the rule for most turfgrass plantings. By determining if other factors are causing the turf to look sick, you will solve the problem more quickly and avoid applying unnecessary fungicides.

An **injury** to turfgrass is a destructive physical occurrence such as pesticide damage (Plate 1), mowing the grass too short (Plate 2) or a fuel leak. A turfgrass **disorder** is an interaction between the plant and its environment that is usually associated with imbalances of physical or chemical requirements for turfgrass growth. Examples would be nutritional deficiencies, cold stress, drought (Plate 3) or excessive rainfall. Again, while these problems may appear to be diseases, there are no pathogens involved. However, these injuries or disorders may weaken the turf so much that a pathogen may attack the plants and cause a disease.

Plate 1. Damage from an excessive rate of herbicide - no disease.

1. This document is SS-PLP-14, a series of the Plant Pathology Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. This information is included in the Florida Lawn Handbook, SP-45. For a copy of this handbook, request information on its purchase at your county extension office. First published: July 1991. Revised: April 2001.
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Plate 2. St. Augustinegrass mowed too short, resulting in 'scalped' turfgrass - no disease.

Plate 3. Dry 'patches' in St. Augustinegrass - no disease.

A **disease** is an interaction between the plant and a pathogen that disrupts the normal growth and appearance of the plant. It consists of three components: host, pathogen and the conducive environment in which the host and pathogen interact. The environment is the key factor for disease development since the turfgrass host and turfgrass pathogens are naturally always present. While diseases may affect turfgrasses all year, individual turf diseases are active for only a few months each year, usually due to weather patterns and the resulting environmental effects. However, any stress (environmental or man-made) placed on turf will weaken the turf, and thus make it more susceptible to disease development.

Except for one disease caused by a virus, turfgrass diseases in Florida are caused by fungi. Examples of fungi in your daily life include the molds in the bathroom or refrigerator, the green stuff on an old orange or bread, and the mushrooms you eat. Unlike plants, fungi are unable to produce their own energy and must rely on living or dead hosts for energy and growth. Most fungi living in the turfgrass environment are totally harmless, using only dead organic matter (such as thatch) for growth. A very limited number of fungi, at some point in their life cycle, cause plant diseases by infecting living plants.

It is important to know that when a fungal pathogen is not actively attacking the plant, it has not disappeared from the turfgrass area. It is simply surviving in the environment in a state of dormancy (like a bear in hibernation) or as a saprophyte (non-pathogenic phase) living off dead organic matter in the thatch and soil layers.

The one viral disease, centipedegrass mosaic or St. Augustinegrass decline, in not observed very frequently in Florida. The St. Augustinegrass cultivars commonly used are resistant to the virus. In centipedegrass, the virus alone does not cause decline and death, but it does add another stress factor to the turfgrass.

Disease process

There are many steps in the disease process, and all are dependent on environmental conditions. The first step is inoculation, when the pathogen comes in contact with the susceptible plant. For turfgrass, this is always occurring. It is the next steps that will determine if a disease will develop. In the second step, the pathogen must actually enter the plant. This is called infection. Fungi can enter a plant via wounds (cut leaf blades), natural openings (stomates), or they can penetrate directly using a number of different mechanisms. Just because a fungus enters/infects a plant does not mean a disease automatically develops. In the next step, the pathogen must become established inside the host. It is at this point that the pathogen will start to disrupt the normal growth of the plant or affect the appearance of the plant. Depending on the pathogen, it may then reproduce (example: produce spores). These reproductive structures or other parts of a pathogen may then spread to other turfgrass plants. A disease epidemic means that large populations of turfgrass plants are affected by the pathogen.

Disease monitoring techniques and symptoms

Unlike insects or weeds, it is not possible to monitor the number of turfgrass pathogens present in a given area. Instead, one monitors disease symptoms (if already present), the weather, and the stress factors affecting the turfgrass. It is critical to document active disease sites, as many disease outbreaks will occur in the same location each year. Use these records to determine why the disease is occurring in those locations (shade, fertility, soil type), to help predict disease outbreaks, and to design effective management strategies.

There are two common patterns of turfgrass disease symptoms. One is a circular patch of turfgrass, either small or large, that is no longer uniformly green. The second is turf that has 'spots' on the leaves. For disease patches, examine the leaves and roots in these patches for characteristic symptoms of a disease and signs (actual fungal structures) of the pathogen. (See key and description of individual diseases that follows.) The best time to observe fungal mycelia is in the early morning when dew is still present. Early afternoon is a good time to look for localized patches of wilt or drought symptoms that may indicate root or crown diseases. For turf with spots, note the color and shape of the spots.

Monitoring the weather will help with disease prediction and with determining the necessity of fungicide applications. If the disease affected areas are small and the weather is not conducive for an epidemic, then a fungicide may not be necessary or only spot applications will be required. However, if the long-term weather forecast is conducive for disease development of a disease that routinely occurs in your area in specific landscapes, then a fungicide may be useful to prevent a disease outbreak. Also take note of the location in the landscape where the disease occurs, especially if it occurs more than once in a year or recurs each year. The disease may be occurring in areas affected by a microclimate created by man.

Disease control is not simple or easy!

Since it is usually not practical or desirable to eliminate the turfgrass host, disease control recommendations are aimed at: 1) altering the environment so it is less favorable for disease development, 2) suppressing growth of the pathogen, and 3) decreasing stress on turfgrass. An integrated management program that includes cultural and chemical methods is the key to preventing and controlling turfgrass diseases.

There are three steps to disease management. First, correctly identify the disease. Second, identify the conditions promoting infection and disease development. Third, identify the management techniques that will alter or eliminate these conducive conditions.

For landscape maintenance companies and pest control companies, the primary obstacle they may face is lack of control over **all** the management practices. For example, the homeowner may control the irrigation system. One company does the mowing. Another company or the homeowner applies the fertilizer. Then, if necessary, another company applies the pesticides. Better coordination and communication among **all** the people involved with maintenance is required to insure healthy turfgrass.

Cultural Control Practices

Cultural practices should promote an environment that is <u>not</u> conducive for pathogen infection and disease development. We realize you cannot change weather patterns (the overall environment), but you can change localized environments. Water-saturated soils due to excessive irrigation are a local environmental condition created by humans. The north side of the house is cooler and receives less sun than the south side. A big oak or ficus tree creates a local environment that is much different than under a palm tree or in an area with no trees. **Remember that *every* maintenance practice, fertilizer application and chemical application has an impact on turfgrass health.**

If a disease should affect turfgrass, cultural practices should be implemented first or at the same time that fungicides are applied. If a particular home lawn, recreational site, or commercial landscape has a history of developing a particular disease at a particular time of year, then it makes sense to implement cultural practices to <u>prevent</u> this yearly reoccurrence. Before you say to yourself that "this is easy to say but difficult to put into practice" - THINK! Habits are hard to break. Why do you implement a certain maintenance practice? Because that is the way you have always done it? Is that a good reason? If changing a practice will prevent problems later, then maybe it is reasonable to change that practice.

If you are a landscape maintenance professional, explain to the landscape owner your reasons for altering a practice. Provide them with records indicating disease outbreaks, cost of fungicide applications, turf replacement, etc. Explain the potential benefits for altering a maintenance practice in both economical and ecological terms.

The cultural practices discussed below are all designed to alter the turfgrass environment to prevent diseases or at least lessen their severity. For more specific details on each topic, see the relevant chapters in the *Florida Lawn Handbook*.

Turfgrass selections

The selection of turfgrass species (St. Augustinegrass, centipedegrass, bahiagrass, etc.) and cultivars within that species (example: `Floratam vs. `Raleigh St. Augustinegrass) should be based on your location, and how the turf will be used and maintained. Selections that are not suited for a particular area will be continually stressed, more susceptible to diseases (and other pests) and require increased maintenance costs in terms of labor and pesticides. For example, it is difficult to grow St. Augustinegrass without supplemental irrigation. Centipedegrass should be grown on soils with low pH (below 6). Check with your county extension office for local recommendations.

Mowing practices

Mowing is the most common turf maintenance operation, and the most damaging when done improperly. Mowers must be sharp so they cut rather than tear the turf leaves. Turfgrasses that are cut below their optimum height will become stressed and more susceptible to diseases, especially root rots. This is especially true during periods of low light intensity (cloudy days) or in shaded areas. Be sure to mow as frequently as necessary so that *no more* than one third of the leaf is being removed at any one time. The actual recommended turf height depends on the turfgrass species being grown. It is especially important not to mow St. Augustinegrass too short, as the growing point of this grass is aboveground.

When <u>any</u> disease occurs, raise the cutting height! A low height of cut reduces the leaf tissue necessary for photosynthesis, the process by which the plant produces energy for growth. An active disease eventually reduces the leaf canopy and photosynthesis is reduced even further. Raising the height of cut increases the green plant tissue available for photosynthesis resulting in more energy for turfgrass growth, and the subsequent recovery from the disease.

Mulching mowers do not increase diseases. However, if a turfgrass area has an active leaf disease, this area should be mowed *last* to prevent the spread of the disease. Likewise, wash the mower with water after mowing the diseased area to remove diseased leaf clippings. Put the clippings collected from diseased areas or washed from the mower into a compost.

Water management

While irrigation is essential to prevent drought damage during the dry season, the amount of water and the timing of its application can prevent or contribute to disease development. Most fungal pathogens that cause <u>leaf</u> diseases require free water on the leaf or very high humidity to initiate the infection process.

Dew (more importantly, the length of the dew period) is a critical factor for leaf disease development. Dew is dependent on temperature and humidity. Extending the length of the dew (free water) period by irrigating in the evening before dew forms or in the morning after the dew evaporates extends the dew period. Therefore, irrigate when dew is already present, usually in the pre-dawn hours. A good time range is between 2 and 8 AM. In addition, this will dilute or remove the guttation fluid (fluid being forced out of the leaf tips by internal plant pressure) that can accumulate at the cut leaf tip and may provide a food source for some pathogens.

Irrigate only when drought stress (curled leaf blades) is observed, and then apply enough water to saturate the root zone of the turfgrass. Make sure the irrigation system is applying the water uniformly across the area. Irrigating everyday for a few minutes is not beneficial for the turfgrass because it does not provide enough water to the root zone, but it *is* beneficial for the turfgrass pathogens.

Nutrition management

Many diseases are also influenced by the nutritional status of the grass, especially nitrogen. A perfect balance is the goal. Both excessively high and low nitrogen fertility contributes to turfgrass diseases. Excessive nitrogen applications encourage Brown Patch and Gray Leaf Spot diseases, whereas very low nitrogen levels encourage Dollar Spot disease. Remember, it is easy to add nitrogen but impossible to remove it. Therefore, apply the minimal amount of nitrogen required for your particular turfgrass type.

Potassium (K) seems to be an important component in the prevention of diseases, perhaps because it prevents plant stress. Again, a non-stressed plant is not as susceptible to diseases. This has probably best been documented with 'Helminthosporium' diseases. To maintain healthy turfgrass, the amount of elemental potassium applied should either be the same or greater than the amount of nitrogen applied. In an area prone to disease, it may be beneficial to increase the potassium level applied. It is important to remember that potassium will leach just as readily as nitrogen. The use of both slow-release nitrogen and potassium sources is highly encouraged. If it is not possible to obtain slow-release potassium, then apply smaller amounts of quick-release potassium, but more frequently. This would be especially useful during the rainy season.

Even micronutrient deficiencies may play a role in disease development, as is the case with take-all root rot. Also, you can use micronutrients, specifically iron sulfate and manganese sulfate applied as a foliar spray, to keep the turfgrass green rather than applying nitrogen.

When turfgrass roots are damaged or not functioning properly from diseases, nematodes or water-saturated soils, it would be beneficial to apply nutrients foliarly (liquid nutrient solution sprayed on the leaf tissue). Damaged roots will have a difficult time absorbing nutrients from the soil. Frequent applications of small amounts of nutrients to the leaves will help to keep the plant alive until new roots are produced.

Thatch management

Thatch is the tightly bound layer of living and dead stems and roots that develops between the zone of green vegetation and the soil surface. It is a natural component of turfgrass. When an excessive thatch accumulation occurs, it means plant tissue is being produced more quickly than it is being decomposed. Thatch is decomposed by bacteria, fungi, earthworms and other organisms that naturally live in the soil.

Factors that prevent or slow down decomposition are excessively wet or dry conditions, very high or low thatch pH, inadequate or excessive nitrogen levels and repeated use of chemical pesticides that may reduce the level of organisms responsible for decomposition. These factors may also be conducive for disease development. Physical removal is the best way to eliminate excessive thatch. To prevent excessive thatch from occurring again, review your maintenance practices. Are you applying too much nitrogen? Are you applying too much water when you irrigate? Or not enough? Correct those practices that may be promoting excess thatch development.

Soil physical and chemical status

Compacted soils will prevent proper drainage resulting in areas that remain excessively wet. Once they dry out completely, they are often difficult to rewet. Turfgrass in these areas may have root systems that are deprived of oxygen resulting in a weak plant. This is also an ideal situation for root rots to develop. High soil pH may affect nutrient uptake and weaken the plant. High salt concentrations will impact turfgrass health resulting in a plant more susceptible to diseases.

If you have areas in the lawn or landscape that appear to dry out first or are the first to appear sick, use a metal rod to be sure that there is nothing buried at that location. It is not uncommon to find building materials buried in the landscape. If you have an area that is water logged for long periods, build that area up and make it level with the rest of the lawn.

Chemical Control Practices

What is a fungicide?

Fungicide is the name for a pesticide used to manage fungal diseases. Fungicides suppress or slow down fungal growth or prevent the fungus from reproducing. They do not eliminate or kill the pathogens in the turfgrass area. Most fungicides are active against a limited group of fungi. This is why it is important to know which pathogen you need to control.

Fungicides do not promote the growth of the turfgrass. The only way healthy turfgrass will reappear is when new growth occurs. For example: A leaf spot will remain on the leaf, even after a fungicide is applied. This diseased leaf area will remain until it is removed by mowing, and new leaf tissue replaces it. Since many of the turfgrass diseases to be described later occur when the grass is not growing actively, complete recovery may be very slow. You may think you are seeing no response to the fungicide application when in fact the fungicide has been effective against the fungal target. It is simply that the turfgrass has not grown enough to replace the diseased tissue.

When to use a fungicide

Fungicides should be used only during those time periods that are conducive for disease development. It is acceptable to use fungicides on a preventive basis (prior to disease development) as long as you really understand what diseases/pathogens you are protecting the grass from at any given time of the year. For example: Why apply a fungicide to protect against Pythium Blight on St. Augustinegrass when this an extremely rare disease on warm-season turfgrasses? Why apply a fungicide to prevent take-all root rot when you have never observed this problem in the landscape that you manage?

Only use fungicides when absolutely necessary as overuse has the potential to increase or shift the disease spectrum on turfgrasses or lead to development of fungicide-resistant strains of pathogens. Just because one site has a disease does not mean that disease will occur on the lawn next door as the management techniques or turfgrass cultivar may be different. Remember that the primary factor for turfgrass disease development in Florida is the environment, not just the overall environment, but the microenvironment created by placement of the buildings in your landscape site or your management practices. In fact, each side of the house may have its own microenvironment as influenced by trees, other buildings, lakes, etc.

When you do use a fungicide, read the label and follow the directions regarding rates, the amount of water needed to apply the product effectively, irrigation requirements, as well as safety instructions for mixing, applying and storing the product. Almost all pesticide 'failures' are due to misapplication, including misidentification of the problem! Don't waste your money, become a safety risk, or pollute the environment by using a product incorrectly.

Think about fungicide applications relative to other maintenance practices. Unless the clippings are returned to the turfgrass, do not mow for at least 24 hours and preferably longer. The fungicide is probably on the leaf. If you mow and collect the clippings, you have also collected the fungicide. Unless the product is supposed to be irrigated into the soil, do not irrigate for at least 24 hours after a fungicide application. Ideally, the turf area should be mowed and irrigated prior to a fungicide application to allow a maximum time interval between fungicide application and the next turfgrass maintenance operation.

Fungicide categories

Turfgrass fungicides can be divided into four broad categories based on the location of their activity: 1) contact fungicides, 2) systemic fungicides, 3) local-penetrant fungicides, and 4) mesostemic fungicides. They can also be divided into very small groups based on chemical properties.

Contact fungicides

Contact fungicides are generally applied to the leaf and stem surfaces of turfgrasses. They are considered protective or preventive fungicides. They inhibit the fungi on the plant surface so the fungus will not be able to enter/infect the plant. These fungicides remain on the plant surface and do not penetrate into the plant. They remain active only as long as the fungicide remains on the plant surface in sufficient concentration to inhibit fungal growth, usually 7 to 14 days. Leaves that emerge after the fungicide has been applied will not be protected. Any fungus already in the plant will not be affected. To obtain optimum protection, it is important that contact fungicides evenly coat the entire leaf surface and are allowed to dry completely before irrigating or mowing.

Contact fungicides are normally used to control foliar diseases and not root diseases. The exceptions would be those used to control Pythium root rot (chloroneb and ethazol). Contact fungicides have a broad spectrum of disease control activity and have been used extensively in the turf industry for a number of years. However, recent changes in labeling have occurred. Mancozeb can only be applied by a professional pesticide applicator. Chlorothalonil can no longer be applied to the turfgrass in residential landscapes (single-family homes, condominiums and apartment complexes). It can be applied to the turfgrass of commercial landscapes and to the ornamentals in a residential landscape.

Systemic Fungicides

Systemic fungicides are chemicals that do penetrate plant surfaces and are then translocated (moved) within the plant vascular system, either in the xylem or phloem tissue. Except for fosetyl-Al (Aliette) which is translocated in xylem and phloem (primarily phloem) tissue, systemic fungicides are xylem-limited.

In general, systemic fungicides have curative and protective activities with extended residual activity. Because systemic fungicides are absorbed by the plants, they work inside the plant to: a) control pathogenic fungi which have already entered the plant and initiated a disease (curative action), and b) inhibit fungi that enter the plant from initiating a disease (preventive action). Their residual activity is also due to the fact that the plant absorbs them. Once a systemic fungicide is inside the plant, it will not be removed by water or degraded by sunlight. Newly emerged plant tissue may contain sufficient concentrations of the fungicide to protect them from fungal infection. Therefore, systemic fungicides do not need to be applied as often as contact fungicides; usually 21-30 day intervals are adequate.

Systemic fungicides usually have a very specific mode of action and do not have as broad a spectrum of disease control as contact fungicides. However, they will control both foliar and root pathogens. When attempting to control root diseases, systemic fungicides should be watered into the root zone for maximum effectiveness. As indicted above, the majority of systemic fungicides are xylem-limited. If the fungicides are only applied to the leaf tissue, the compounds may never reach their root target in the amount needed for control.

Local-penetrant fungicides

Local-penetrant fungicides are capable of penetrating the plant surface, but they only move very short distances within the plant and do not enter the xylem or phloem tissue. The majority of the fungicide applied remains on or near the plant surface. Included in this group of fungicides are iprodione and vinclozolin. These fungicides are considered protective/preventive type fungicides. The discussion on contact fungicides applies to this group of fungicides also.

Mesostemic fungicides

Mesostemic fungicides are a new group of fungicides that includes trifloxystrobin (Compass). This fungicide is strongly attracted to the plant surface and is absorbed by the waxy plant layers. It appears to continuously penetrate the leaf surface. However, it is not translocated in the plant vascular system (xylem or phloem), and so is not truly systemic. The fungicide is able to redistribute itself on the plant surface via localized vapor movement and surface moisture. This fungicide works best as a preventive fungicide. Because the fungicide is not directly exposed to weathering factors, reapplication intervals will be 14-21 days.

Chemical names and classes

Each fungicide has three different names. It will have only one chemical name (a long technical name based on its chemistry), and only one common name (a simpler one-word name). This fungicide can have multiple trade or brand names. Fungicides are also divided into chemical classes based on their chemical properties and activities. Table 1 lists fungicides based on chemical class and provides the common names of turfgrass fungicides and a trade name example. Table 2 lists the common fungicide names and their corresponding chemical name.

To prevent fungicide resistance from developing in a pathogen population, it is important to know which fungicides belong to the same chemical class. Fungicides in the same chemical class will have the same mode of action. Fungicides should be periodically alternated or used in mixtures with fungicides belonging to different chemical classes to prevent fungicide resistance. For example, alternating between Bayleton (triadimefon) and Banner MAXX (propiconazole) does not mean you have alternated between chemical classes because both fungicides belong to the same chemical class, the demethylation inhibitors.

Read labels!

You would not or should not give a family member any medication without following the instructions on the label. Turfgrass pesticides deserve the same amount of respect. In addition to rates and intervals for application, labels provide information concerning the use or non-use of additives (such as surfactants) with the material, compatibility with other pesticides or fertilizers, amount of water to use in the application process, irrigation needs, posting or re-entry restrictions, and more. Keep up to date with the labels. Every time you obtain a new batch of pesticide, read the label. You should especially pay attention to where the pesticide can be legally used, the total amount of product that can be applied in a year, and the restricted entry interval. Remember, **labels are the law**; they are considered legal documents!

Except for chemicals used to buffer the water pH, do NOT add any additive (example: surfactants) to a fungicide unless the label specifically states this is acceptable. The majority of fungicides already have a surfactant as part of the fungicide formulation. NEVER mix fertilizer solutions with fungicides, especially fungicides that contain metals (examples: mancozeb, fosetyl-Al, chlorothalonil with zinc) without determining compatibility. It has taken years of research to produce the fungicides currently on the market. Please take advantage of that knowledge by reading the label and asking questions of university and chemical company researchers.

Biological Control Practices

Microorganisms naturally present in the turfgrass ecosystem will help reduce disease potential or disease damage, but only if they are allowed to flourish. They accomplish these tasks by: a) competing with the pathogens for food sources, b) producing chemicals that inhibit the growth of the pathogens, or c) physically excluding the pathogens from the plant by occupying the space first. Therefore, it is just as critical to keep the soil microbial population healthy as it is the turfgrass. Reducing pesticide use is one way this may be accomplished. Although many products (sugars, enzymes, carbohydrates, etc.) are being sold that claim to increase natural microbial populations, there is no documentation that this does occur in home lawns or landscapes in Florida.

Microorganisms not naturally present in your turfgrass environment can be introduced in an attempt to control diseases. This can be done by applying organic materials that have natural microbial populations (composts) or have had microbial populations added to them (natural organic fertilizers with microbial supplements). In both cases, the products must be applied prior to disease development as they work preventively and not curatively. Again, there is no documentation that these products consistently prevent diseases. Natural organic fertilizers should be used for their nutrient value (nitrogen and potassium) and not for any possible secondary effects.

There are many products composed of living organisms, primarily bacteria and fungi, being sold that claim they will increase turfgrass health. However, for any material to be considered a biological fungicide or microbial biopesticide, the

U.S. Environmental Protection Agency (EPA) must register it. EPA registration indicates that the safety of the product to humans, non-humans (fish for example) and the environment has been determined. Materials that have not been approved by EPA should be used with caution. Many naturally occurring bacteria and fungi are also secondary human pathogens, especially for people with weak immune systems. As part of the natural ecosystem, they will cause few problems. However, when concentrated formulations of these organisms are applied through a pesticide sprayer to create aerosols, caution should be exercised. Also, many of these products have not been evaluated using proper experimental protocols.

Useful References for Turfgrass Diseases

- ***Compendium of Turfgrass Diseases***, Second Edition by R. W. Smiley, P. H. Dernoeden, B.B. Clarke, 1993. Available from: APS Press, 3340 Pilot Knob Road, St. Paul, MN 55121 Phone: 1-800-328-7560(continental U.S.) or 612-454-7250 Fax: 612-454-0766. This item is also available in an expanded form for your computer. ***Turfgrass Diseases: Diagnosis and Management CD-ROM*** by G. L. Schumann and J. D. MacDonald. Available from APS Press (see above).

- ***Diseases of Turfgrasses*** by H. B. Couch, 1995. Available from: Krieger Publishing Co., P.O. Box 9542, Melbourne, FL 32902-9542 Phone: 407-724-9542

- ***Management of Turfgrass Diseases*** by J. Vargas, 1994. Available from: Lewis Publishers, 2000 Corporate Blvd. NW, Boca Raton, FL 33431 Phone: 1-800-272-7737

- ***Color Atlas of Turfgrass Diseases*** by T. Tani and J. B. Beard, 1997. Available from: Ann Arbor Press, Inc. 121 South Main St., Chelsea, MI 48118 Phone: 313-475-8787

Table 1. Turfgrass fungicides listed by chemical class.

Chemical Class	Location of Activity	Common Name	Trade Name Example
Acetanilide	Systemic; xylem-limited	Mefenoxam	Subdue MAXX
Aromatic Hydrocarbon	Contact	Chloroneb Etridiazole (also Ethazole) Quintozene (also PCNB)	Terraneb Koban, Terrazole Terraclor
Benzamide	Systemic; xylem-limited	Flutolanil	ProStar
Benzimidazole	Systemic; xylem-limited	Thiophanate methyl	Fungo, Cleary 3336
Benzonitrile	Contact	Chlorothalonil[1]	Daconil
Carbamate	Systemic; xylem-limited	Propamocarb	Banol
Demethylation Inhibitor (DMI, Triazole, Sterol Inhibitor)	Systemic; xylem-limited	Myclobutanil Propiconazole Triadimefon	Eagle Banner MAXX Bayleton
Dicarboximide	Local-penetrant	Iprodione Vinclozolin[1]	Chipco 26019 Curalan
Dithiocarbamate	Contact	Mancozeb[2] Thiram[1]	Dithane T/O Spotrete
Ethyl Phosphonate	Systemic; primarily phloem	Fosetyl-Al	Aliette
Strobilurin B-methyoxyacrylate Oximinoacetate	 Systemic; xylem-limited Mesostemic	 Azosystrobin Trifloxystrobin	 Heritage Compass

[1]Chlorothalonil, thiram, and vinclozolin cannot be applied to residential lawns (single-family homes, condominiums and apartment complexes). They can be applied to turfgrass in business and industrial landscapes.
[2]Mancozeb can be applied to residential lawns only by a professional pesticide applicator.

Table 2. Common name and chemical name of turfgrass fungicides.

Common Name	Chemical Name
Azoxystrobin	methyl (E)-2-{2-[6-(2-cyanophenoxy)pyrimidin-4-yloxy]phenyl}-3-methoxyacrylate
Chloroneb	1,4-dichloro-2,5-dimethoxybenzene
Chlorothalonil	tetrachloroisophthalonitrile
Etridiazole (Ethazol)	5-ethoxy-3-trichloromethyl-1,2,4-thiadiazole
Flutolanil	N-[3-(1-methylethoxy)phenyl]-2-(trifluoromethyl) benzamide
Fosetyl-Al	aluminum tris (O-ethyl phosphonate)
Iprodione	3-(3,5-dichlorophenyl)-N-(1-methylethyl)-2,4-dioxo-1-imidazolidinecarboxamide
Mancozeb	coordination product of zinc ion and manganese ethylenebisdithiocarbamate
Mefenoxam	(R)-2-[2,6-dimethylphenyl)methoxyacetylamino]-propionic acid methyl ester
Myclobutanil	a-butyl-a-(chlorophenyl)-1*H*-1,2,4-triazole-1-propanenitrile

Table 2. Common name and chemical name of turfgrass fungicides.

Common Name	Chemical Name
Propamocarb	propyl [3-(dimethylamino)propyl] carbamate monohydrochloride
Propiconazole	1-{[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl}-1*H*-1,2,4-triazole
Quintozene (PCNB)	pentachloronitrobenzene (PCNB)
Thiram	tetramethylthiuram disulfide
Thiophanate methyl	dimethyl 4,4'-o-phenylenebis[3-thioallophanate]
Triadmefon	1-(4-chlorophenoxy)-3,3-dimethyl-1-(1H-1,2,4-triazol-1-yl)-2-butanone
Trifloxystrobin	(E,E)-methoxyimino-{2-[1-(3-trifluoromethyl-phenyl)-ethylideneaminooxymethyl]-phenyl}-acetic acid
Vinclozolin	3-(3,5-dichlorophenyl)-5-ethenyl-5-methyl-2,4-oxazolidinedione