

DISEASES AND DISORDERS

Landscape and turf plant damage can result from many causes such as insect feeding, equipment injury, heavy use, growth disorders and infection by disease organisms. Growth disorders occur when plants are grown with incorrect amounts of water, nutrients, or light. Temperature extremes can also cause growth disorders.

Plant diseases caused by pathogens are called infectious diseases. These diseases can be hard to diagnose and treat. They are caused by organisms that are too small to see with the naked eye. Microorganisms that infect plants are called plant pathogens. Pathogens include fungi, bacteria, viruses, and nematodes. When they infect a plant, they change the way in which it functions. They can kill or stunt the plant. A disease is passed from plant to plant as the pathogen multiplies and spreads.

Plant diseases and disorders are both common in turf and landscape plants. Distinguishing between plant diseases, disorders and other forms of damage is the first step in developing an IPM program. When faced with plant damage, it is often easiest to rule out insect feeding and environmental causes first.

To plan an IPM program for plant disease organisms (pathogens), you must know their life cycle and biology. It is also important to know the type of treatments that are available and how they work. The following section provides information on:

- Plant disorders
- The biology of plant pathogens
- The treatments that can be used for plant disease

The final section outlines a sample IPM program to manage pink snow mold on turf.

Learning Objectives

Completing this chapter will help you to:

- **Know common diseases. Know how to manage them using IPM.**
- **Know the types of fungicides. Give an example of each.**
- **Know what affects the effectiveness of fungicides.**

Disorders

A variety of environmental conditions can cause plant disorders. Poor environmental conditions stress plants and cause abnormal growth or disease-like symptoms.

The cause of plant symptoms must be identified in order to choose a proper treatment. Treat plant disorders by changing the conditions that caused the damage (if possible).

Conditions that cause plant disorders include:

- Air pollutants
- Toxic chemicals (including road salt)
- Pet urine
- Temperature extremes (hot and cold) or wind
- Lack of light, water or soil nutrients
- People pressures (heavy use, soil compaction)
- Damage by equipment (e.g., string trimmer damage to trees, mower damage to golf greens)

Knowing recent weather conditions can help in identifying whether plant damage is caused by environmental factors or a pathogen. It is important to identify and correct the conditions that cause disorders.

Diseases

Plant disease is often caused by a combination of environmental conditions and pests. Plants already weakened by environmental stress are more likely to be attacked by pathogens or insects. For example, wood boring insects often attack weakened trees. Stressed plants sustain more damage and heal more slowly from any type of damage. Removing the source of the stress improves plant appearance in landscapes. It also helps them to resist pest attacks.

Fungi, bacteria, and viruses are microorganisms that can cause plant disease. Nematodes (microscopic worms) that damage plants are also covered in this section. There are also many beneficial microorganisms. Some beneficial fungi, bacteria, and actinomycetes (soil organisms that are similar to fungi and bacteria) help plants resist disease. Others attack pathogens and nematodes that cause disease.

Fungi

Fungi are the largest group of organisms that cause plant disease. These include the molds, rusts and mushrooms. Fungi do not have chlorophyll. They obtain nutrients by breaking down other materials or organisms.

- Saprophytic fungi feed on dead or dying plants. The majority of species in this group of fungi are beneficial decomposers
- Parasitic fungi feed on living plants. Species in this group can cause disease in desirable plants.

Life Cycles of Fungi

Most pathogenic (disease-causing) fungi grow and reproduce on one host plant. Some require a second host plant to complete the life cycle (e.g., many species of rusts). Cedar apple rust passes between cedar and apple trees to complete its life cycle.

The life cycles of most fungi starts with an over-wintering spore. These spores are often found in the soil or on diseased leaves and in leaf litter on the soil surface. Spores are carried to new host plants on equipment, or by irrigation water or rain. If the temperature, moisture, and host plant are suited for fungal growth, the spores can germinate and infect the plant.

Spores can die if environmental conditions do not support germination (e.g., too hot or cold, very dry). They can also be washed off plants before they germinate. Some spores can remain dormant until conditions improve.

When conditions are right and a spore lands on the leaf, it germinates and sends out **hyphae** (fine strands of fungus). The infection begins when the hyphae enter plant tissue and grow within the plant. The fungi grow and produce the next generation of spores. The spores are released and carried to other plants by wind, rain, or splashing water. Some can be carried on the feet of birds moving between trees (e.g., black knot on cherry). Spores or tiny fungal pieces can be spread by moving infected plants, plant parts, tools, machines, humans, animals, and soil. Fungal diseases are managed through the use of preventative practices, sanitation (removal of diseased plants or plant parts) and the use of fungicides.

Bacteria

Bacteria are single-celled microorganisms. Plant pathogenic bacteria often enter plants through natural openings or wounds. Major bacterial plant diseases include leaf blights, wilts, leaf spots, galls, and root rots.

Bacteria reproduce quickly under the right conditions. The plant is used as a food source. Reproduction is affected by temperature and humidity. Bacteria are spread by:

- Rain
- Ground or surface water
- Animals, insects, or equipment

Bacterial diseases must be managed by sanitation and prevention. Very few can be controlled by bactericides.

Viruses

Viruses (and mycoplasmas) are very small organisms. They cannot be seen with an ordinary microscope. Viruses cause diseases that can reduce plant vigour or kill them. Viruses must reproduce within living cells. Viruses can be spread by:

- Mechanical means (e.g., carried on tools during pruning)
- Propagation material (e.g., seeds, tubers, and other plant parts)
- Other organisms (vectors) such as some sucking insects and nematodes.

The symptoms of viral diseases can be very striking. They include:

- Wilting
- Mottling
- Streaking and discolouration of leaves and flowers
- Abnormal growths

No pesticides directly control viruses. Pesticides can be used to control the vectors of viruses. This will reduce the risk of infection. To manage plant viruses, choose virus-resistant cultivars and apply strict sanitation methods to prevent the spreading of a virus to other plants.

Nematodes

Nematodes are microscopic worm-like organisms. Some very tiny species feed on plant roots, stems, and leaves. Others are essential soil decomposers or beneficial parasites of insects. Infection by plant pathogenic nematodes can affect movement of water and nutrients within a plant. They can also make wounds in roots that allow fungi or bacteria to enter. Symptoms of nematode damage include:

- Wilting
- Leaf drop
- Stunting
- Lack of vigour
- Growth deformities in roots, shoots, and leaves

Nematodes reproduce by producing eggs. Both eggs and nematodes move through soil on a film of water. They can also be transported in contaminated soil, water, containers and equipment. Nematodes can be controlled with nematicides, however they are not widely used in the Landscape industry.

Developing an IPM Program for Plant Diseases

The following section outlines a general IPM program for plant diseases. It includes the following steps: prevention, identification, monitoring, injury and action thresholds, treatments, and evaluation. For more information on IPM, see **Chapter 5** above. Also see the **Applicator Core Manual Chapter 7: Integrated Pest Management**.

Healthy, well maintained plants can often defend against infection. As well, if healthy plants become infected they may recover from disease more quickly. In an IPM program, all plant health factors are checked and corrected, if necessary.

For a plant disease to develop, three things must be present. These are:

- The disease-causing organism (pathogen)
- A host plant that is susceptible to the pathogen
- Environmental conditions that favour pathogen growth

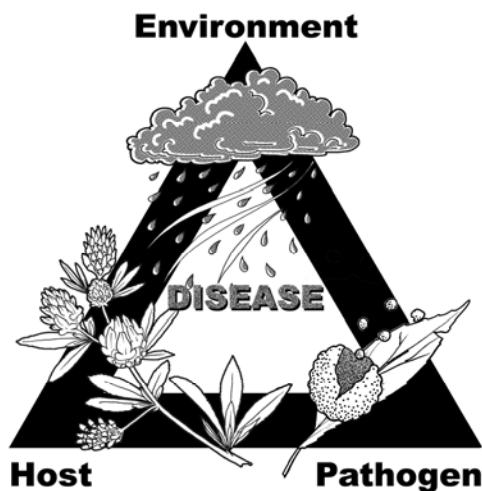


Figure 8-1: The plant disease triangle.

The plant disease triangle (**Figure 8-1**) illustrates this concept. All three sides of the plant disease triangle must be present for disease to occur. Remove one or more of the sides of the disease triangle to prevent plant diseases.

An IPM program for plant diseases should include prevention, identification, monitoring, injury & action thresholds, treatments and evaluation.

Prevention

In general, prevention methods create conditions that are not favourable for the development of plant diseases.

- **Remove the pathogen.** Use sanitation to keep pathogens out of an area. Reduce the presence of infectious spores or other stages:
 - Inspect plants for signs of disease before buying them. Buy only healthy plants. This avoids bringing disease into a landscape.
 - Remove alternate host plants.
 - Rake up and destroy diseased leaves and other plant parts (e.g., from black spot-infected roses or scab-infected ornamental apples).
 - Prune out and destroy infected plant material (e.g., branches with black knot).
- **Avoid susceptible host plants.** Choose disease-resistant cultivars or plants not affected by diseases. This should be considered for all new plants and replacement plants in landscapes. For example, hardy disease-resistant rose cultivars can be chosen to replace susceptible cultivars in display beds.
- **Make the environment less favourable to the pathogen.** Grow seedlings in warm conditions to slow the spread of damping-off diseases. Pruning plants promotes good air circulation among branches and allows leaves to dry more quickly. This removes moisture that most fungal and bacterial spores need to germinate. Avoid over-watering and correct poor drainage to reduce root diseases. In high maintenance turf areas (e.g. sports fields and golf greens) correct soil compaction and damage caused by turf wear. Both make the turf more susceptible to disease. Time irrigation practices to allow the turf canopy to properly dry out each day. Prolonged periods of leaf wetness can contribute to disease problems.

Identification

Plant diseases are often hard to diagnose. Symptoms may look like damage caused by:

- Insects or mites
- Herbicides
- Disorders (described previously)

Many diseases have similar symptoms. This makes identification of the pathogen difficult.

You may need to watch affected plants in the landscape for a number of days or weeks. Changes in symptoms can help with diagnosis. Knowing weather conditions (temperature and rainfall) in the weeks before symptoms appear can also be helpful when diagnosing fungal diseases. To make a proper diagnosis, collect affected leaves or plant parts. These must be examined with a hand lens or under a microscope. A plant pathologist may be needed to diagnose the problem.

Monitoring

Some diseases develop quite slowly, disease development can be monitored over a period of time and treatment decisions can be made. Other diseases develop very rapidly. When symptoms of plant disease are visible, it may be too late to control it. Pathogens inside the plant tissue may not be susceptible to treatments. Monitoring for rapidly developing disease includes looking for the conditions that allow plant pathogens to develop and spread. When conditions are favourable for disease development, plants should be checked regularly for the first signs of disease. A working understanding of the biology of the diseases common to your area and the plants that you manage is critical to planning an effective monitoring program.

Visual Inspections

Using a hand lens and other tools (e.g., shovel, soil probe, pocket knife), inspect foliage, soil and roots.

Look for conditions that allow pathogens to enter plants, such as:

- Cuts or scrapes to bark or foliage

- Poor growing conditions that injure roots (e.g., compacted, waterlogged or dry soil)
- The presence of sucking insects

Look for signs and symptoms of disease, such as:

- Wilted, distorted or abnormally shaped shoots and leaves
- Spots, streaks or discolourations on leaves, stems or flowers
- Discoloured or damaged roots
- Reproductive structures of fungi or fungal growth

Weather Records

Different pathogens need different climate conditions to germinate and grow. Keep records of humidity, temperature and rainfall when plant diseases are expected to be most active. These records can be helpful in identifying the conditions that are favourable for the development of fungal and bacterial diseases. This allows closer monitoring or application of protective treatments to be planned.

Assessment Methods

To measure the progress of a plant disease, the number of diseased leaves, plants, or areas of infected turf must be assessed on a regular basis. These assessments may not be as useful in landscapes as keeping track of weather. Most landscapes include a variety of plants. Most pathogens only attack one or a few plant species. The spread of disease is often limited. If there are a large number of susceptible plants in the landscape, counting infected plants or plant parts may be useful because it shows if the disease is spreading. Percentage estimates are often used to assess the amount of damage in specialty turf (e.g., golf courses, sports fields).

Injury and Action Thresholds

It is difficult to develop general information on injury thresholds. Injury levels are often site specific. They can depend on how much damage site users will accept. For plant disease, injury levels also depend on risks to the long-term health of the plant. The risk of the disease spreading must also be taken into account.

Injury thresholds for disease can be based on the proportion of damaged leaves on a given plant, the number of affected plants on a site, or the percent of area affected (e.g., turf or leaf canopy).

Action thresholds depend on the planned treatment. For example, most fungicides prevent the pathogen from infecting healthy tissue. These are not meant to kill the pathogen once it is in the plant. On high-risk plants, these fungicide applications might be used when weather conditions favour disease development and there is a history of disease problems in the area. Landscape managers often factor in the past history of disease at the site when deciding to treat or not. This is only possible when good records are kept.

Treatments

Physical and Mechanical Controls

In some cases, (e.g., diseases on ornamental plants) you can effectively treat the disease by removing the infected plant or plant part.

Chemical Control

Fungicides, bactericides and nematicides are pesticides that are used to kill, prevent or alter the growth of plant pathogens. These can be natural or synthetic. Fungicides are used to control plant diseases caused by fungi. Individual fungicides may control some plant diseases, but not all. Bactericides are used for sterilizing tools to help prevent the spread of bacterial diseases. Nematicides (soil fumigants) may be used on rare occasions. **The use of soil fumigants is not covered by a landscape applicators certificate/license. You must obtain a fumigation certificate/license to apply fumigants.** Herbicides may be used to remove weeds that serve as reservoirs for pathogens.

CHARACTERISTICS OF FUNGICIDES

Fungicides kill fungi, prevent their spread, or protect plants from infection. Fungi are most susceptible to fungicides at the incubation stage of their life cycles.

Dormant and over-wintering fungal spores are resistant to fungicides. Fungi are also difficult to control once they are inside the plant tissue. At this point, they are protected. A systemic fungicide may keep the disease from spreading to other

parts of the plant. To be effective, it must be applied before infection is too severe.

Many fungicides are selective, meaning that they control some diseases but not others. To get good disease control, it is essential to correctly identify the disease-causing organism.

Fungicides are classified as follows:

- **Contact fungicides** (also called protectant fungicides) are applied as a film on the plant leaves and stems. They prevent the fungal spores from germinating. Contact fungicides must be applied before the fungus infects the plant. These fungicides can protect the plant from infections. They often do not kill the fungus inside the plant. New plant growth that appears after treatment is not protected. A number of applications are required. Contact fungicides may be applied to turf and to the leaves, stems and flowers of landscape plants. These are the most widely used type of fungicides. Examples include mancozeb and thiram.
- **Systemic fungicides** are absorbed into plants. Once in the plant, they move within plant tissues. They often act to protect against infection. Systemic fungicides may kill fungi that are already established within the plant. These are called **eradicants**. Once inside the plant, systemic fungicides move to new areas of plant growth. Examples include triforine and benomyl.

FACTORS AFFECTING FUNGICIDE EFFICACY

The effectiveness of a fungicide in controlling disease depends on:

- **Timing of application:** The fungicide should be on, or in the plant before or during the early stages of infection. If the fungicide breaks down quickly, it may have to be applied more often.
- **Fungus life cycle:** Timing of application(s) depends on the type of fungus. If the fungus has a short life cycle, it may have many infection periods in a growing season. Frequent applications may be needed.
- **Rate of plant growth:** Fungicides must be applied to protect new growth. As new leaves grow, more applications may be needed.

- **Weather:** The timing of fungicide applications can vary with environmental conditions. If the weather does not favour fungal growth, fewer applications may be needed. Rain can wash off a fungicide. A repeat application may be needed.
- **Fungicide Resistance:** Some pathogens can develop resistance to certain fungicides or groups of fungicides. Disease organisms can become resistant after repeated fungicide applications. See **Applicator Core Manual** for more information on resistance. To prevent or delay resistance, alternate fungicides with different modes of action.

BACTERICIDES

Bactericides are pesticides that are toxic to bacteria. They kill bacteria on contact. They must be used before bacteria infect a plant.

The effectiveness of bactericides depends on the application timing, weather, and the amount of bacteria present.

NEMATICIDES

Nematicides are pesticides that control nematodes. Some nematicides act through direct contact with the nematode. Others can act systemically when nematodes feed on a plant and acquire a lethal dose. Nematicides are rarely used in landscapes, but they may be used to disinfect nursery soils.

Evaluation

At the end of each season review all aspects of the IPM program, consider the results obtained and identify changes that can be made to improve the program's effectiveness. Before the next season starts, determine if there are any new products and tools that could be used in the program.

In Review

Landscape and turf plants can be damaged by insect feeding, equipment injury, heavy use, growth disorders and infection by disease organisms. It is important to distinguish between plant diseases, disorders and other forms of damage when developing an IPM program.

Fungi, bacteria, and viruses can cause plant disease. Nematodes (microscopic worms) damage plants. For a plant disease to develop, the pathogen, a susceptible host and environmental conditions that favour disease development must be present. Diseases can often be prevented by affecting one of these factors. It is often easier to prevent diseases than to control them. In an IPM program, plant diseases are monitored by watching for weather conditions that favour disease development and by looking for disease symptoms. Fungicides, bactericides and nematicides are used to kill, prevent or alter the growth of plant pathogens. Fungicides can be classified as contact or systemic. A number of factors affect fungicide effectiveness. These must be considered when planning applications.

A Sample IPM Program for Diseases

This section outlines an IPM program for a common turf disease called pink snow mold. It is caused by the fungus *Microdochium nivale*, formerly called *Fusarium nivale*.

Description of Pink Snow Mold

This disease can occur with or without snow cover. In cooler, coastal areas of Atlantic Canada, pink snow mold can occur at almost any time during the year. When it occurs without snow cover, the disease is usually called “Fusarium patch”.

Under snow, infected turf is covered with patches of white, fluffy, fungal growth. This growth turns salmon pink when the snow melts and sunlight reaches the fungus. The pink colour comes from spores produced in response to sunlight. The patches later become bleached and eventually turn brown.

The fungus mainly infects the leaves of turf grasses starting with the lower leaves. It may attack stems. If leaves are damaged a number of times, roots and crowns may become weak and die.

Biology and Life Cycle

The pink snow mold fungus (*M. nivale*) lives in living plant tissue and plant debris (e.g., thatch). It infects leaves when temperature and relative humidity are favorable. Disease progress is slow at first. Leaves begin to turn brown two or three weeks after infection. The disease is spread quickly by spores when conditions are right.

The fungus may be active all year round. It does the most damage from fall through spring (wet, cold weather). Turfgrass is most at risk when it is growing slowly or dormant. Infections can occur from 0° to 31° C. Most occur below 16°C. Turf that is snow-covered, but not frozen, is ideal for the disease to spread. Other conditions that promote spread are:

- Repeated frosts
- Alternate freezing and thawing

- Drizzling rain
- Cold fog

Prevention

Some fescue cultivars are less prone to pink snow mold than other grasses. Check with local turf seed vendors. They can recommend grasses suited to the region that is more resistant.

The following will also help prevent or reduce infection:

- Mow and remove clippings in the fall until turf growth stops. Rake any leaves off the turf. Going into the winter, turf should be short with little dead plant material.
- Remove brush, bushes, or fences that cause snow to pile up. This may cause localized winter kill during extreme cold winters.
- In winter, prevent compacting of snow on the turf by snowmobiles, skiing, etc.
- When snow begins to melt in early spring, remove any large piles or drifts.
- Leave some snow cover on the turf.
- Use a balanced fertilizer. Avoid heavy applications of nitrogen, especially late in the year. Highly water-soluble nitrogen applied in late fall promotes growth of soft, succulent leaves. These are at risk of attack by the fungus.
- The disease is most severe where trees and shrubs shade the turf and block movement of air. Prune trees and shrubs to increase sun and air circulation.
- Spores and infected leaves can be moved on shoes, mowers, and other equipment. These can spread disease to uninfected areas. When working on the turf, work in infected areas last. Clean all equipment before using it on other areas.

Monitoring

Pink snow mold shows up as brownish-pink patches of damaged turf. In wet conditions, small tufts of fluffy, white fungal growth (mycelia) may be seen at the edge of the patches. To identify pink snow mold, look for tinges of pink or orange colour on blades of grass plants. When magnified, spores appear as salmon-pink clusters on leaves.

Check for signs of disease in the fall, as the weather becomes colder and wetter. Look again in the spring as the snow begins to melt.

Injury and Action Thresholds

The establishment of injury and action thresholds must be done on a site by site basis. Thresholds should consider factors such as forecast and typical spring weather conditions, location of the site, type of soil or media, drainage and other factors. If turf heals quickly in the spring with little damage, no treatment is required. *See cultural practices under Prevention section* above for ways to prevent the fungus in the future.

Treatment

Chemical Controls

Fungicides are often may be used to control this disease if it regularly causes severe damage. Monitor for the first signs of disease in the fall. Apply fungicides when conditions promote the growth of the fungus but before the first snow fall. Resistance to fungicides is a problem in some areas. Alternate fungicide types to reduce the build-up of resistance.

In Review

Pink snow mold occurs throughout the Atlantic Region. This disease can be a problem on high value turfgrass such as golf greens. It is rarely a problem on lawns and other turf areas. The fungus can infect the leaves of turfgrass when cool wet conditions exist. Severe damage may involve the roots and crowns. Prevention is the best way to control this disease. Some fescue grass cultivars are less susceptible to this disease. Where appropriate, these should be used in areas prone to snow mold. Mow and remove clippings in the fall until turf growth stops. Prevent traffic and compaction during the winter. Remove large piles or drifts of snow. If it appears in one turf area, avoid spreading the disease to other areas. Save this area for last when working.

Summary

Landscape and turf plant damage can result from many causes such as insect feeding, equipment injury, heavy use, growth disorders and infection by disease organisms. Growth disorders occur when plants are grown with incorrect amounts of water, nutrients, or light. Temperature extremes can also cause growth disorders.

Plant diseases caused by pathogens are called infectious diseases. With infectious diseases, new plants can become infected when the disease-causing organism is spread to them. Several groups of organisms cause plant diseases including bacteria, viruses, nematodes, and fungi.

Plant disorders are treated by changing the conditions that caused the damage (if possible).

To plan an IPM program for plant disease organisms (pathogens), you must identify the pathogen and know its life cycle and biology. Prevention is the corner stone of an IPM program for plant diseases. Healthy, well-maintained plants can often defend themselves against infection and may recover from disease more quickly if they become infected. If treatment is required it is important to understand the nature of treatments and how they work.

A sample IPM program for pink snow mold demonstrates how the parts of an IPM program can be used to control a common turf disease.

Self-test Questions for Chapters 5, 6, 7, 8

Answers are located in appendix A of this manual.

1. Give two examples of realistic objectives when starting an IPM program for the first time.

2. What information should be gathered to prepare for an IPM program?

3. Why are sticky traps for insects often not a good outdoor monitoring method?

4. What are two main ways to use natural enemies of pests in an IPM program?

5. How do horticultural oils affect insects and mites?

6. Why are selective pesticides the better choice for an IPM program if a pesticide is needed?

7. List three ways to prevent weed problems.

8. Why must you diagnose and correct if possible, environmental conditions that cause plant disorders?

9. What fungal stage is least likely to be affected by a fungicide?

10. The life cycle of an insect species with complete metamorphosis includes egg, larva, pupa, and adult. **True or false?**

11. Insect growth regulators attract beneficial insects to plants attacked by pests. **True or false?**

12. You must remove at least two sides of the “disease triangle” to manage plant disease. **True or false?**

References for Further Reading for Chapters 5-8

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IPM Training and Consulting:

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Nova Scotia Agricultural College, Centre for Continuing and Distance Education, PO Box 550, Truro, NS B2N 5E3 Tel: 902 893-6666 Fax: 902-895-5528. www.nsac.ns.ca/cde/coursedes.htm

