Interior Plantscape Pest Control

Living plants are commonly used indoors primarily for aesthetic purposes. Restaurants, hotels, shopping malls, and office buildings use plants to make the indoor environment more pleasing for customers and employees. **To maintain healthy interior plants one must have an understanding of optimal growing conditions for the species of plants involved.** These include proper light, temperature, humidity, soil moisture and pH. Providing these conditions becomes challenging when an interior landscape can contain many species of plants in a variety of environments.

Indoor plants are also susceptible to attack by many types of pests. In addition, plants often are under environmental stress due to less than optimal growing conditions. In interiorscapes, plants endure suboptimal light, water and temperature for sustained growth and may be exposed to excessive salts. These plants may also be exposed to human-induced stresses, such as having coffee, soda pop, or cleaning liquids poured on them. Under these stressful conditions plants are more susceptible to pests and less capable of recovering from an infection or infestation.

Treatment options in the interior plantscape are limited and indoor pest control is a highly sensitive issue. **Control measures must be safe for humans and for the plants themselves.** Pesticide risk can be minimized by selecting pesticides carefully, limiting applications, using lowest practical rates and correcting improper practices that contribute to the problem. Using many tactics or strategies to manage pests so that 1) an acceptable appearance and quality can be achieved, 2) management is economically feasible, and 3) minimal disruption to the environment occurs, is called **integrated pest management (IPM)**.

The **goal of IPM is to reduce the occurrence of plant problems and to maintain insect populations and disease problems at levels where aesthetic losses and economic losses are tolerable**. Rarely is pest eradication a goal, as it is not possible to completely eliminate a pest or pathogen once it establishes. a successful IPM program includes all economically and environmentally sound practices that help prevent or reduce plant injury. Integrated pest management incorporates a wide range of pest controls such as resistant plant varieties, cultural practices, mechanical controls, biological controls and pesticide applications

The **basic components of an IPM program** include:

- Proper horticultural care of plants and minimization of plant stress.
- Regular monitoring and early detection of disorders.
- Proper diagnosis and identification of plant disorders.
- Determination of economic or aesthetic significance.
- Selection of management methods or actions.
- Evaluation of management methods through continued monitoring.

Monitoring and Detection

Typically, a plantscape manager visits an interior landscape on a regularly scheduled basis. Monitoring for plant pests, diseases, and/or poor growing conditions should be an integral part of each visit. While watering, rotating, and cleaning, one should be alert to general plant health and identify early signs or symptoms of pest infestations and diseases. **Early detection allows for management of pests or alteration of conditions before host plants suffer serious injury.** In addition, low levels of pest infestation are typically easier to manage and the use of less toxic management strategies may still be an option. Washing foliage with a soap solution, pruning symptomatic tissue, or correcting poor site conditions may eliminate problems without the use of a pesticide.

Some insect species can be detected with the use of yellow or blue sticky cards. These cards have a sticky substance on the surface so that insects cannot escape. The cards are either hung in the plant canopy or attached to a stick inserted into the soil. Yellow cards are highly attractive to aphids, whiteflies and thrips, while blue cards are more specific for thrips. Both colors also will attract fungus gnats. Regular inspection of these cards will help to determine what insects are present and to show relative changes in numbers from one visit to the next. It is important to record the numbers and types of insects per card on each visit. Written records confirm whether problems are improving, getting worse or staying the same. Cards should be changed on a regular basis, when they become so heavily covered with insects that it is too difficult to count them, or after a pesticide treatment. Circle insects captured each week so they are not counted on the next visit.

Disease agents may be more difficult to monitor and detect, and disease symptoms are often confused with abiotic disorders. For example, most plant diseases are caused by microscopic organisms that cannot be seen with an unaided eye. Likewise, abiotic disorders often resemble disease symptoms. Monitoring of these types of problems includes close examination of plant tissue. Sample collection is often required so that diagnosis can be confirmed by a laboratory. Soil tests and leaf tissue analysis is an effective assessment for deficiencies and toxicities; this information is sometimes needed to better understand plant problems.

To keep monitoring and detection information uniform, **develop a system to rank plant condition.** If time allows, documenting healthy plant conditions provides a written record of an inspection. If a problem does occur, this background information will help in making a diagnosis. Record information useful for planning management strategies:

- Level of light (footcandles)
- Plant species
- Plant age and size
- Date of installation
- Size of container
- Type of soil or media

- Symptom details (incidence, severity)
- Signs of pests or disease
- Life stage of the pest
- Type and level of damage
- Date of detection, etc.

Diagnosis and Identification

When damage or poor plant health is detected, the interior plantscape manager must determine what cultural or environmental conditions, diseases, insects, mites, or human activity is responsible. Remember, **there is often more than one damaging influence**. Identify all conditions that may have stressed the plant, causing it to be more susceptible to the problem or pest observed. Below is a general guide to common symptoms and possible causes of indoor plant disorders.

- ## Identify the plant

Certain plant species are more prone to specific pest problems. For example, *Ficus* are susceptible to scales, *Schefflera* are susceptible to mealybugs, and palms are susceptible to spider mites. Become familiar with common pest, disease, and abiotic disorders; inspect the whole plant, especially the undersides of stems and twigs. If possible, carefully remove the damaged plant from its container to examine root and soil conditions. Inspecting the root environment is often difficult but necessary.

- ## Clearly define the symptoms

Document where the symptoms occur on the plant. Examine the site to determine source or pattern (air flow, temperature change, canopy density). Determine whether symptoms are the same as the symptoms the client is concerned about.

- ## Categorize the cause of the problem as biotic or abiotic

Biotic disorders are caused by insect or mite infestations or by a disease agent.

Abiotic disorders are caused by non-living agents such as improper light, temperature, humidity, water, media, pH, soluble salts, volatile gas, cleaning compounds, relocating, breakage, food/beverage wastes, watering with excessively cold water.

- ## Evaluate the environment

An interior plantscape environment is generally favorable for pests and disease organisms when appropriate cultural and environmental conditions fail to provide stress-free plants.

Consider these factors of the macroclimate: Where are the heat or air-conditioning vents? Are there drafts from doorways? Are light levels adequate? Note temperature and humidity levels and the plant's proximity

to windows. Ask the client about activities that may disturb the plant. Is the container being used as a receptacle for coffee, cigarette butts, or cleaning compounds?

Selection of Pest Management Methods

The **pest management methods most appropriate for a specific circumstance will depend upon the biology of the pest and host plant, and the interior landscape situation**. For every pest problem consider all available management tactics and evaluate the benefits and risks of each. Often the use of multiple tactics is more effective than use of a single tactic.

Choose methods that are:

1. Practical in an indoor setting.
2. Least toxic to nontarget organisms.
3. Enhance natural controls and plant defenses.
4. Likely to limit the pest permanently.
5. Least hazardous for the applicator to handle.

Also, as a plant manager, **consider the option of removing the plants to be treated from an interior landscape and temporarily relocating them outside or to a greenhouse**. Relocating plants makes available a larger selection of products registered for use in those areas (including some that may not have been appropriate for use in the interior landscape setting.) Furthermore, the conditions in a greenhouse (light, temperature, and water) may be more conducive to the plant's recovery. Once the plant has been treated and the problem corrected, it can be replaced in its original interior landscape location.

IPM Evaluation

It is extremely important to **evaluate the results of your pest management strategies**. This can be done in several ways. Record pest counts or level of infection before and after treatment, comparative damage ratings, length of recovery time, etc. Sticky cards, as discussed under monitoring in this section, are helpful in evaluating the results of an insect management treatment. Keep written records of successes and failures, timing of treatment, and special conditions.

A General Diagnostic Guide for Indoor Plants with Symptoms and Possible Causes

Brown or scorched leaf tips

1. Poor root health from overwatering, excessive soil dryness (especially between waterings), excessive fertilizer or other soluble salts in the soil or root rot disease.
2. Specific nutrient toxicities such as fluoride, copper or boron.
3. Low humidity.
4. Pesticide or mechanical injury.

Leaf spots, blotches, blemishes, blisters, or scabby spots

1. Intense light (sunburn) associated with a recent move of the plant or excessive soil dryness and wilting.
2. Chilling injury (below 50°F).
3. Chemical spray injury.
4. Overwatering.
5. Fungal or bacterial infections (not common unless plants have recently come from a field or greenhouse).

Older leaves yellow-green

1. Insufficient fertilizer, especially nitrogen.
2. Poor root health due to pot-bound growth, compacted soil, or poor drainage.
3. Insufficient light.
4. Senescence (natural aging process of individual leaves).

Newer leaves yellow-green

1. Soil pH (acidity) imbalance.
2. Trace element imbalance.

All leaves yellow-green

1. Too much light or large changes in light intensity.
2. Insufficient fertilization.
3. High temperatures, especially when associated with dryness.
4. Insect infestation or root rot disease.

Leaf drop

1. Poor root health from overwatering, excessive dryness or excessive fertilizer or other soluble salts in the soil, compacted soil or pot-bound roots.
2. Sudden change in light, temperature, or relative humidity.
3. Root rot disease.

Wilting or drooping of foliage

1. Poor root health from overwatering, excessive dryness or excessive fertilizer or other soluble salts in the soil, compacted soil, or a poorly drained container or root rot disease.
2. A toxic chemical poured into the soil.

Roots brown in color, soft or rotted roots with tissue that can easily be "slipped off" leaving behind the string-like center tissues; roots massed at top or bottom of pot.

1. Poor root health from overwatering, excessive dryness, excessive fertilizer or other soluble salts in the soil, compacted soil, or a poorly drained container.
2. A toxic chemical poured into soil.
3. Root rot disease.

Yellowed leaves with tiny speckling; leaves later bronzed and drying; webbing noted near growing points.

1. Spider-mite infestation.

Leaves or stems covered with a sticky substance; mold growing on leaves; tiny brown or white objects seen on leaves or in crotches of branches; leaf drop or branch dieback; leaf or growing point distortion.

1. Scale, aphid, whitefly or mealybug infestation.

Leaves emerging from buds small, thickened and brittle with margins curved downward; may resemble exposure to a phenoxy herbicide.

1. Broad or cyclamen mite infestation.

Material in this chapter adapted from Michigan State University Extension Bulletin E-2308 Interiorscape Pest Management. A Training Manual for Commercial Pesticide Applicators. Julie Stachecki, Editor.

Plant Selection

The most important step in interiorscaping is the **selection of plants matched correctly with the environmental characteristics of the planting site**. Plants differ significantly in their light needs, sensitivity to temperature, and ease of maintenance. This, in turn, impacts their susceptibility to pest problems.

Consistent success with indoor plants is most likely to be achieved by:

- **Selecting plants that match the condition**s of a given interior environment.
- Purchasing **high quality plants** from a known and reliable source.
- **Acclimating the plant** before installation by reducing light, moisture, and fertilizer.
- **Watering, fertilizing, cleaning, and pruning appropriately**.

Light is probably the most important environmental condition and plants should be placed and grouped according to their need for light. Plants grown under correct conditions are vigorous, compact, and bushy. Color is vibrant, leaves are normal in size, stems are sturdy, and flowering is promoted.

Light helps balance food production (photosynthesis) and consumption (respiration) by the plant. The rate at which plants make their own food is, to a large part, determined essentially by the quantity and duration of available light. The higher the light level, the greater the supply of food. The rate of food consumption is basically determined by temperature. The warmer the temperature, the greater the demand for food. Therefore, **in interiorscapes, the low light and warm temperatures create a high demand for food but a slow rate of production.**

Plants grown at a light intensity below their optimum will have smaller leaves and less vivid color. They often grow more open and leggy, and pruning may be necessary for compact form. They need to be kept drier than those in bright light and fertilized less frequently. A plant that receives significantly less than its required amount of light may survive for several months to a year, while gradually deteriorating in appearance and vigor.

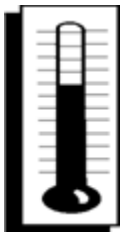
Three factors lower the light requirement for a plant moved indoors:

- The plant's growth slows dramatically or even stops. This growth reduction triggers a lesser demand for food.
- While the existing leaves cannot change their structure, they can increase their chlorophyll content.
- The new leaves that are produced in the indoor environment will be structured as shade leaves. This has been shown to result in a reduction in the plant's light compensation point.

The **light compensation point** is defined as the minimum light level at which the amount of food produced by photosynthesis is equal to the amount of food consumed during respiration. Shade leaves have lower light compensation points than sun leaves. Acclimation to low light involves a reduction in the plant's light compensation point either by changes in leaf metabolism so light energy is captured more efficiently in low light or by replacement of inefficient sun leaves with shade leaves tolerant to low light levels.

Artificial light can be used to supplement or replace natural sunlight. **Cool-white fluorescent lights used alone or in combination with warm-white fluorescent lights are the most economical and best all-purpose lamps.** Typically, a fixture holding two 40-watt tubes is positioned approximately 12 inches above the plants. **Most plants need 12 to 16**

hours of artificial light per day for good growth. For large specimen plants, use spot or flood lights to maintain good appearance and accent the plant. Lighting design should take into account anticipated use of indoor plants. Indirect and track lighting are very effective design features for this purpose.



Understanding how a plant reacts to **temperature stress** is important in making adjustments to correct problems and improve plant longevity. In addition to problems caused by chilling, heat from registers can dry out media and foliage quickly. A minimum/ maximum thermometer will record temperature differences plants may be experiencing in the interior landscape.

Most public buildings are heated and cooled with human comfort in mind rather than the growth requirements of indoor plants. Fortunately, the desirable temperatures for humans fall within the optimum range for most foliage and flowering plants. **Daytime temperatures of 70° to 80°F and a nighttime range of 60° to 70°F are satisfactory for most species.** Many flowering plants bloom longer at the lower end of these day-night temperature ranges. Variations in temperature ranges should be considered in selecting plants for the interior environment.

Plants differ in their degree of sensitivity to chilling. Generally, most foliage plants cease to grow at 60°F. **Temperatures between 45° and 55°F often result in chilling.** Chilling causes changes in cell membrane structure, which, in essence, causes the cells to "leak" their contents. This causes a loss in plant vigor and reduced growth. The damage may not be visible for months after chilling has taken place. Many times a secondary problem such as disease will begin to increase due to the loss of vigor. This secondary problem is then blamed for the damage, and chilling goes undetected.

Chilling damage is very subtle and may be very difficult to detect unless maintenance personnel are looking for it. Symptoms of chilling injury include:

- Foliage discoloration.
- Poor growth or wilting.
- Foliage bending or curling.
- Flower bud drop.
- Plant death.

The **severity of chilling damage is a result of temperature and length of exposure**. For example, exposure to 50°F for 12 hours may cause chilling injury as severe as exposure to 40°F for 2 hours. **Chilling injury can result from only a few minutes exposure at freezing temperatures.** Plants can get chilled in the truck going to a job site, during transfer from the truck to the indoors, and from exposure to cold winds near doorways.

The following conditions can contribute to chilling injury in the interior environment:

- Shopping malls and public buildings that maintain lower temperatures.
- Air drafts from air conditioning units, doorways, and windows can cause sudden changes in temperature.
- A reduction of temperature in public buildings on weekends and holidays.

The low **humidity** indoors may also stress plants. During the summer, air conditioning reduces relative humidity and the same is true with heating in the winter. **If the growing medium is slightly dry as is common in commercial interiorscapes, plants leaves dry out and become more susceptible to spider mite infestations.**

Humidity around plants can be modified. Placing potted plants on shallow trays filled with pebbles and water, locating plants near fountains, or installing humidifiers on HVAC systems can moderate relative humidity for plants and reduce plant stress.

Maintenance of the Interiorscape

Once plants have been properly placed, their appearance needs to be sustained through proper maintenance and care. Usually, this is limited to watering, fertilizing, cleaning, and pruning.

Watering indoor plants is a widely misunderstood practice. Water content in the container and plant need for water are difficult to measure accurately. **As a result, improper watering is the underlying cause of many plant problems.** Watering can also be used to limit the buildup of salts in the growing media. Unless water percolates through the medium, soluble salts from fertilizers may buildup to harmful levels. Water thoroughly at every watering.

Fertilization is necessary for growth and maintenance of plants. A plant's need for fertilizer depends on its growth rate, the amount of leaching that occurs during watering, soil volume, and other factors. Fertilizer levels that were ideal during production can severely damage plants in interiorscapes. Soluble salts in the media can cause root burn when too much fertilizer is applied, when the medium dries out, and when water quality is poor. For many plants, fertilizers are often applied during the summer when light levels are higher.

Plant cleaning includes dust and water-spot removal, leaf shining, and removal of senescent leaves. The leaves of indoor plants can become coated with a heavy layer of dust in a surprisingly short time. This dust and grime interferes with normal leaf functions and makes the plant less attractive. Accumulated dust will shade the leaves and may so drastically reduce light that the plant will eventually die. Dust with a soft brush or cloth moistened with warm water to clean both upper and lower leaf surfaces at least every two or three months.

Pruning to encourage branching or to remove an entire section of the plant to maintain its intended design or size may be necessary. Pruning may be used to remove insect pests, such as scales, or diseases attacking specific branches.

Abiotic Disorders

Abiotic or non-infectious disorders are caused by environmental, cultural, and non-living things. Things causing abiotic or non-infectious diseases do not grow, reproduce, or spread from plant to plant; they are not contagious. These disorders are not diseases, but stresses can make plants more susceptible to infection. The section titled Diseases of Indoor Plants contains information on disease management.

Abiotic disorders **produce a wide range of symptoms** such as reduced vigor, yellowing leaves, leaf drop, or rapid death of plants. These **symptoms may resemble plant diseases**.

Further, **stressed plants may become more susceptible to pathogenic diseases.** For example, if Pythium root rot develops on a plant that is usually resistant to this disease, an investigation may reveal that the plant was consistently overwatered, resulting in high moisture and humidity (abiotic conditions) in the planting area. In this case, correcting the cultural practice that allowed the pathogen to become established may be the only corrective measure necessary for managing the water mold pathogen.

Many cultural and environmental conditions that lead to poor plant health are mentioned throughout this manual. This section will focus on some of the most likely abiotic disorders found in an interior landscape.

Environmental Conditions Contributing to Abiotic Disorders

There are **certain ranges of temperature, light and water/humidity that provide for optimal plant health.** The importance of these factors is considered here in relation to the development of abiotic disorders.

Typically interior spaces utilized for living or work environments provide temperatures adequate for growing foliage plants. A **temperature range between 50° and 90° Fahrenheit can be tolerated by most foliage plants.** Attention must be given to temperatures during times when interior spaces are not occupied by people. With a more energy-conscious society, the thermostat may be set to temperatures that may injure plants when they are exposed over a period of time. Foliage plants can suffer cold damage without freezing. This is referred to as chilling injury. A few plants that are injured by exposure to chilling temperatures between 35° and 50° F for short periods of time include *Aglaonema* X 'Silver Queen', *Dieffenbachia maculata*, *Dracaena* spp. and *Polyscias fruiticosa*. **Symptoms of chilling injury include yellowing or brown water-soaked areas on leaves, loss of foliage, poor growth, and wilting.**

Plants exposed to **hot temperatures for prolonged periods** of time can also suffer injury. **Wilting, marginal burn on foliage, and leaf drop** may occur. Since most foliage plants can tolerate temperatures as high as 95°F, provided they receive adequate water, the problem is not related entirely to maximum temperature but to utilization of stored food reserves due to elevated respiration levels. When a plant depletes its stored carbohydrates, it may become weak and predisposed to other stresses including invasion by pathogens.

Light affects numerous physiological conditions and processes in plants. When plants are subjected to inadequate light levels, disruptions of these functions may cause stress. Plants may exhibit poor growth and color. These symptoms are easily mistaken for something other than poor environmental conditions.

If plants haven't been adequately acclimatized to the conditions of an interiorscape (lower light levels, lower temperatures and humidity), they may experience yellowing and leaf drop and possible death following installation.

Many growers are producing **acclimatized plants which require more time to grow, but are more tolerant of environmental stress at the job site.** Be familiar with the growing practices of your supplier and symptoms

associated with an inadequately acclimatized plant. If the grower doesn't acclimatize the plants, establish a method and facility to do so before installing the plants directly into an interior landscape.

Cultural Practices Contributing to Plant Disorders

Most plant replacements result from a combination of poor environmental conditions and poor cultural practices. Symptoms of abiotic disorders, resulting from poor environmental conditions and cultural practices, are extremely variable and are often misdiagnosed. Pesticide applications will not correct an abiotic disorder. It is vital that plant technicians understand the impact of their cultural practices on the plants they maintain.

Disease Management in the Interiorscape Environment

by Dr. Nicole Gautheir, Department of Plant Pathology, University of Kentucky

The occurrence of diseases on indoor landscape plants is typically a **result of adverse environmental conditions combined with the presence of pathogens** (fungi, water molds, bacteria, viruses or nematodes). Diseases are uncommon in the indoor landscape setting if it was established using disease-free plant material. It is critical to identify the causal agent or the type of disease that arises in the interior landscape in order to take appropriate corrective measures.

To manage plant diseases and disorders successfully, one must be able to:

- **Recognize** symptoms and signs that indicate the presence of a disease or disorder.
- Accurately **identify** the cause and type of problem (abiotic or pathogenic or both).
- **Select** the best method(s) for correcting conditions that contributed to the disease development.

The Disease Triangle

In order to manage plant health, it is helpful to understand which conditions influence disease development. The "disease triangle" illustrates the **three primary factors** that must be present for a disease to occur:

Pathogen: the abundance, aggressiveness, and other characteristics of the pathogen causing disease can influence disease development. Some pathogens are widespread and infect many types of plants; others are notpathogens are host-specific

Host Plant: the genetic susceptibility and general condition of the plant influence disease development. Healthy, stress-free plants are less susceptible to disease than weakened plants. Different species or cultivars of plants may be more or less susceptible to infection. Plant vigor can also affect disease severity; stressed plants often become increasingly susceptible to infection and disease.

Environment: certain environmental conditions which are favored by pathogens. These include temperature (moderate temperatures) and moisture (free water, humidity, and soil moisture). Factors such as light, density of plantings, location of plants, and climates/microclimates affect temperature and moisture.

The goal is to recognize and manipulate these primary factors to promote stress-free plants and to eliminate conditions favorable for disease development.

Managing Diseases

The disease triangle reminds us of the factors necessary for disease development. **A susceptible host plant and a pathogen must be present, along with the proper environmental conditions in order for a disease to occur.** Conditions that favor the development of pathogenic diseases can be avoided in the interior landscape setting.

Overhead irrigation, splashing water, prolonged leaf wetness, high humidity, crowded blocks of similar plants, and propagation of infected stock are conditions that may be common in poorly managed interiorscapes.

Additionally, diseases in the interior landscape may manifest as a "secondary" disease after a plant has been stressed by adverse cultural or environmental conditions. Correcting the stress often prevents infection or reduces development of disease.

Introduction of plant pathogens by infected plant material is the most common source for plant disease in the interiorscape. The goal of nursery growers is to produce high-quality plants that are pathogen-free. These facilities often rely on fungicides to prevent the development of diseases. **If fungicides are used after infection occurred, the fungicides suppress disease; they do not cure it**. Thus suppressed infections may be introduced to interiorscapes and later develop into disease.

The use of fungicides in an interior landscape is not always possible due to the need for repeated treatments and the limited number of fungicides registered for use in interior landscapes. For example, a fungicide may be labeled for use on a plant(s) and/or for a pathogen, but often it is not labeled for use in an interior landscape setting. In these cases, **it may be necessary to temporarily relocate the plant to a location that is on the label (such as outdoors or in a greenhouse) in order to make the treatment.** By removing a plant from its interior landscape, the options for fungicide applications are expanded, although temporarily relocating plants may not always be practical.

Accurate diagnosis is critical for selecting appropriate corrective measures.

Fungicides are only effective in controlling specific pathogens listed on the label. Confirmation of the pathogen causing disease is important. Accurate diagnosis of plant pathogens may require laboratory analysis. Samples should be collected from symptomatic tissue that is representative of the particular problem. Larger samples, preferably whole plants, generally enable more accurate diagnoses. Otherwise, collect multiple leaves, stems, and roots from plants showing a range of symptoms. Remember that leaf symptoms may be the result of a stem or root problem. Always leave soil around roots so that soil can be analyzed. Diagnostic assistance can be obtained from your local Cooperative Extension Service.

Disease symptoms on foliage or stems are more likely to be noticed than root or crown symptoms. Rapid diagnosis and management can stop the spread to other plants. If plant damage is not severe and has been checked by your management procedure the plant may still be attractive enough to remain on site. **When an infection becomes severe, the best alternative is removal of the plant and infested growing media.**

Fungi

Fungi are the most prevalent of the plant pathogens. They cause a number of leaf spots and blights, stem cankers and tip blights, and root rot diseases. Most foliar diseases caused by fungi develop circular, dead spots or lesions. Leaf spots often have dry, gray-to- brown centers with darker edges. As surrounding tissue is invaded, lesions may exhibit concentric rings which gives the affected tissue a "target-like" appearance with a faded green halo forming the outermost ring. These circular lesions can overlap, forming larger lesions, producing a blotchy appearance. Some fungi produce black, pinpoint-like pustules within centers of spots. These black specks are the reproductive structures of the fungus which include thousands of spores that are easily carried by air currents, water or soil movement, and tools and clothing. After reaching a host plant, **spores can remain inactive for long periods** until conditions are favorable for growth and infection of plants.**Temperatures from 65° to 80° F and high moisture levels encourage fungal growth.** Similar lesions may develop on stems and roots, although closer observations are needed to recognize symptoms on inconspicuous plant parts.

Management of fungal diseases should focus on prevention. Exclusion of the pathogen is the first step toward prevention. Environmental conditions such as moisture can be managed through increased air circulation and good drainage. This will help reduce infection and spread. Cultural practices such as sanitation help remove sources of fungi (e.g. infected leaves) from the site. Fungicides do not cure infected leaves and stems, but they can protect new tissue as plants grow. Fungal root rots cannot be managed with fungicides, and infected plants should be destroyed to avoid spread.

Water Molds

Water molds, properly called **oomycetes**, are fungus-like organisms. Water molds cause diseases such as downy mildew, Pythium root rot, and Phytophthora root rot. The **most common water molds in interiorscapes are the root rots.**

Water molds produce a spore stage that is adapted to spread by swimming in water. High soil moisture levels caused by **overwatering, poorly drained media, or water standing in the bottom of the containers** induce infection of roots by these water molds.Root damage caused by **over fertilization, buildup of salts in the soil, chilling or freezing temperatures, or phytotoxicity** increase susceptibility to root rots.

Management of water mold disease includes prevention. Exclusion of the pathogen, especially though contaminated soil and infested pots and tools, is the first step toward managing disease. Avoid environmental conditions that are favored by water molds, including excess soil moisture, and poor drainage. **Proper soil drainage and proper irrigation, as well as managed fertilization and good sanitation practices help avoid and/or correct root rot diseases in general.** Be aware of the changes in the physical structure of the rooting media. As media ages, it may settle and pack in the bottom of containers and hinder drainage. Diseased plants cannot be cured with fungicides; drenches may suppress disease in limited situations, but symptoms return once fungicide applications are terminated. **Destruction of infected plants is recommended.**

Bacteria

Plant diseases caused by bacteria are less common than fungal diseases, but they can still cause economic losses.

Localized bacterial disease symptoms may occur in the form of **leaf spots and/or stem rots**. Bacterial leaf spots may be distinctly different from fungal leaf spots. They are often dark-colored with a greasy, water-soaked appearance when viewed from the underside of the leaf. Eventually these areas turn tan, dark brown, or black depending on the plant species and the bacterium involved. A distinct yellow edge (referred to as a halo) often surrounds the periphery of spots or lesions. Bacterial disease lesions can enlarge rapidly and consume an entire leaf within a short time.**Infected tissue becomes soft and mushy, often with a foul odor.** Bacterial cells ooze out of infected tissues and spread by water splash and by tools during maintenance. Clean hands with soap and water and disinfect pruning tools after handling infected plant material.

Management of bacterial diseases begins with **prompt removal of infected plant parts.** As with other plant diseases, bacterial diseases should be prevented. Exclusion of the pathogen is the first step toward prevention. Once disease is observed, it must be contained as soon as possible to prevent spread. Environmental conditions such as surface moisture can be managed through air circulation and avoidance of overhead irrigation. Copper-based products can help protect nearby healthy plant material from infection. Infected material should be destroyed to avoid spread. Bactericides will not cure infections.

Viruses

Viruses behave much differently than other plant pathogens. They infect cells of plants, but they are multiplied by the host. Viruses live and multiply only within living cells. Viral diseases are usually introduced into interior landscapes via infected plants or by insect vectors. They **can be spread to healthy plants by the feeding activity of sucking insects such as aphids and leafhoppers or mechanically via the hands and tools.**

Symptoms of viral diseases are diverse. **Symptoms of viral infection include: mosaic, patterns, crinkling, cupping/curling, distortion, stunting, and ringspot patterns.** These symptoms may resemble abiotic disorders, chemical damage, or even fungal disease. Viruses become systemic within plants; **once a plant is infected, all plant parts are infected.**

Management options for viral diseases are limited. Exclusion is the first step toward disease management. Suspect plants should be isolated and/or removed until disease confirmation is possible. Although most viruses are specific to only a few types of plants, prompt and complete removal to prevent its potential spread is recommended when a virus is discovered. Currently there is **no chemical control for virus diseases.**

Nematodes

Penn State Department of Plant Pathology & Environmental Microbiology Archives, Penn State University, Bugwood.org

Nematodes are microscopic roundworms that can infect or infest interiorscapes. Most nematode **species feed on roots and cause plant stunting and poor growth** because their feeding weakens the root system. Foliar nematodes live within leaf tissues, resulting in brown lesions on older leaves (as in the photo). Nematode diseases tend to be **rare on indoor plants.**

Management of nematodes should focus on prevention. Exclusion of the pest is the first step toward prevention. There are no fumigants registered for nematode management in interior landscapes. Infested plants should be destroyed before spread occurs.

Mites and Insects in the Interiorscape Environment

Most pest problems on interiorscape plants originate because the plants were not grown in an indoor environment. They originated where the plants were originally grown, such as fields, shade houses, or greenhouses. Once introduced to the interiorscape, many insects and mites will thrive, and spread to other plants. The **key to preventing insects and mite infestations is to make sure the plants are pest-free before permanent installation**. There is much greater flexibility in control procedures (chemicals, application methods, etc.) in a greenhouse or even an acclimatization room than in the interiorscape. **Quarantine purchased plants in an isolated room and carefully inspect and monitor them for insects and mites.** If present, use an insecticide or miticide and re-inspect them before moving them to the interiorscpe. Avoiding pest problems is often much easier the controlling an established problem.

The **importance of early detection and diagnosis of the problem cannot be overemphasized**. This is the key to controlling nearly all pests before significant plant injury or control expenses occur and while pest populations are low. Pesticides and natural enemies will control most insects and mites, if correct procedures are followed.

Mites

Several mite species attack plants indoors, often causing severe injury. Most common among them is the **two-spotted spider mite**. They have a wide host range, so very few plants are safe from attack. Adult spider mites are about 1/50 inch long and are usually found on lower leaf surfaces. Feeding injury on many plant species produces light-colored, speckled or mottled areas on leaves. This is called stippling. Webbing is also produced. Severe spider mite infestations cause leaves to dry and fall from the plant. At 75° F, about two weeks are required for mites to develop from egg to adult.

Other important mites include the **broad mite and cyclamen mite**. Because these mites are about 1/100 inch long, infestations are recognized by plant injury symptoms rather than by seeing the mites. Most feeding injury occurs on young foliage or in the buds, where injury is characterized by **thickened and brittle foliage, with leaf margins cupped downward and stunted**. Many of these symptoms are characteristic of injury by phenoxy-type herbicides or virus infection, so infestations can go unnoticed for long periods of time. Since **these mites are attracted to dusty conditions**, removing dust from the plants with soapy water and a soft cloth (which will also remove the mites) will help discourage their presence.

Insects

While many insects may injure plants indoors, the groups discussed below are the most common with indoor plantings.

R. Bessin, University of Kentucky

Mealybugs are very common and are difficult to control. Several species can be found on plants indoors, including some that feed on the roots as well as the stems and leaves. All mealybug species have sucking mouthparts that remove plant sap. **Sticky honeydew is produced, which drips on foliage below the infested area, attracts ants, and promotes black sooty mold growth.** Damage results in stunted plant growth or death. Each female mealybug may produce several hundred eggs. The egg-to-adult cycle is 6 to 8 weeks. Moving infested plant material into the interiorscape is virtually the only way mealybugs become established.

United States National Collection of Scale Insects Photographs,
USDA Agricultural Research Service, Bugwood.org

Several species of **scale insects** infest interiorscape plants, arriving on previously infested plants. One of the most common is the **soft brown scale**. Scales, similar to mealybugs, are sap-sucking insects, which also excrete honeydew. Females produce up to 1,000 eggs underneath their protective shell or "scale." The eggs hatch into tiny crawlers, which spread about the plant. After dispersing, crawlers settle and feed in one location for the remainder of their lives. The length of the life cycle varies with each species, ranging from 1 to 8 or more generations per year. Scale damage reduces plant vigor. The honeydew attracts ants and promotes the growth of a black, sooty mold.

Jim Occi, BugPics, Bugwood.org

Aphids also have piercing-sucking mouthparts and produce honeydew. They are soft-bodied, somewhat pear-shaped insects. **Indoors, all aphids are female, reproduce year round, and multiply rapidly.** Each mature female may produce up to 50 daughters that, in turn, begin reproducing in 7 to 10 days. Aphid infestations often are evident by the white cast skins that are shed by the aphids when molting. Aphids reduce plant vigor and distort leaves. The honeydew attracts ants and promotes the growth of a black, sooty mold.

Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Whiteflies have piercing-sucking mouthparts which they use to suck juices from the plants. They excrete large quantities of honeydew. Whiteflies, including greenhouse whitefly and silverleaf whitefly, are common pests of

many ornamental plants. Indoors, whiteflies are most likely to be found on **poinsettia, fuchsia, chrysanthemum, or other flowering plants** brought into the location for color. All whitefly life stages **develop on undersides of leaves**. The egg-to-adult cycle takes 21 to 36 or more days, depending on temperature.

R. Bessin, University of Kentucky

Thrips cause problems indoors on both foliage and flowers. These small, slender insects are less than 1/20 inch long. They feed by rasping plant tissues with their mouthparts and consuming plant fluids. **Heavily infested areas on leaves appear silvery gray, with lighter infestations showing up as small whitish-colored areas.** Black dots of excrement also are present. Eggs are laid on or in plant tissues. The egg-to-adult cycle takes 18 to 21 days. Some species of thrips leave the plant and transform to the adult in the growing medium. Thrips are difficult to control indoors. Few insecticides are registered for use on plants indoors that provide effective control, unless the plants are moved to a greenhouse or outdoors prior to treatment.

R. Bessin, University of Kentucky

Fungus gnats are small, dark gray or black flies that resemble midges or mosquitoes. Presence of fungus gnats **may indicate overly wet growing medium**. The flies often get trapped in the moisture on leaf surfaces, which detracts from the plant's appearance. Nuisance and decreased aesthetic value are the greatest impacts done by adult fungus gnats; however, the larvae also damage plants by feeding on decaying or healthy organic matter (including roots)

and fungi. **Fungus gnats have increased in importance recently because of the prevalence of soil-less mixes** in the plant industry. Some of these growing media, especially those that contain peat moss, apparently are excellent for survival of the insects.

Control

Commercial indoor landscape accounts are perhaps the most difficult areas in which to attempt pest control. Interior plantscapes extend from public conservatories to extensive plantings in homes, hotels, office buildings, restaurants, shopping malls, hospitals, schools, and other environmentally sensitive areas. The **use of insecticides in these areas is often greatly restricted** because of the sensitivity of the surroundings. In addition, **few chemicals are cleared for ornamental plant use in public areas**, and public prejudice against pesticide odors can prevent application of pesticides in many situations.

An amazing variety of insects feed on flowering and foliage plants. The routine use of insecticides usually eliminates predaceous insects and mites. However, pests remaining after treatment sometimes tolerate commonly used insecticides. To stay in business, most commercial flower and foliage plant growers must become fairly sophisticated in using various types of pest management practices, insecticide formulations, application equipment, and in rotating insecticides from one chemical group to another.

Integrated Pest Management Tactics

Prevention

Always inspect new plants for potential pest and disease problems before they are introduced into the interiorscape. Avoid using plants that appear unhealthy or damaged. These problems should be corrected before their use in an interiorscape. Become familiar with the potential pest and disease problems with the types of plants you manage. Highly susceptible plants can serve as indicator plants to alert you to developing problems.

Sanitation

Sanitation is an important component of an integrated approach to pest and disease control. This term refers to the cleanliness approach to excluding and eradicating diseases and pests to eliminate or reduce spread. Exclusion is the first step of a good sanitation program. Avoid introduction of infected or infested material. Once diseases or pests are confirmed in an interiorscape, sanitation methods can reduce their populations and limit spread to healthy plant material. **Affected plant tissue should be removed promptly.** Heavily infested or diseased plants need to be removed from the interiorscape to reduce spread to other healthier plants. **Plant debris should be promptly collected and disposed of. Tools used to prune, replant and care for plants need to be regularly cleaned and sanitized.**

Biological Control

Interest in biological control in indoor landscapes has expanded in recent years because of restrictions placed on interiorscape pesticide applications, pesticide costs, poor control with pesticide products, phytotoxicity, need to repeat applications, and potential human health hazards. **Biological control relies on parasitoids, predators, or pathogens to suppress insect and mite pest populations, as well as some fungal diseases.** Biological agents are usually released and become established before pest population increase to damaging levels. For some biocontrol agents, they may need to be released periodically. **To be successful at managing pest problems with biological control agents requires a proper identification of pests, knowledge of the biology of the pest species, the biological control agent(s), and a great deal of time and commitment.** Biological control programs do not look after themselves and need to be maintained properly to be successful.

Here are some examples of biological control agents that are commercially available against specific pests:

Pest	Biological Control Agent	Description
Spider mites	*Phytoseiulus persimilis*	Predator mite that develops twice as fast as two-spotted spider mites
Mealybugs	*Cryptolaemus montrouzieri*	Mealybug destroyer,a small lady beetle.
Whiteflies	*Encarsia formosa* *Eretomocerus eremicus*	Two tiny wasp parasitoids depending on the species of whitefly: *E. formosa* for silverleaf whitefly, *E. eremicus* for greenhouse whitefly
Aphids	*Aphidoletes aphidimyza*, *Aphelinus abdominalis*, *Aphidius colemani*, and *Aphidius ervi*.	Several tiny wasp parasitoids
Thrips	*Amblyseius swirskii* *Neoseiulus cucumeris*	Predatory mites
	Steinernema feltiae	Predatory nematode
Fungi	*Bacillus amyloliquefaciens, Bacillus subtilis, Bacillus pumilus, Streptomyces lydicus, Trichoderma harzianum.* Potassium bicarbonate, hydrogen peroxide.	Bacteria

Resistance to Pests and Disease

Selecting plant species or varieties that are less susceptible to recurring pests and diseases can help to reduce their impact and reliance on pesticides. **Proper horticultural care** of the plants will also minimize plant stress and help plants better maintain their own defenses. Be careful to avoid over- or under-watering of plants. Interiorscapes are inherently stressful on plants, so try to minimize those stresses on plants. Plants may need to be swapped out so that they can recover from long periods in an interiorscape.

Regular Monitoring for Pests and Diseases

Develop a routine to monitor regularly using a consistent method. **Look on the undersides of leaves, on stems and branches for early signs of developing problems.** Keep written records of what you observe so that you are able to detect trends over time. If you can't identify what is causing a problem, take samples to or contact your local Extension Service office.

A written log should be kept of pest type, locality, abundance, and all pesticides applied. Such records can be of long-term benefit as many pests tend to appear at about the same time each year. However, the short-term benefits of written records may be greater. Knowing what pests survive a pesticide application alerts the manager to the possibility of poor timing, poor application, or pesticide resistance in the pest population. A change in strategy, application technology, or type of pesticide can be made before the plants are significantly damaged.

Pesticides

Thorough, timely applications of properly labeled pesticides are another important aspect of an integrated pest control program. **Rotating infested plants back into a greenhouse** where they can be treated thoroughly and revived in vigor before being returned to the indoor landscape is a sound practice but may not be practical with all plants. **Treat commercial landscape areas at night, on weekends, or when a minimum number of people are present. The public should not be allowed in the vicinity of treated plants until the pesticide residue on the foliage has dried completely.**

Keep written records of all pesticides applied. **Regularly rotate among pesticide groups** to change modes of action to slow the development of resistance to a particular pesticide.

Pesticide Applications in the Interiorscape

Because conditions are so varied in the interiorscape, no single pest control program can be suggested. Chances of success using proper pesticides is possible only when the correct material is applied in the correct manner at the correct time to a susceptible stage of the pest. Make certain that interiorscapes and the target pest or disease is on the pesticide label.

Maintenance or preventative sprays may be applied every one to three weeks, depending upon the pest, time of year, and residual activity of a pesticide. An effective maintenance spray program should control any initial invaders and prevent pest populations from developing. It is much easier to maintain pest-free plants than to control established populations. If a preventative program is not used, it will be necessary to inspect plants closely at frequent intervals and apply control measures before pests reach damaging levels.

Spray Applications

Many pesticides are broken-down (hydrolyzed) in the spray tank when mixed with water above pH 7. Be aware of the water pH and when above 7 a buffering solution should be added to **maintain pH in the 6.5 to 7 range**.

Sprays should be **applied only to thoroughly wet the foliage. Excessive volume or concentration of any pesticide may cause phytotoxicity. Both leaf surfaces, especially the underside, must be sprayed.** Proper mixing by adequate mechanical agitation in the spray tank is necessary for best results. For safety and efficacy pesticides should be applied the same day they are mixed with water.

To obtain better coverage and residual persistence of the pesticide, an adjuvant may be recommended. Read the container label and use the material at the concentration specified by the manufacturer. Different pesticides may require different types of adjuvants and the **wrong adjuvant may reduce the effectiveness of some pesticides**. Some formulations already contain the necessary adjuvants. **Always check the label before selecting and using an adjuvant or assessing if one is needed.** If you are using a new spreader-sticker, be careful to evaluate it for any phytotoxic effects on just a few plants. Phytotoxicity can vary by plant species or growth stage.

Formulations

The formulations discussed below are those most commonly used with indoor plantings.

Granular Applications (G)

Granular materials are **applied to the surface of the growing media** in a manner to insure even distribution over the media surface. These are used against pests in the media or with pesticides that have systemic activity. **DO NOT apply them to wet foliage. Following surface application of granular pesticides, the media surface should be watered thoroughly to leach the pesticide into the upper layer of media.** This precaution will make the pesticide quickly available to the plants and position the granules where they are less likely to be contacted by those using the building.

Wettable Powders (WP)

Wettable powder formulations are mixed into water and leave long lasting, uniform residues. Although wettable powders are **considered safer to plants** than some other formulations, they frequently **leave objectionable residues on the foliage**.

Emulsifiable Concentrates (EC)

Emulsifiable formations are liquids that are dissolved in petroleum distillates, sometimes called organic solvents. These form an emulsion when mixed with water. These may cause plant injury in some situations and **should not be used on ferns.**

Suspension Concentrates (SC) and Flowables (F)

These are suspensions of an insoluble pesticide and are **less likely to cause phytotoxicity than emulsifiable concentrates**. They often provide more uniform coverage than wettable powder formulations. SC formulations need to be agitated periodically as they settle out over time.

Water Dispersable Granules (WDG)

Unlike standard granules, these are designed to be mixed with water in the spray tank to dissolve and form a suspension before application. WDGs have less dust than wettable powder formulation. These are simple to measure but **need some time to thoroughly dissolve**.

Compatibility

Spray tank mixtures of insecticides, miticides or fungicides may result in plant injury that does not occur from use of any one of the materials alone. Before materials are tank mixed, study the manufacturer's label carefully. Mixing pesticides that require different types of adjuvants should be avoided. It is best to treat just a few plants with a new combination of pesticides and wait a week for any phytotoxic effects to appear.

Phytotoxicity

Phytotoxicity is generally **characterized by damage to foliage, usually exhibited as marginal burn, chlorosis or spotting**. Plants grown in an interiorscape may be more susceptible to damage. **Distortion or abnormal growth** is also a common symptom of plants injured by pesticides. Although any portion of the plant may be affected, the new growth is most likely to show damage.

Because many plantscapes are usually located adjoining large glass areas, plant damage can be minimized when pesticides are applied during the cooler part of the day. **Avoid applications during hot, sunny weather or when the plants are stressed.**

Read the label for plants that are sensitive to the pesticide. Regardless of the pesticide or mixture of pesticides used, it is strongly recommended that the effects be evaluated on a few plants, under your particular condition before treating all plants. There may be several formulations of a chemical compound available. Concentrations vary and consequently recommendations on the manufacturer's label should be followed explicitly.

Best Practices With Pesticides

All pesticides must be handled with caution. Some pesticides are more toxic than others. Pesticide labels displaying the signal words “DANGER-POISON” are highly toxic need to be handled with extreme care and are not typically used in interiorscapes. Labels with the signal word “WARNING” are moderately toxic and those with “CAUTION” are least toxic.

Pesticide Safety Practices

- A **notebook containing all pesticide labels** for the products used on site and **safety data sheets (SDS)** must be available and accessible at the site for interiorscape technicians. Techicians can use this notebook to obtain complete information associated with the pesticides that are being used.
- Safety precautions, including the use of proper personal protective equipment (PPE), printed on the label must be followed.
- Pesticides **must be labeled for interiorscapes** and that you have a label in possession when using them.
- Read the entire label, including the small print, before opening the container. Labels are designed to protect personnel who are going to apply the pesticide.
- Use all of the personal protective equipment as listed on the label. Avoid getting pesticides on your skin or in your eyes or near your mouth nose or eyes. If you get pesticide on your skin, promptly wash the area with soap and clean water. If any pesticide gets in your eyes, flush your eyes with clean water for 15 minutes and seek medical attention. After completing the application, wash exposed with soap and water.
- Never smoke, eat, or drink while handling pesticides.
- Do not apply more pesticide than allowed by the label. This can result in plant injury or jeopardize the safety of technicians. This is also a violation of regulations.
- Allow plenty of time after applying pesticides so **plants are completely dry before people are present** in the area.
- Use **low pressure to prevent contamination of non-target areas** (pools, seating and food areas, etc.), spray only to point of glisten (not dripping) and use plastic drop cloths. Drop cloths used for shielding purposes should be handled carefully to avoid exposure.
- Store pesticides in original closed and labeled containers, out of reach of children, irresponsible people, pets, and preferably keep pesticides under lock and key.
- Store application equipment out of reach of children and adults. **Always designate and use one sprayer for insecticides and miticides and another for fungicides.**
- **When containers are empty, rinse with water three times and pour rinsing into spray tank**. Rinse water should be applied to interiorscape plants or plants that have been moved outdoors. Dispose of empty containers promptly and safely.
- Maintain records of your applications.
- **Always launder pesticide contaminated clothing separate from non-contaminated clothing**.

- If you become ill during or shortly after applying a pesticide, seek medical attention immediately. Have the name of the active ingredients of the pesticide for the label. Follow instructions on the label for first aid treatment.

Calibration of Application Equipment

Pesticide applications must be accurately calibrated to be effective and safe. Proper calibration ensures the correct amount of spray is prepared to minimize leftover solutions for disposal. Calibration is the process to determine the correct amount of pesticide to apply to manage a pest or disease. Each type of equipment used to apply pesticides needs to be calibrated. There are two methods used to calibrate equipment; the concentration and volume methods.

The **concentration method** is commonly used for interiorscape pesticide applications when the pesticide label lists rates as concentrations of sprays to be applied. It involves knowing how much water it will take to treat the plants in the landscape and then determining the amount of pesticide to mix in water to obtain the concentration listed on the label.

The procedure for calibrating for concentration method applications consists of the following:

1. Fill the spray that will be used to apply the pesticide with water only.
2. Select a plant representative of those to be treated and apply the water until the leaves glisten (just before run-off).
3. Measure the amount of water used.
4. Multiply the amount of water used by the number of plants to be treated. This is the total volume of water needed for the application.
5. Determine the amount of pesticide to get the desired concentration, as listed on the pesticide label, based on the volume of water determined in the previous step. Add this amount to the water and mix thoroughly.

The **volume method of calibration** is used when the label specifies how pesticide is used per plant or per area to be treated. To use this method you need to know size of the area to be treated and amount of water needed to treat this area. The procedure is as follows:

1. Fill the spray that will be used to apply the pesticide with water only.
2. Measure and mark-off a known area on concrete or asphalt. Spray the area as you would when making the application to plants using the same walking speed, nozzle height, overlapping pattern, and sprayer pressure.
3. Measure the amount of water needed to treat the calibration area of known size.

4. Determine the area in the interiorscape needing treatment. The amount of water need to treat this area is the amount of water used divided by the area in the calibration exercise multiplied by the area needing treatment.

Example:
It took 0.5 gallons of water to treat 250 square feet during calibration.
Plants needing treatment cover an area of 1500 square feet.

Water need = (0.5 gal./250 sq ft)*1500 sq ft = 3 gallons water

5. Determine the amount of pesticide for the area based on the rate on the label.

Example:
The label states that 1.5 fluid ounces is used per 1000 square feet and
we have 1500 square feet of plantings to cover.
Divide the area to be treated by 1000 sq ft and multiply by the labeled rate.

Pesticide needed = (1500 sq ft/1000 sq ft)*1.5 fl oz = 2.25 fl oz

6. Mix the measured amount of pesticide with sufficient water to cover the area to be treated. Mix thoroughly and make the application.

Material in this chapter adapted from Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Bulletin S-33 Interior Landscape Pest Management. F. Miller (PSEP Coordinator), R. Cloyd, and M. Kennelly.