COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY • COLLEGE OF AGRICULTURE

Training Manual for Ornamental and Turf Pest Control

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Introduction

This manual, when used with the core manual Applying Pesticides Correctly, provides information to meet minimum EPA standards for certification of commercial applicators in Category 3, Ornamental and Turf Pest Control.

Identification or recognition of pests is essential to proper pesticide application. Once the pest has been identified, the best control method must be chosen. If a pesticide is to be used, the commercial ornamental or turf pesticide applicator should know proper application techniques and understand potential dangers and side effects of the pesticide. This publication discusses how to recognize common insects and the damage they cause, weeds, and symptoms caused by disease agents on ornamentals and turf. Recommendations for control of these pests are available at your county Extension office.

A list of useful publications for ornamental and turf applicators is in the Appendix.

Contents

Introduction 1
Be an Informed Pesticide Applicator 1
Avoid Phytotoxicity 2
Minimize Pesticide Hazards to the Environment 3
Worker Protection Standard 3
Pesticide Laws 4
Pesticide Toxicity 4
Calculating Areas for Pesticide Application 5
Application Tips 5
Safety Tips 5
Diseases of Ornamentals 6
Insect and Mite Pests of Ornamentals 11
Turf and Ornamental Weeds 14
Turf Diseases 19
Insect Pests of Turf 22
Vertebrate Pests of Turf 23
Appendix 24

Be an Informed Pesticide Applicator

1. Know your local agricultural and horticultural Extension agents. Ask them for printed information on local pest control recommendations, pesticide usage, precautions to follow, and results to be expected. Keep current copies of pesticide suggestions and spray schedules.
2. Be aware of the mode of action of pesticides you are using. Broad spectrum pesticides tend to be nonselective and active against many pests. Selective pesticides tend to be active against specific pests and less damaging to non-target organisms. Systemic pesticides are absorbed by plants and moved to other parts, providing effective control of the plant or pests on the plant.
3. Know as much as possible about the insect, weed, and disease problems of the turfgrasses, flowers, trees, and shrubs that you are responsible for. If you cannot identify a problem or need to know how much of a threat a particular pest may represent, get help from your county Extension office.
4. Know about cultural and biological control alternatives to applying a pesticide. Select the safest, most effective, and most economical means of control.

5. Learn to recognize beneficial insects such as ladybird beetles, syrphid flies, and aphid lions. Carefully check for insects dead or dying from disease. Know what effect weather conditions may have on insect pest buildup. Avoid using pesticides if natural forces are likely to bring the pest population under control.
6. Remember that many environmental conditions such as temperature extremes, water or humidity, air pollutants, pesticide injury, and other noninfectious agents can produce symptoms that mimic plant disease and mite or insect injury.
7. Know the resistant turfgrass, flower, tree, and shrub varieties recommended for Kentucky. Encourage use of species that are more tolerant of pests.

Avoid Phytotoxicity

Phytotoxicity, or unintentional pesticide damage to plants, results in abnormal growth, foliar burn, leaf drop, and discolored, curled, and spotted leaves (Figure 1). If phytotoxicity is severe, the plant may die. Phytotoxicity often resembles such other problems as insect damage, plant disease, and poor growing conditions such as insufficient moisture and improper fertilization. The following contribute to accidental plant injury by pesticides:

- The wide variety of plant material involved in ornamental pest control
- Pesticide drift
- Pesticide persistence beyond the intended period of pest control

Wide Variety of Plant Material

Ornamental plants include herbaceous, semi-woody, and distinctly woody species. Generally, herbaceous plants (chrysanthemums, petunias, turfgrasses, etc.) are more susceptible to pesticide damage than woody plants, and the woody plants are more susceptible when growth is young and tender.

Accidental plant damage is most likely to occur with herbicides, since their function is to injure certain kinds of plants. For example, herbicides used to kill broad-leaved weeds in turfgrasses may also injure broad-leaved ornamental trees, shrubs, and flowers if not used properly. Insecticides and fungicides can cause injury to certain sensitive species of plants and also to normally tolerant plants under unusual conditions such as hot weather. The pesticide label is the best guide for the safe use of pesticides on a specific ornamental plant. If the pesticide is not known to be safe for use on a specific ornamental plant, it should not be used. Greenhouses present a special problem because phytotoxic vapors tend to be trapped in the closed environment, exposing all plants within the greenhouse to the pesticide.

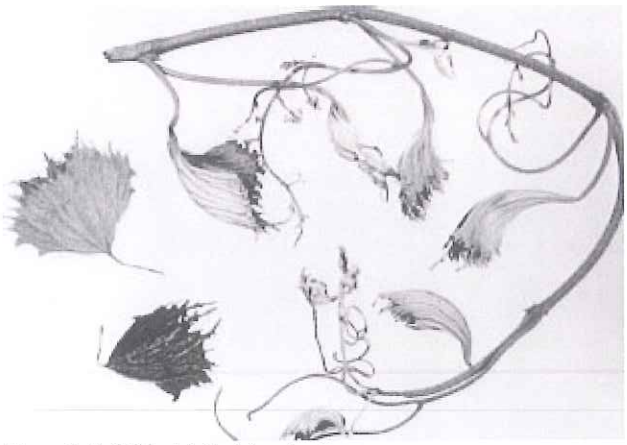


Figure 1. 2,4-D herbicide injury to grape

Drift Problems

The proximity of different plants with varying susceptibility to pesticide damage requires that commercial ornamental and turf pesticide applicators be especially aware of drift problems. Several steps can be taken to prevent damage to non-target plants.

Drift can be prevented or minimized by using methods described in a later section. If possible, select pesticides that are safe for both target and non-target plants. It may be necessary to place a barrier around the target plant or remove susceptible plants from the area (such as removing susceptible potted plants from a greenhouse). A decision may have to be made whether or not to apply a pesticide to the target plant if the benefit does not justify the hazard to nearby plants.

Persistence Beyond the Intended Period of Control

Persistence is an important part of pest control, since successful pest control requires a knowledge of the persistence period to make subsequent applications. A persistent chemical has an advantage for long-term pest control because fewer applications are needed.

The period of pesticide residual activity varies greatly from one class of pesticides to another. Persistence is directly related to the rate of application, soil type or texture, temperature, moisture conditions, rainfall, and other factors. Commercial applicators must be familiar with the persistence of each pesticide that may be applied to ornamentals and turf, especially where adjacent areas may be affected or where treated soil is used to grow other plants. When different plants are rotated in the same soil, phytotoxicity can be a problem because a pesticide used to control some pests on one plant may leave residues in the soil that will damage or kill another plant. Information on the persistence of a given pesticide can be found on the product label.

Minimize Pesticide Hazards to the Environment

Turf and ornamental pesticides must often be applied in areas that humans, as well as pets and other domestic animals, frequently use. The pesticide applicator must be constantly alert to the hazard associated with this situation. Primarily, the problem is twofold: (1) hazardous amounts of pesticides must be prevented from drifting into non-target areas; and (2) humans, pets, and other animals must be prevented from contacting hazardous amounts of pesticides within the treated area.

Preventing or Minimizing Drift

Where several pesticides are available, the applicator should strongly consider the hazard and toxicity of the active ingredient in making a choice. Use formulations and methods of application that will minimize drift.

Air blast sprayers can be used in ornamental and turf pest control if very safe pesticides are used (toxicity to applicator and non-target plants is low). Air blast sprayers should never be used to apply herbicides.

Two types of drift are associated with pesticides. The most common, drift of spray droplets or dust particles, is directly affected by such things as spray pressure, nozzle opening size, wind velocity, and pesticide formulations. Lower sprayer pressures will result in larger droplet sizes and less drift potential. The same is accomplished with larger nozzle opening sizes. Movement of a chemical with low vapor pressure (or high volatility) termed "vapor drift," is a second kind of drift. Vapors or gases can drift in harmful concentrations—even in the absence of wind. Fumigants, such as methyl bromide, must be confined so they will not drift from the treated area (proper sealing with a plastic tarp is essential). Some pesticide products are volatile, or capable of vaporizing from soil and leaf surfaces in potentially harmful concentrations after application. Herbicide vapor can severely damage and even kill desirable plants.

Groundwater Advisories

The potential for contamination of groundwater is an important consideration when choosing pesticides. Several products have groundwater advisory statements on their label. Such statements advise not to apply these products where the water table (groundwater) is close to the surface and where the soils are very permeable (well drained soils such as loamy sands). Refer to these statements and observe all precautions on the label when using these products.

Protecting Humans, Pets, and Domestic Animals

Before applying a pesticide, the application site should be cleared of such things as toys, pet food dishes, bird feeders, and other articles. Pesticide residues on these articles can be a hazard.

Animals and humans should be kept from the area during pesticide application. (They should also be kept from the area of potential drift and run-off until the spray has dried or the dust has settled, regardless of the toxicity of the pesticide used.) Some pesticides may be potentially hazardous for a longer time; therefore, label directions concerning reentry should be closely followed.

Highly toxic systemic insecticides should not be used on plants just before they are sold to the public. It is possible that in the process of selecting a plant, customers may handle the soil and be exposed to the active chemical. In commercial operations, it is necessary to hold the plants until the chemical has lost its toxicity. Recently sprayed ornamental plants with showy flowers or edible fruits present a special hazard because they are likely to be handled or even eaten by children.

Earthworms

Earthworms are important, beneficial invertebrates in turfgrass, where their burrowing and feeding activity enhances soil structure and fertility and incorporates thatch and other plant residues into the soil. Certain pesticides can significantly reduce earthworm populations with long-term effects. Preservation of earthworms and other beneficial soil invertebrates may be critical to long-term stability of the turfgrass ecosystem.

Worker Protection Standard

The U.S. Environmental Protection Agency (EPA) has issued final rules governing the protection of employees on farms, and in forests, nurseries, and greenhouses from occupational exposure to agricultural pesticides. The new Worker Protection Standard (WPS) covers:

- **Agricultural Workers**—performing tasks related to the cultivation and harvesting of plants, including pruning, sucker removal, watering, and potting.
- **Pesticide Handlers**—assigned to mix, load, or apply agricultural pesticides; enter greenhouses to operate ventilation equipment after applications; handle equipment with residues; adjust or remove soil fumigant coverings, etc.

In greenhouses, employers must ensure that workers and other persons do not enter specific areas during, and in some instances, after certain pesticide applications. In nurseries, employers must make sure that during certain pesticide applications, workers and other persons do not enter treated areas on the nursery. Employers affected by the WPS must post specific types of information at a central

location, provide decontamination sites, provide emergency assistance if needed, provide pesticide safety training, give notice about pesticide applications, and provide personal protective equipment.

All pesticide products affected by the WPS will carry a statement under the *Agricultural Use Requirements* section of the labeling. This statement will instruct users affected by the WPS to comply with all provisions of the WPS. For more information about the WPS, please contact your local Cooperative Extension Service Office or the Division of Pesticides at (502) 564-7274.

Pesticide Laws

The state government agency that regulates pesticides in Kentucky is the Division of Pesticides. Some of the more important points from the laws and regulations they enforce are: Within Category 3, there are two types of licenses:

- **Pesticide Applicator**—any person employed by a pesticide applicator who operates equipment for the application of pesticides or applies pesticides manually.
- **Pesticide Operator**—any person who owns or manages a pesticide application business which is engaged in the business of applying pesticides upon the lands of another.

Separate examinations are given for each type of certification. Certification is valid for five years.

Licenses

No person shall engage in the business of applying pesticides to lands of another at any time without a **Pesticide Applicators license**. A license can be obtained after passing the Category 3 applicator examination and paying a fee. **Operators** also need a license, which can be obtained by taking and passing the Category 3 operator exam and paying a fee.

Recertification

To maintain certification, at least two training programs approved by the Division of Pesticides must be attended during the five years of validity. If this qualification is met, no test or fee will be required.

Recordkeeping

All commercial applicators who purchase, use, or apply restricted-use pesticides must maintain application records for a period of three years from the date of use or application. Required records include the following information:

- Name and address of person requesting services
- Kind and amount of pesticide(s) applied
- Date of use or application
- Purpose of application
- Area of land treated, where applicable
- Crop or type of area treated
- Name of person with certification to purchase, use or apply restricted-use pesticides
- Pesticide dealer where restricted-use pesticides were purchased
- Street address or site of use or application

Posting

Kentucky laws require posting of treated turf areas accessible to the public, informing people that a pesticide has been used. The lawn marker must be at least a 4 x 5 inch white sign attached to a supporting device at least 12 inches long. Lettering on the sign must be easily read (at least 3/8 inch high) and must read on one side "LAWN CARE APPLICATION—PLEASE STAY OFF GRASS UNTIL DRY." The lawn marker can be removed by the property owner or other authorized person the day following application.

Any customer or neighbor next to a customer may receive prior notification 24 to 48 hours in advance of application by contacting the applicator. The applicator then needs to provide notification in writing, in person, or by telephone, of the date and approximate time of application. The applicator needs to provide customers with written information concerning lawn chemical application procedures and other general guidelines about the safe use of lawn chemicals.

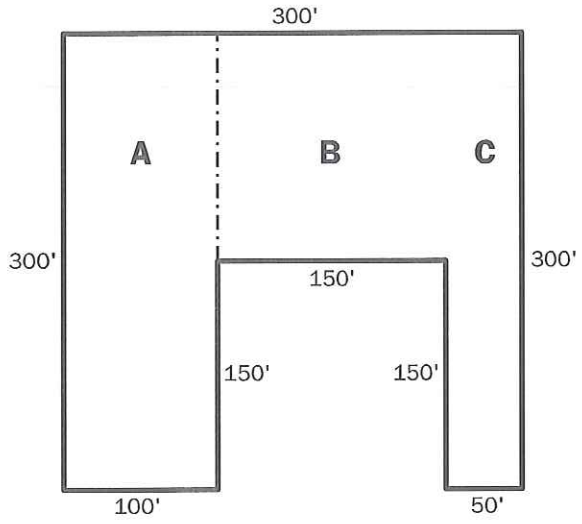
Pesticide Toxicity

Toxicity is the capacity of a chemical to cause injury. Pesticides, by their nature, must be toxic in order to destroy pests. The more toxic pesticides cause injury at smaller doses and therefore are more hazardous. One way to measure the toxicity of a pesticide is by giving test animals known doses and observing the results. In this way a lethal dose or lethal concentration is established; this information is used to predict the hazards to people and nontarget organisms.

Pesticide toxicity is rated by determining the amount, or lethal dose, that will kill 50% of a test population of animals, referred to as the LD_{50}. LD_{50} is expressed as milligrams (mg) of pesticide per kilogram (kg) of body weight of test animal (mg/kg). Toxicity is also rated by measuring how much pesticide vapor or dust in the air or what amount of pesticide diluted in river, stream or lake water will cause death of 50% of a test animal population. This is *lethal concentration* or LD_{50}. Lethal dose or lethal concentration classifications do not provide information about chronic, long-term toxic effects.

Calculating Areas for Pesticide Application

When calculating areas to be treated with pesticides, divide larger areas into smaller sections that are easier to calculate. As an example, the large area below can be divided into squares or rectangles and then figuring the area for each one. Adding these areas together will give you the total area to be treated.



A = 300 x 100 = 30,000 sq. ft.
B = 150 x 150 = 22,500 sq. ft.
C = 300 x 50 = 15,000 sq. ft.
Total Area = 67,500 sq. ft.

Application Tips

- Use the proper size sprayer or duster for the job at hand. Smaller equipment is often more useful around home landscapes. Use the right kind of nozzles.
- Use separate spray equipment for certain types of weed control work. Many herbicides cannot be completely washed out of the spray tank.
- Carefully adjust and calibrate equipment.
- Consider using equipment that is convenient to mount and dismount as well as to operate.
- Use proper pressure for spraying. Avoid high pressures (above 30 psi) for weed control work.
- Be sure that everyone in the spray crew knows what chemical or pesticide is being applied.
- Never leave spray puddles on hard surfaces that may attract children, pets, or birds.
- The efficiency of some pesticides can be improved by adding surfactants (spreader-stickers) to the spray mix.
- The amine formulation of 2,4-D is less volatile than the ester form and less likely to cause drift problems.
- Know where beehives are and notify the beekeeper before applying insecticides to nearby areas. Sevin is very toxic to bees. The safest time to apply insecticides to plants without harming honey bees is in the evening after 7 p.m.
- Do not apply any fungicide or insecticide spray when the temperature is 85°F or above. Early morning or early evening application is best in hot weather.
- Do not apply fungicide-oil sprays if the temperature is below 45°F.
- Prepare only enough spray to complete the job at hand.
- Never use unlabeled or unregistered pesticides.
- Before applying a pesticide, be absolutely sure where and what to spray. If you are a supervisor, give explicit instructions that cannot be misunderstood.

Safety Tips

- Transport pesticides in truck beds—not in the driver's compartment. Do not transport pesticides, other than small packages of household pesticides, in the passenger compartment or trunk of a vehicle. Pesticide fumes can be dangerous and in case of an accident, the pesticide container may rupture and spill on occupants.
- Observe directions, restrictions and precautions on pesticide labels. Failure to do so is not only dangerous and wasteful; it is also illegal.
- Mix pesticide solutions in a well-ventilated area, preferably outside. Avoid inhaling pesticide sprays or dusts.
- Use pesticides at correct dosages and intervals to avoid excessive residues and injury to plants and animals.
- Apply pesticides carefully to avoid drift, especially where water supplies, vegetable gardens or fruit trees are nearby.
- Use proper safety equipment and needed protective devices. While these devices may be available, they serve no purpose unless used.
- Never smoke, drink or eat while handling or applying pesticides.
- Store all pesticides behind locked doors in original containers with labels intact.
- Dispose of properly rinsed pesticide containers so that contamination of water and other hazards will not occur. Recycling programs are becoming more available.

Diseases of Ornamentals

Infectious diseases of ornamentals and turf are caused by parasites—fungi, bacteria, viruses, phytoplasmas, and nematodes. All the plant pathogens (parasites) discussed in this manual are microscopic; therefore, disease identification requires a recognition of symptoms—the reaction of plants affected by these organisms. These symptoms may include leaf spotting, chlorosis, cankers, galls, wilting, and decay of roots. Three factors necessary for a disease to develop are the pathogen being present, a susceptible host plant, and the proper environmental conditions.

Sometimes, adverse growing conditions or environmental factors produce symptoms similar to those of plant diseases. These problems need to be distinguished from plant diseases. Problems such as frost injury, dog urine burn, nutrient deficiencies, drought, girdling roots, changes in grade, chemical injury, air pollution injury, and mechanical damage are not corrected by fungicide applications.

By knowing the disease-causing organisms, the proper chemical or cultural practice can be chosen to control the problem. A root problem identified as a root rot when it is actually a nematode infestation will not be cured by applying a fungicide; a nematicide is required.

Accurate identification and diagnosis is an art as well as a science, and experience is essential. This section is not intended to make anyone an expert in identifying diseases. It is meant to acquaint the pesticide applicator with the general symptoms of diseases. For more accurate disease diagnosis, consult your county Extension agent.

Diseases Caused by Fungi

Fungi are many-celled microbes that feed on living green plants or on dead organic material. When they attack living plants, a disease occurs. Fungi usually produce spores which, when carried to a plant, can begin an infection. These spores may be carried from plant to plant by wind, water, insects, and tools. Fungus spores require adequate moisture and the right air temperature to begin new infections. A plant wound is sometimes also needed as an entry for the fungus. Many fungal diseases are common during wet, humid seasons. Chemicals used to control fungi are fungicides. Usually, fungicides are applied to prevent, not cure, fungus disease.

Leaf Spots—Fungal leaf spots (also known as anthracnose, scab, leaf blotch, or shot hole) are usually definite spots of varying sizes, shapes and colors (Figures 2 and 3). The spots have a distinct margin and are sometimes surrounded by a yellow halo. Spots or dead areas may enlarge to cover an entire leaf. As the spots become more abundant, leaves may yellow, die, and drop. Usually, leaf spots first occur on the lower leaves and progress up the plant. Fungus growth in the spot may consist of tiny pimple-like structures or a moldy growth of spores. A hand lens or microscope may be needed to see these symptoms.

Leaf spots are more common in the early spring and fall when an abundance of moisture, necessary for infection, is present. When infected leaves fall and become part of the refuse around a plant, fungus spores may be produced. If carried to healthy plants, these spores can begin a new infection under appropriate environmental conditions. Leaf spots occur on virtually all ornamental plants.

Leaf blights may have the same effect on plants as leaf spots, but are generally larger diseased areas and less regular in shape. Dogwood anthracnose disease may begin as a leaf spot, become a leaf blight, and even progress to twigs and branches, causing dieback.

Rust—Rusts often produce spots called pustules that are similar to leaf spots (Figures 4 and 5). Pustules may be on the upper and/or lower leaf surface and are brown, reddish brown, orange, or yellow. Rust pustules are usually raised above the leaf surface, and rubbing the affected leaf surface will leave a dusty rust color (caused by the spores) on fingers. Rust fungi may also attack twigs, branches, and fruit.

Rust spores are often carried by wind and can be blown from infected plants to healthy plants, spreading the infection.

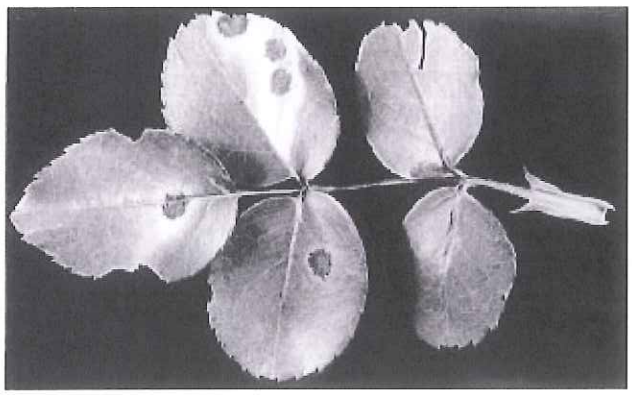


Figure 2. Black Spot—Rose

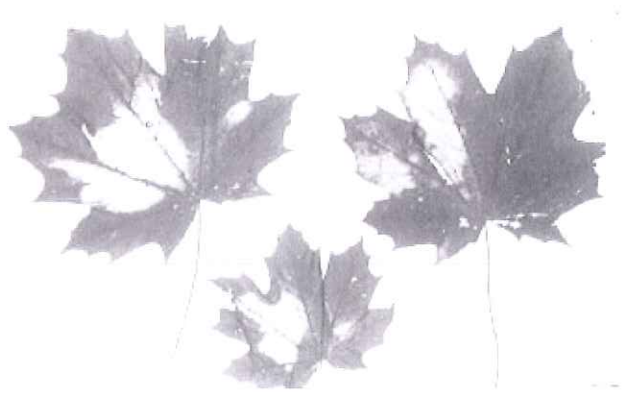


Figure 3. Anthracnose of maple showing dead areas along the leaf veins.

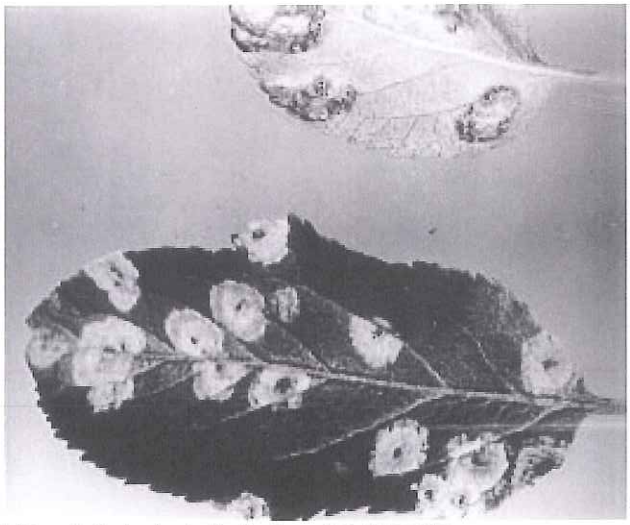


Figure 4. Cedar-Apple Rust—Flowering Crabapple

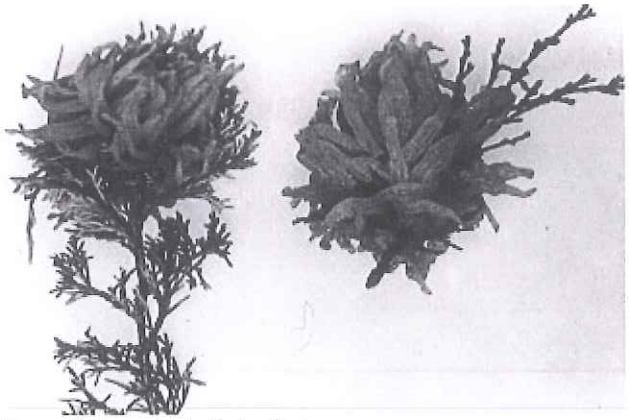


Figure 5. Cedar-Apple Rust—Cedar

Rust diseases have very complicated life cycles and, in many cases, require two separate hosts to complete their life cycle. In such cases, removing either one of the hosts can break the cycle and stop rust. Cedar-apple rust and related rusts are common ornamental disease problems.

Powdery Mildew—The typical symptom of powdery mildew disease is the white or gray layer of fungus growth produced on the surface of the plant leaves and stems (Figure 6). Plants affected by powdery mildew may also show crooked stems or bubbled and curled leaves. Spores produced by the fungus can be blown by the wind or carried by rainsplash to new plants, initiating new infections. The fungus produces small, black, overwintering structures that can withstand the cold winter. Roses, oaks, tulip poplars, lilacs, zinnias, and euonymous are commonly affected by powdery mildew.

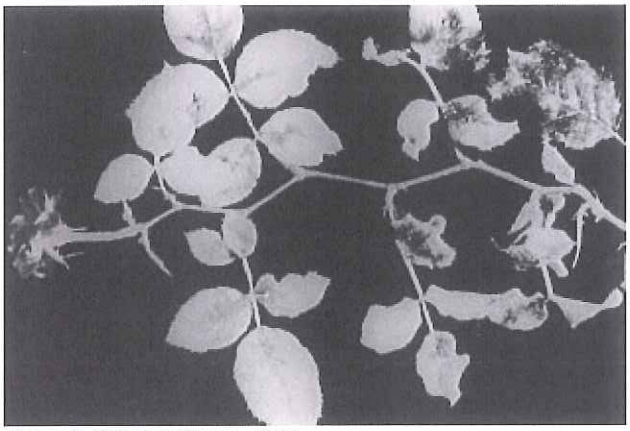


Figure 6. Powdery Mildew—Rose

Leaf Galls—Leaf gall diseases are caused by fungi and are favored by cool, moist weather. However, some galls are caused by insects or mites. Leaf galls can usually be seen shortly after new growth begins in the spring. Part of the leaf becomes distorted with a pale green to whitish bladder-like thickening. The young, thickened, fleshy leaf is covered with a white growth. As the galls age, they turn brown, dry up, and fall to the ground. If the disease is severe, plant vigor can be affected due to leaf loss. The dead, dry leaves which have fallen to the ground will be a source of spores for infection the following season. Leaf galls occur on azalea, camellia, and plum (Figure 7).

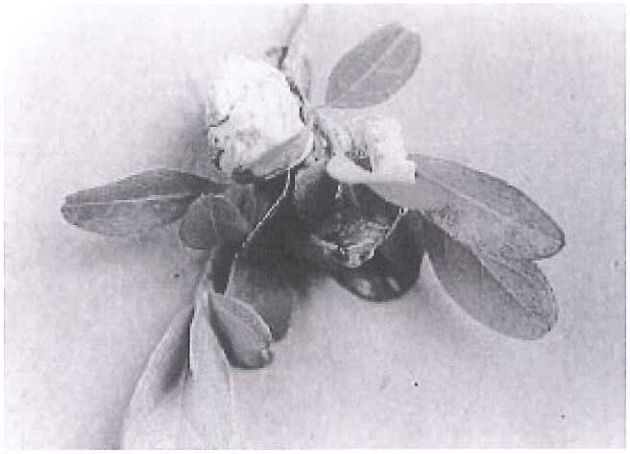


Figure 7. Azalea Leaf Gall

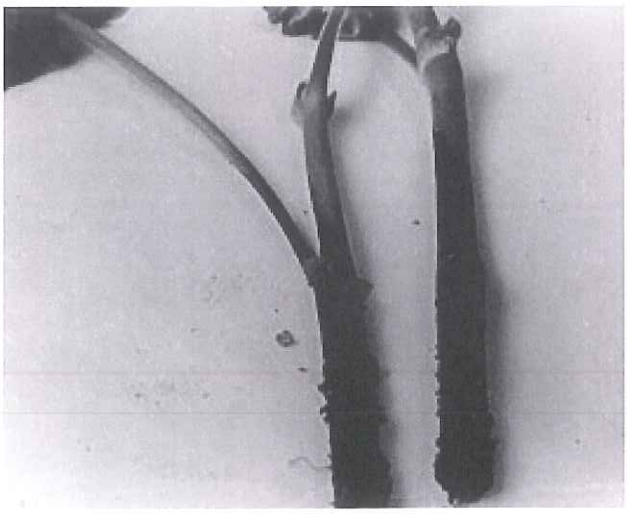


Figure 8. *Pythium* Root Rot—Geranium

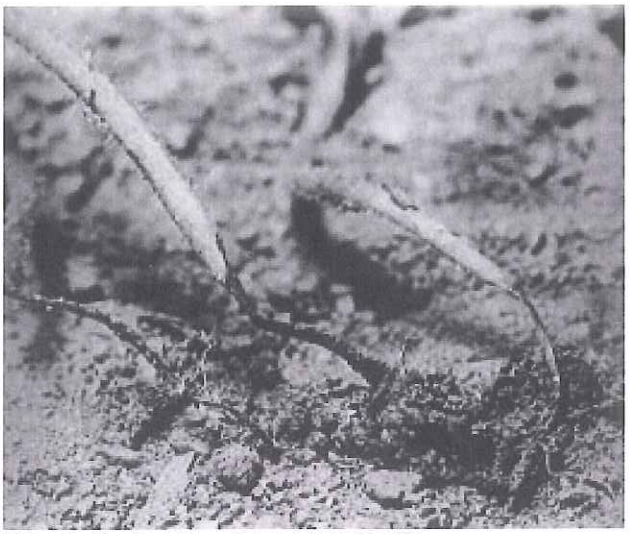


Figure 9. Seedling Stem Rot and Damping-Off

Root Rot—The first symptoms of root rot generally appear on the above-ground parts as a gradual loss of vigor, yellowing of leaves, or wilting. Attempts to correct the problem with fertilizers and water generally yield little or no response. Diseased roots appear decayed, generally brown to black, and may be mushy or spongy (Figure 8). The fungi*Pythium, Phytophthora, Fusarium, Rhizoctonia,* and *Thielaviopsis* are common root rotting organisms. Excess soil moisture favors root rot disease on ornamental plants.

Stem Rot—The pathogens commonly associated with stem rot of ornamentals (Figure 9) include *Pythium, Phytophthora, Rhizoctonia, Sclerotium,* and *Botrytis*—all common soil-inhabiting fungi. These fungi can be spread in infected debris, on cuttings, or when soil is moved.

Affected plants wilt slightly, become more severely wilted, and eventually die. The stems may be brown and shrunken at the soil line. Under extremely moist conditions, the white, cottony fungus mycelium may be visible on the surface of the stem. Chrysanthemums, geraniums, petunias, and other herbaceous ornamental plants are quite susceptible to stem rot. Damping-off kills ornamental seedlings when seedling roots and stems decay.

Cankers—Cankers are localized diseased areas on trunks, stems, or branches of woody plants such as shrubs and trees. Canker diseases cause bark tissues to shrink and die. The dead tissues then crack open and expose the wood underneath (Figure 10). Cankers begin as small, discolored yellow, brown, or red spots that sometimes appear watersoaked. These spots enlarge and their centers may become tan or gray. Small, black, pimple-like structures (fungus fruiting bodies) may form in the canker. Cankers can enlarge and girdle the stem, causing death to parts of the plant above the canker. The fungi causing cankers usually begin infection in a wound or injury to the bark or wood of the plant. Rose canker is a common example of a disease showing this symptom.

Figure 10. Nectria canker—Black Cherry

Figure 11. *Verticillium* wilt—Jerusalem Cherry

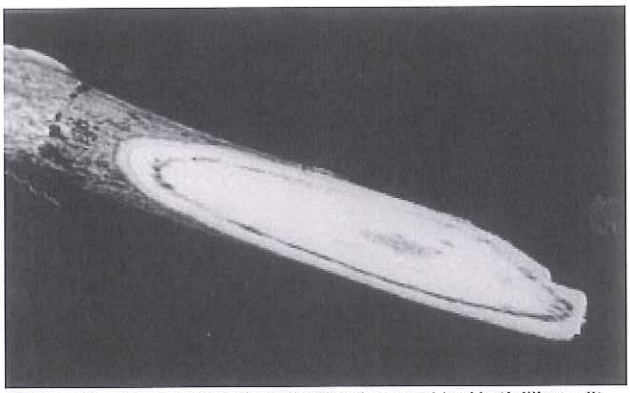


Figure 12. Discoloration of Maple Wood caused by *Verticillium* wilt

Vascular Wilt—Fungus parasites such as *Fusarium, Verticillium*, and *Ophiostoma* can cause wilting of many ornamental species by restricting the water flow to leaves and stems. The wilting caused by such parasites is sometimes due to the toxins they produce; later, the water-conducting vessels may become plugged by fungus growth. Vascular wilt diseases often affect one side of the plant first, causing individual limbs or branches to wilt and die back (Figure 11). *Fusarium* and *Verticillium* infections usually begin in the roots and gradually spread internally throughout the infected plant. *Verticillium* wilt of maple is an example of this kind of vascular wilt. The fungus *Ophiostoma*, the cause of Dutch Elm Disease, usually initiates infections in the top of the tree, in the crotches of small branches where wounds have been created by the feeding of elm bark beetles. The wilt-causing fungus slowly spreads internally throughout the tree, gradually killing it. Symptoms of vascular wilt disease often include discolored streaks in the wood of infected branches (Figure 12).

Diseases Caused by Bacteria

Bacteria are single-celled microbes. Some bacteria attack living plants and cause plant disease. Bacteria can be carried from plant to plant by wind, rain splash, insects, and tools. Few bacterial diseases can be controlled using chemical bactericides.

Crown Gall—Crown gall first appears as a soft swelling of the roots or stems. As the disease develops, the swelling enlarges, becoming firmer and darker. The outer surface of the gall may become rough (Figure 13).

Crown gall bacteria may survive in the soil for years in slowly decomposing galls from a previous crop. The bacteria enter the plant only through wounds and natural microscopic openings. Once inside, normal cell development of the plant is altered. After galls have fully developed, they begin to decompose and release additional bacteria that can reinfect the plant or infect new plants. Euonymous and rose are frequently affected by crown gall.

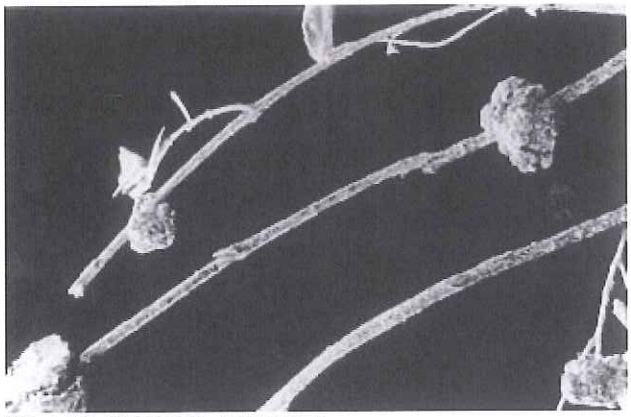


Figure 13. Crown Gall—Euonymous

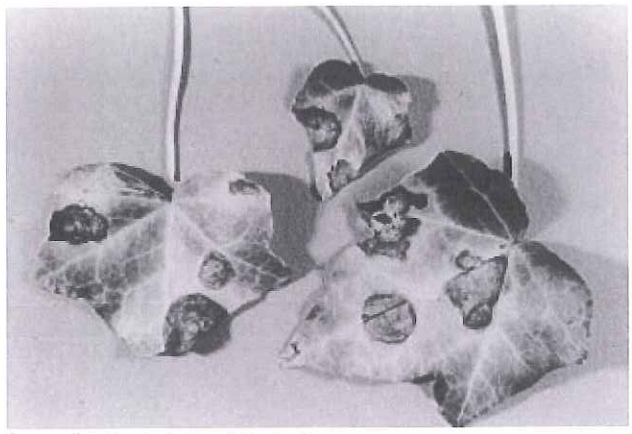


Figure 14. Bacterial Leaf Spot—Ivy

Bacterial Leaf Spot—Bacterial leaf spot may begin as a light green, water-soaked area. Later, the spots may turn brown to black (Figure 14). These spots generally are more irregular in shape than fungal leaf spots. Under warm, moist conditions, the leaf spot will appear soft and mushy. However, under dry conditions, the same spot may be brittle.

Figure 15. Fire Blight—Flowering Crabapple

Figure 16. Fire Blight Canker—Flowering Crabapple

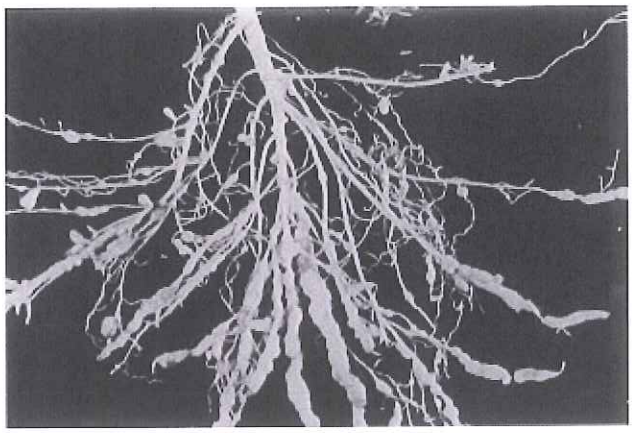


Figure 17. Root Knot Nematode Galls

The bacteria generally overwinter in plant debris and are introduced to the plant by splashing rain or through watering. Bacteria require either a wound or a natural opening for entrance into the plant. Once inside, the bacteria multiply enough to cause symptoms, and leaves may fall prematurely. Infected leaves become a source of bacteria the following year. This disease occurs frequently on ivy.

Bacterial Blight—Fire blight is perhaps the most common bacterial blight, affecting a large number of woody plants. It is commonly found on flowering pears and crabapples, cotoneaster, and pyracantha.

Infection generally occurs in the spring and may be more damaging during long periods of cool, wet weather. The bacteria, which overwinter in stems and in bud scales, can be transported by bees during pollination so that symptoms may occur on blossoms and fruit spurs.

Symptoms first appear on new shoots as a dark discoloration as if the leaves and twigs have been scorched by fire (Figure 15). Later, discolored, sunken cankers may appear on infected limbs and branches (Figure 16). Entire plants may be killed.

Bacterial Leaf Scorch—This disease of shade trees causes premature leaf browning and loss in late summer. Individual leaves may have brown margins due to the bacterial pathogen living in the tree xylem. Infected trees gradually decline. Bacteria are thought to be transported by certain leafhoppers.

Diseases Caused by Nematodes

Nematode injury—Nematodes are microscopic worms that live in the soil and feed on plant roots. In some cases, they even feed on leaves and stems. Many different types occur in the soil and, under certain conditions, build up to high populations that can affect plant root development. Some nematodes cause swellings on roots (Figure 17); others simply kill the tips of feeder roots. The above-ground symptoms of nematode damage may include wilting, yellowing of foliage or stunting, and a general decline of the plant. It is difficult to distinguish between the symptoms of some kinds of nematode damage and root rot infection. Laboratory analysis of soil near the affected plant or an examination of the roots is essential for a definite diagnosis. Root-knot of boxwood is an example of a nematode disease of ornamentals.

Diseases Caused by Viruses and Phytoplasmas

Viruses and phytoplasmas are extremely small microbes that cause plant diseases. Those infecting ornamentals usually produce symptoms such as chlorosis, leaf scorch, mottling, ring spots, and deformed growth (Figure 18). Infection occurs in wounds made by insects or mechanical means. These pathogens can be carried from one plant to

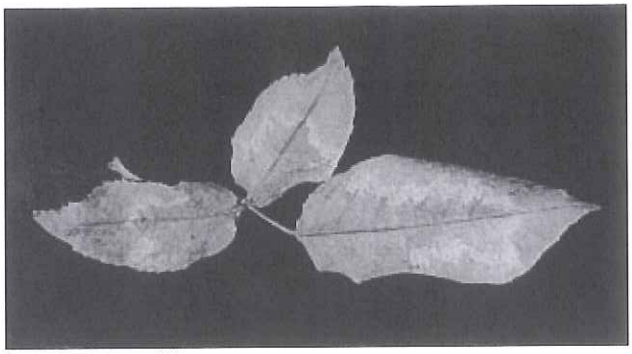


Figure 18. Rose Virus

another by feeding insects, on or in seeds, by pruning equipment, or by hands and clothing. These diseases, which may affect woody and herbaceous ornamentals, are not usually controlled using pesticides.

Insect and Mite Pests of Ornamentals

A wide variety of insects and mites can attack ornamental plants. Other insects observed may be predators or parasites of these pests. One of the more notable predators, the lady beetle, can arouse attention by aggregating around homes in the fall, looking for favorable overwintering sites. Still others may only collect nectar or pollen or scavenge on dead or dying plants. You can get help with identification from your county Extension agent, Extension entomologist, or other source. Some common pests attack many different kinds of plants and will become familiar to you.

Ornamental pest insects may be divided into two groups by the way they feed: (1) sucking types (scales, aphids, mealybugs, whiteflies, true bugs, thrips, and mites); and (2) chewing types (grasshoppers, beetles, sawflies, and caterpillars).

Some types of insects, such as aphids, thrips, and leafhoppers, can spread diseases to healthy plants.

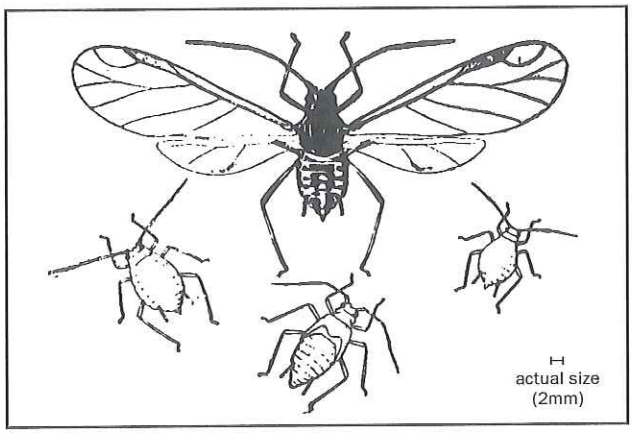


Figure 19. Aphids

Insects with Sucking Mouthparts

Pests with sucking mouthparts cause similar types of damage. Using their mouthparts, the pests pierce or rasp tissue so they can suck plant juices. Damaged foliage is usually mottled, but other symptoms may be wilting, scorched leaf tips, or puckering and curling. When sooty mold occurs on plants, it is almost always associated with "honeydew" that is excreted by certain kinds of sucking insects.

Aphids—Aphids (Figure 19), or "plant lice," are small, soft-bodied insects that usually cluster on stems or undersides of terminal leaves. Aphids may be green, black, or red, but sometimes their color is hidden by a white waxy coating. Much of the sap that aphids suck passes through them undigested and is excreted as "honeydew." Honeydew makes the leaves sticky, and sooty mold may grow on these deposits. Feeding by some kinds of aphids will cause leaves to pucker, curl, or twist.

Scales—During most of their lives, scale insects are legless and motionless and do not resemble insects at all (Figure 20). They may be circular, oval, or pearshaped. Some are flat, others convex. Two major groups of scales are most common in Kentucky. The armored scale produces a waxy shell that gives the soft-bodied insect under it some protection. The unarmored or soft scales do not produce a shell, but their bodies may be tough.

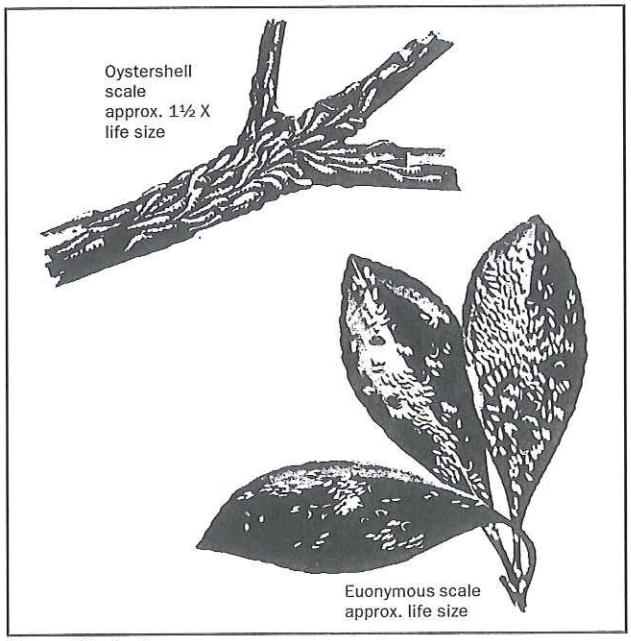


Figure 20. Scales

Scales reproduce by giving birth to "crawlers" or by laying eggs that hatch into crawlers. Crawlers have legs, eyes, and antennae, all of which allow them to move out from under the mother's shell or body and seek a suitable place of their own on the plant. Soon after inserting their beak to feed, they molt and lose their legs, eyes, and antennae and remain motionless for the rest of their lives.

Plants infested with scales may lack vigor and appear sickly. Unarmored scales are honeydew producers like aphids and cause the same symptoms as mentioned for aphid honeydew.

It is easier to control most scales while they are in the crawler stage because they are not protected by a shell or waxy coat. Treatment applied for scale control should coincide with crawler activity. A second treatment in 2 to 3 weeks is usually recommended. Timing of systemic insecticide applications is not so critical. On oil-tolerant plants, oil sprays can be used to control all stages of scales, including eggs. Summer oils may be effective during the warmer months. Apply dormant oils in winter. Insecticidal soaps are another alternative for controlling scale crawlers as well as aphids, mealybugs, whiteflies, thrips, and mites.

Mealybugs—Mealybugs differ from typical scales in that they can move about slowly throughout their lives. They are soft-bodied and covered with a white, powdery, cottony, or mealy wax-like material (Figure 21). Mealybugs suck juices from stems and leaves, an activity which stunts or even kills plants. Black, sooty mold often grows on honeydew deposited by mealybugs. The stressed look of azaleas is often due to mealybug infestation.

Whiteflies—Whiteflies are small, powdery-white insects that resemble tiny moths (Figure 22). The greenhouse whitefly is the only pest species in our area. The immature stages of whiteflies resemble scale insects. Both the adults and immature stages suck sap from the leaves of host plants. When an infested plant is disturbed, the adult insects flutter off but settle back down very quickly. Besides ornamentals and flowers, the greenhouse whitefly also infests many different vegetables, shade trees, and weeds. Infested plants lack vigor, turn yellow, wilt, and may die. Leaves may also be covered with sooty mold growing on honeydew these insects produce.

Thrips—Thrips are tiny, slender insects with rasping-sucking mouthparts (Figure 23). Adults may be yellow, brown, or black and have feathery wings held flat on the back. Immature thrips resemble adults but are lighter in color and wingless. Some species feed primarily on foliage while others feed primarily on blooms. The foliage of thrips-infested plants may be streaked or silvered. Flowers may be deformed or have brown-edged petals, or the flower buds may drop off or fail to open. The protection of plants from flower thrips is difficult during May and June when the thrips are migrating and continually reinfesting plants. Thrips are known vectors of some viral plant diseases.

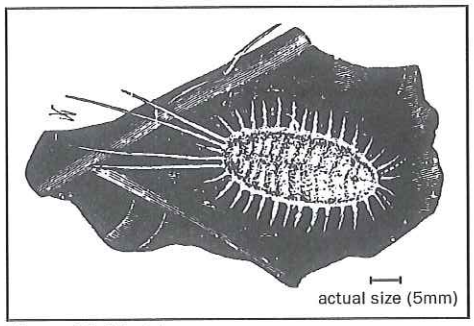


Figure 21. Mealybugs

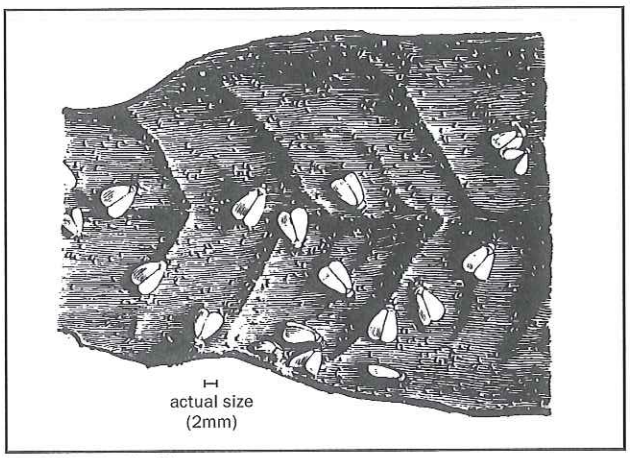


Figure 22. Whiteflies

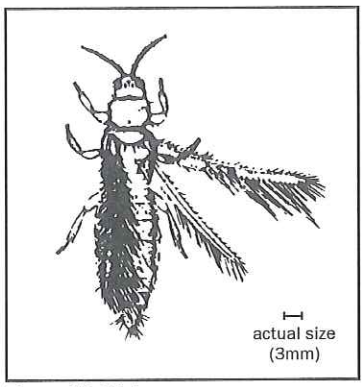


Figure 23. Thrips

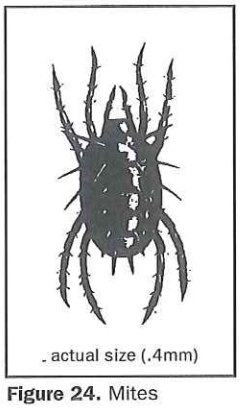


Figure 24. Mites

Mites—Mites are not insects, but their damage and the methods of control are similar to those of insects. They differ from insects in that they have 8 legs, not 6, and have only 1 body region instead of 3. They never have wings (Figure 24). All mites are tiny and usually cannot be seen without the aid of a magnifying lens. By tapping infested twigs over a sheet of white paper, the dislodged mites are much easier to detect. They vary widely in color. Some mites spin fine, delicate webbing on the host plant. This

webbing is usually easier to detect than the mites themselves. Mite damage often appears as a bronzing of the foliage, which sometimes gives it a dusty appearance. Leaf drop may also occur.

Many kinds of plants are attacked by the two-spotted spider mite, and almost all coniferous plants are hosts to the spruce spider mite. The Southern red mite is primarily a pest on broadleaf evergreens such as azaleas and camellias.

Insects with Chewing Mouthparts

Beetles—Beetles vary considerably in size, shape, color, and habits. One of their most distinctive features is that their front wings are hard or leathery and meet in a straight line down the center of the back (Figure 25).

Beetles may attack any part of a plant and in various ways. Some are typical leaf feeders and bite off pieces of leaf, while others are leaf miners or skeletonizers. With some beetles, the adults and larvae both are leaf feeders on the same plant; other beetles may be foliage feeders as adults and root feeders on other plants while in the larval stage. The Japanese beetle is an example of this type of beetle, causing serious damage to the foliage of many landscape plants while the grub is a serious pest of turfgrasses. Some feed during the day and some feed only at night, such as the May beetles.

Some beetles, such as the bronze birch borer, feed as the larval stage in the cambium of trees and shrubs. This boring activity leaves "galleries" underneath the bark, usually causing serious damage to host plants. Girdled plants usually die.

Caterpillars—Caterpillars are the worm-like immature stages of moths and butterflies. They range in size from tiny to 5 inches long. They usually have a distinct head and 4 pairs of fleshy legs on the middle of the body (Figure 26). The body may be fuzzy, naked and smooth, or spiny.

Caterpillars are primarily foliage feeders and eat out irregular areas or they may entirely strip the leaves.

Some caterpillars, because of their special habits, are also referred to as webworms, tent caterpillars, leaf rollers, leaf folders, skeletonizers, bagworms, and leafminers. Some feed as individuals; others feed in groups or colonies.

When only a few large caterpillars are present, handpicking is effective. Webworms and tent caterpillars can either be pruned out or burned out with a torch. If pruning would adversely affect a plant or if the infestation of any caterpillar is generally distributed over a plant, a single treatment of an approved insecticide applied when the caterpillars are young will usually give control.

A group of small moths, usually referred to as clearwing moths, cause serious boring damage to certain plants. The active adults often resemble wasps. The larvae bore through the cambial layer, causing stress, decline and, occasionally, death of plants. Dogwoods, lilacs, and ash are affected by clearwing borers.

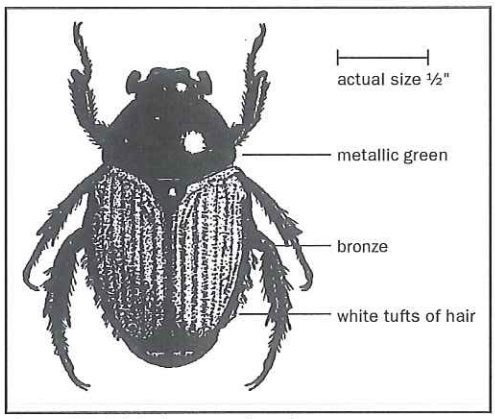


Figure 25. Adult Japanese beetle

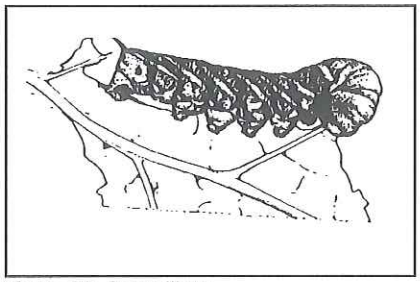


Figure 26. Caterpillars

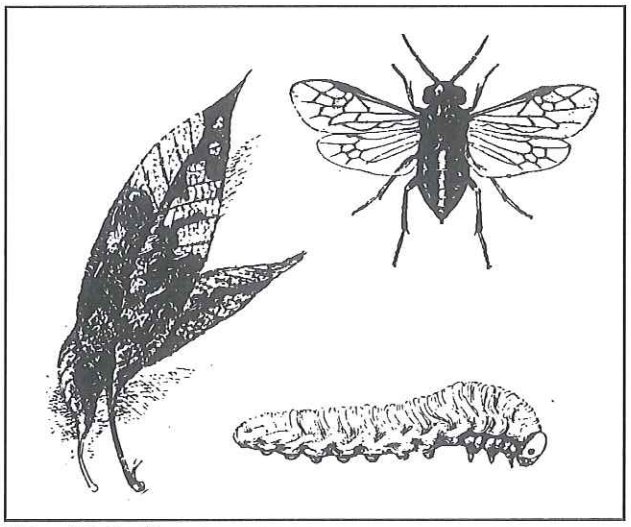


Figure 27. Sawflies

Sawflies—Sawflies are wasp-like insects and are related to typical wasps, bees, and ants (Figure 27). The larval stages of most sawflies resemble naked caterpillars, but they have more than 5 pairs of fleshy legs on the body while caterpillars have only 4 or fewer pairs. Some sawfly larvae are slug-like in appearance, such as the pear slug and rose slug.

Most sawfly larvae are foliage feeders that eat the entire leaf, but slug sawflies are skeletonizers. A few types of sawflies are wood borers or leafminers. These differ further from typical sawflies in that they do not have fleshy abdominal legs.

The most serious sawfly pests in our area are those that attack coniferous shrubs and trees. They feed in groups and can quickly defoliate a plant. This defoliation often leads to the plant's death. A single application of an approved insecticide is usually sufficient for control.

Galls

When some insects or mites feed on or lay eggs in plants, they may inject a chemical into the plant that causes it to grow abnormally and produce a gall. Each species of gall-producing insect or mite produces a characteristic gall on a certain part of a particular type of plant. Each gall may harbor one to many gall insects. The stimulus to formation of the gall is usually provided by the feeding stage of the insect or mite. A plant gall may have an opening to the outside (galls of mites, adelgids, psyllids), or may be entirely enclosed (galls of larval insects). The Hackberry nipplegall maker, which is a psyllid, can be a nuisance in the fall when adults hatch and tend to gather around entries to homes.

Oak Gall Wasps—Hundreds of species of Cynipid wasps cause galls on many species of oaks. Plant parts affected include roots, crown, bark, branches, twigs, buds, and leaves. Some of the more common galls are the many small leaf galls and the large brown galls known as oak apples, each of which is a leaf deformed by a larva. Usually, the galls do very little harm to oaks. No control measures are known, except for pruning out infested twigs and branches.

Turf and Ornamental Weeds

A weed is "a plant growing where it is not wanted." By this definition, any member of the plant kingdom may be called a weed. Weeds present some rather special problems in the production and maintenance of quality turf and ornamental plantings. Certain grasses and broadleaf weeds that are permitted to grow in these areas reduce their aesthetic value. Herbicides must be chosen with considerable care to prevent possible injury to desirable species.

Herbicides

The mode of action of some herbicides is to destroy weeds by damaging leaf cells and causing them to dry up. Others alter the uptake of nutrients or interfere with the plant's ability to grow normally or to conduct photosynthesis.The mode of action often dictates when and how a herbicide is used. Herbicides must (1) adequately contact plants, (2) be absorbed into the plants, (3) move to the site of action in the plant without being deactivated, and (4) reach toxic levels at the site of action.

Those that inhibit germination or seedling growth are used as preemergent herbicides; they are applied to the soil to control weed seedlings before they break through the soil surface. They rely on rainfall or are incorporated into the soil to place the herbicide in close contact with the germinating weed seed. Some products (e.g., trifluralin) do not move within the plant so injury symptoms are confined to site of uptake. Others (e.g., atrazine) are systemic and enter through the roots and move upward. In general, symptoms will be most obvious where the product tends to accumulate.

Other types are used as postemergent herbicides and are applied to the foliage of emerged weeds. Some postemergents have contact activity, meaning they kill the plant by destroying leaf and stem tissues. Other postemergents are translocated (moved within the tissues of the plant) from leaves and other green parts to growing points.

Chemical and physical relationships between the leaf surface and herbicide often determine the rate and amount of uptake. Uptake also can be affected by plant size and age, water stress, air temperature, humidity, and herbicide additives. Differences in the amount of herbicide uptake within the plant often explain the year-to-year variation in herbicide effectiveness.

Like soil-applied herbicides, postemergence herbicides differ in their ability to move within a plant. Nonmobile (contact) postemergence herbicides must thoroughly cover a plant for good control. Mobile herbicides move within the plant to the site of action.

Plants that can rapidly degrade or deactivate a herbicide can escape the toxic effect. The ability of some plants to rapidly degrade a herbicide is the basis whereby plants are differentially susceptible to some herbicides. However, plants under stress (hot or cold temperatures, high humidity, or physical injury) may be affected by herbicides to which they normally are tolerant. Misapplication, especially excessive rates, can overwhelm the ability of the plant to degrade or deactivate the chemical and result in plant injury.

Weeds

Weeds can be divided into annuals, biennials, and perennials; all three categories require somewhat different approaches for their control. **Annuals** are plants that complete their lifecycle in one year. There are two types of annuals: winter annuals grow from seeds that sprout in the fall and flower in the spring; summer annuals start from seed in spring or summer, mature, ripen seeds and die in the same season.**Biennials**produce leaves (rosette) in the first year and a flower head in the second year that produces seed and dies.**Perennials**may produce flowers and seeds year after year. All weed control efforts in a turf and ornamental situation must be selective or used as a spot treatment. The intent is to remove the undesirable species that are growing near desirable species.

Crabgrass

(*Digitaria* spp.)

Two common species of crabgrass are found in Kentucky. Because their life habits and control measures are similar, they will be treated as one.

This annual grass reproduces by seed and by rooting at the lower joints of the stem (Figure 28a). The stems are erect or arise from a creeping base and usually form mats. Small, inconspicuous flowers are produced in two rows along one side of the 3 to 10 finger-like branches at the top of the stem (Figure 28b).

In Kentucky, crabgrass seeds start to germinate in late April or early May. It thrives best during warm summer months when bluegrass is producing the least amount of growth. Crabgrass grows to maturity and develops seed from July until September, then dies in autumn.

Goose-grass

(*Eleusine indica* Gaertn.)

Other common names for this weed are wiregrass, yard-grass, and crowfoot-grass.

This smooth, flat-stemmed, coarse annual grass reproduces entirely by seeds. Stems are branched, arise from tufts, and often form mats. Flowers and seeds are produced in two rows along one side of the 2 to 10 finger-like branches at the top of the stem (Figure 29b). Goose-grass may look like crabgrass; however, goose-grass differs in that it has a flattened stem and does not take root at the lower joints of the stem (Figure 29a).

Goose-grass germinates in April and May, produces seed from June to September, and dies in autumn.

Nimblewill

(*Muhlenbergia schreberi* J. F. Gmel.)

Other common names of this plant are drop-seed and wire-grass. This grass is becoming one of our most troublesome weeds in Kentucky lawns.

Nimblewill is a shallow-rooted perennial grass that spreads by seeds and aboveground stems. The stems are slender, branched, and spread along or near the surface of the ground. Tiny, inconspicuous flowers and seeds are arranged loosely on nodding or ascending branches along the upper part of the stem (Figure 30). The leaf blades are usually less than 1/4 inch wide and not more than 2 inches long. Nimblewill is grayish green compared with the darker green bluegrass.

New growth of nimblewill starts from the crowns or aboveground stems in late March or April. It continues to grow throughout the summer and early autumn. The roots remain alive throughout the year, but the tops die in autumn, leaving dense brown mats in the lawn during the winter.

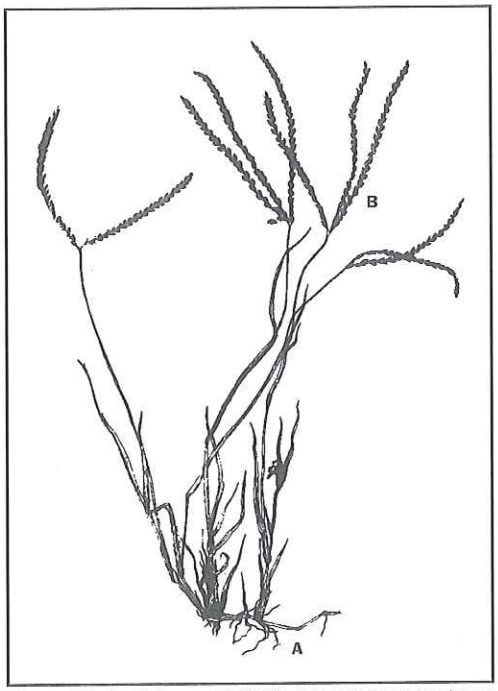


Figure 28. Crabgrass, *Digitaria* spp. (A) creeping base and rooting at lower joints of stem. (B) arrangement of flower and seeds on finger-like head.

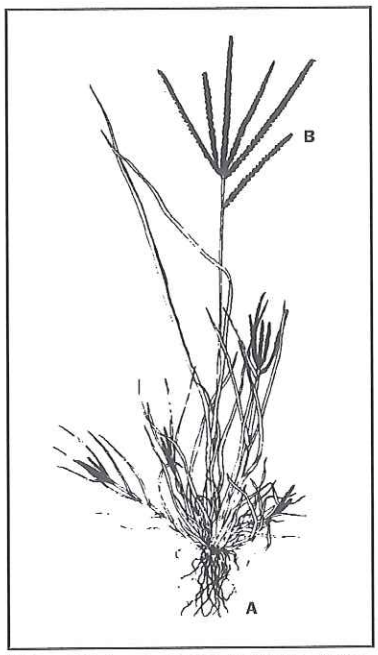


Figure 29. Goose-grass, *Eleusine indica*. (A) stems arising from tufts. (B) finger-like flower and seed head.

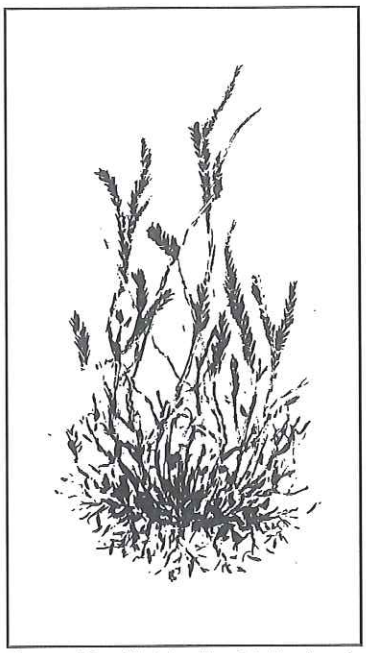


Figure 30. Nimblewill, *Muhlenbergia schreberi*. Entire plant, showing slender creeping stems, ascending seed heads.

Annual Bluegrass

(*Poa annua* L.)

Other common names for annual bluegrass are annual speargrass, dwarf speargrass, and six-weeks grass.

This plant is a winter annual that reproduces by seed. Stems are flattened, grow in tufts, and sometimes take root at the lower joints (Figure 31a). The leaves are very soft, and the seed heads are arranged in the shape of a pyramid (Figure 31b).

Annual bluegrass thrives best during cool weather. Germination occurs from early fall to early spring. The plant grows to maturity, develops seeds, and then dies in late spring or early summer, leaving unsightly brown areas in turf. Annual bluegrass is often lighter green than Kentucky bluegrass. It usually grows from 4 to 8 inches high when left unmowed.

Foxtail

(*Setaria* spp.)

Other common names are summer-grass, pigeon-grass, and wild millet. Foxtails found in Kentucky lawns are annual grasses that reproduce entirely by seed. The stems are erect and may grow from 12 to 48 inches high (Figure 32). In lawns that are mowed regularly, they will develop seed heads just about the soil surface. The stems are somewhat flattened, and the leaves may vary from 1/2 to 1 1/2 inches wide. Seed heads develop at the top of the stems and vary from 2 to 6 inches long.

Common Chickweed

(*Stellaria media* Cyrill)

Other common names are starwort, starweed, winter-weed, and satin flower.

Chickweed is a juicy-tissued, shallow-rooted winter annual that reproduces by seed and trailing stems that take root at the lower joints (Figure 33a). The leaves are arranged in pairs on the stem; they are usually egg-shaped, smooth, and less than 1 inch long -- the lower leaves with hair stalks and the upper without stalks (Figure 33b). The flowers are small, with five white, deeply notched petals.

Chickweed starts to germinate in autumn, grows throughout the winter, develops seeds from April until early summer, then dies. Occasionally, some chickweed may continue to grow during the summer, but most of the plants die during late spring.

Wild Garlic

(*Allium vineale* L.)

Wild garlic, a perennial that looks like the cultivated onion, reproduces by underground bulbs and bulblets above the ground (Figure 34a). Stems are 12 to 24 inches tall, the lower part covered with leaf-bases around the stem (Figure 34c). Leaves are hollow, slender, and round in earlier stages of growth, becoming grooved as the plant develops. The greenish white to purple flowers are often replaced with bulblets, each containing a long, slender appendage. These bulblets are arranged in umbrella-like clusters near the top of the stem (Figure 34b).

Wild garlic has two kinds of underground bulbs. The soft-shelled bulbs germinate in autumn, while the hard-shelled bulbs remain dormant until succeeding years. Some bulbs remain alive in the soil for at least five years.

Henbit

(*Lamium* spp.)

Another common name is winter mint.

Henbit is a winter annual that reproduces by seeds and stems rooting at the lower joints. The stems are 4 to 16 inches tall, square, and branch close to the ground. The plants are erect and have very few or no hairs. The leaves are opposite (two leaves at each stem joint), almost circular, with the edges having rounded teeth or lobes (Figure 35a). The flowers are pink to purple, two-lipped, and arranged in whorls at the base of the leaves (Figure 35b).

The growth habits of henbit are like those of chickweed.

Buckhorn Plantain

(*Plantago lanceolata* L.)

Other common names are English plantain and narrow-leaved plantain.

Buckhorn plantain is a perennial that reproduces by seed and new shoots from the roots. The stems are usually 8 to 16 inches high, leafless, and bear a short, dense flower spike at the top from 1 to 3 inches long. The narrow leaves arise from the base of the flower stems; they are 4 to 8 inches long, lance-shaped with several prominent veins running lengthwise, and arranged in a basal rosette at the surface of the soil (Figure 36).

Buckhorn plantain produces mature seed from June to September.

Broad-leaved Plantain

(*Plantago major* L.)

Other common names are common plantain, whiteman's-foot, and dooryard plantain.

Broad-leaved plantain is a perennial that reproduces by seeds and new shoots from the roots. The stems are usually 4 to 12 inches high and leafless, with a long, slender flower spike at the top which is from 2 to 10 inches long (Figure 37a). The leaves arising from the base of the stem are broad, somewhat egg-shaped, with several prominent veins, and are arranged in a basal rosette at the surface of the soil (Figure 37b).

Broad-leaved plantain produces seed from June to September.

Rugel's plantain (*Plantago rugelii*) looks very much like P. major; because control measures are the same for both species, they are treated as broad-leaved plantain in this publication.

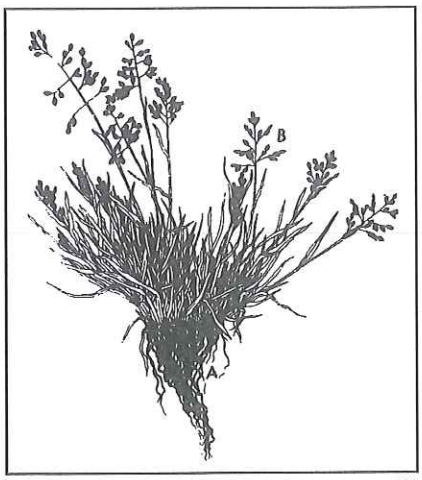


Figure 31. Annual bluegrass, *Poa annua.* (A) plant showing tuft of stems. (B) pyramid-shaped seed head.

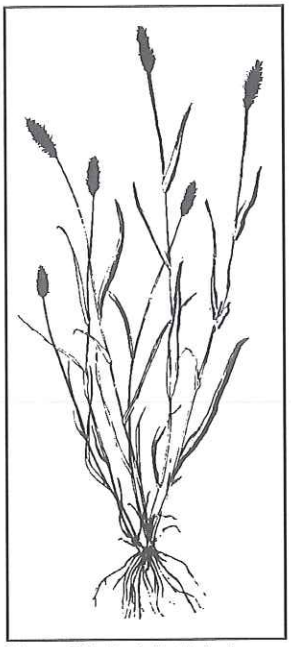


Figure 32. Foxtail, *Setaria* spp. Entire plant showing erect stem with seed head at the top.

Figure 33. Chickweed, *Stellaria media.* (A) trailing stem with roots at joints. (B) pair of opposite egg-shaped leaves.

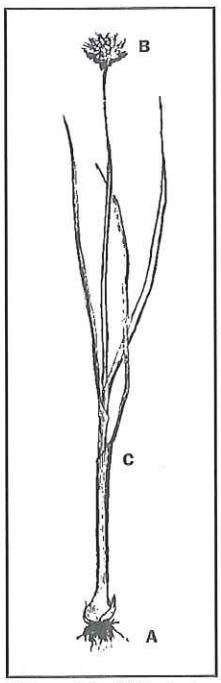


Figure 34. Wild garlic, *Allium vineale.* (A) underground bulb. (B) head of aerial bulblets. (C) leaf base surrounding stem.

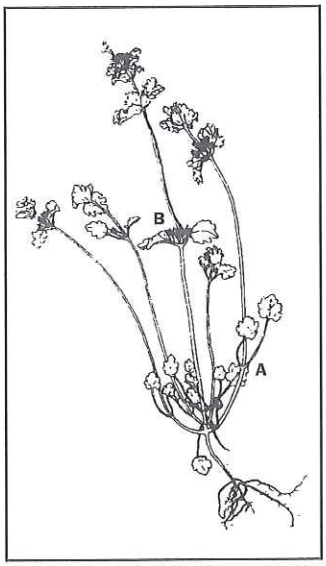


Figure 35. Henbit, *Lamium* spp. (A) pair of opposite somewhat circular leaves with rounded teeth or lobes. (B) flower whorl at base of leaves.

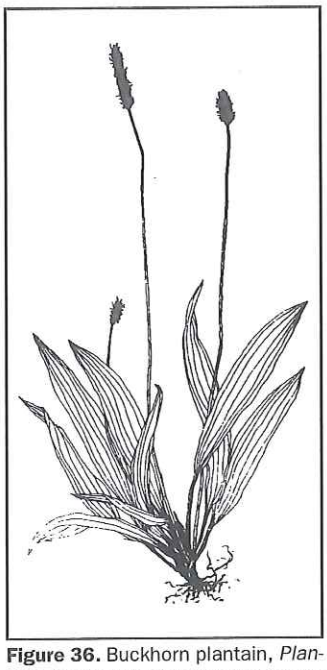


Figure 36. Buckhorn plantain, *Plantago lanceolata.* Note leafless stem with short, dense flower spike at top and narrow, prominently veined leaves arising from basal rosette.

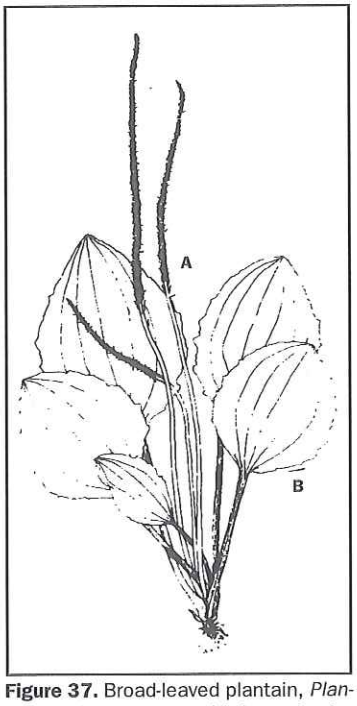


Figure 37. Broad-leaved plantain, *Plantago major.* (A) stem with long slender flower spike. (B) broad, somewhat egg-shaped leaves arising from basal rosette.

Yellow Nutsedge

(*Cyperus esculentus* L.)

Another common name is nutgrass.

Yellow nutsedge is a perennial that reproduces by seed, rhizomes, and tubers (nutlets) (Figure 38). The stems are yellow-green, solid, triangular, and grass-like. Long, slender rhizomes (A) are produced that terminate in tubers (B) which produce new plants.

Yellow nutsedge can be found in home lawns or in wet soil areas.

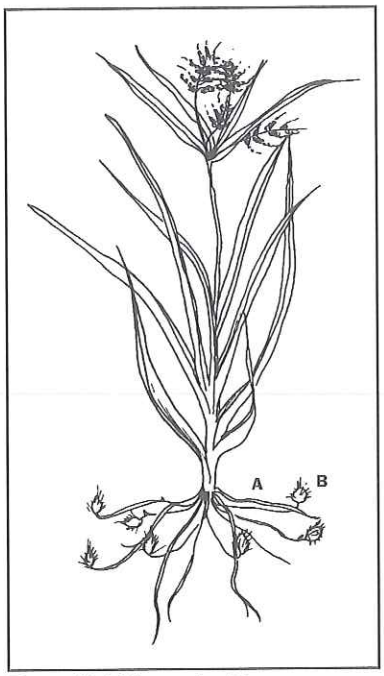


Figure 38. Yellow nutsedge

Wild Violet

(*Viola* sp.)

Wild violets are perennials that reproduce by underground rootstocks (A) and seed. Foilage dies in late fall and regrows in March. It has an upright growth habit with leaves that are somewhat heart-shaped and deep blue or purple flowers (B) (Figure 39).

Figure 39. Wild violet

Dandelion

(*Taraxacum officinalis* Weber)

Other common names are lion's-tooth, blowball, and cankerwort.

Dandelion is a perennial that reproduces by seeds and new shoots from the roots (Figure 40). The stems contain a milky juice and arise from a long, thick, fleshy taproot. The leaves vary in shape, are usually oblong, and more or less tapering in outline. They vary from having no teeth to coarse teeth, usually are covered with short soft hairs, and are arranged in a basal rosette. The yellow flowers are arranged in a single head on a long hollow stalk.

Dandelions produce most of their flowers in May and June.

Figure 40. Dandelion, *Taraxacum officinalis*. (A) upper section of long taproot. (B) coarsely toothed leaves from basal rosette. (C) flower head on long, hollow stem.

Red Sorrel

(*Rumex acetosella* L.)

Other common names are sheep sorrel, field sorrel, sourweed, red-top sorrel, sour-grass, and horse sorrel.

Red sorrel is a perennial that reproduces by seeds and creeping roots (Figure 41). Low stems, usually less than 18 inches high, are scattered or in mats and are produced from creeping roots. Upper leaves may be somewhat long and narrow with the lower leaves shaped somewhat like an arrowhead, but with two small lobes at the base.

The plants produce seeds from late April to September. The seeds are small, triangular, reddish brown, and glossy.

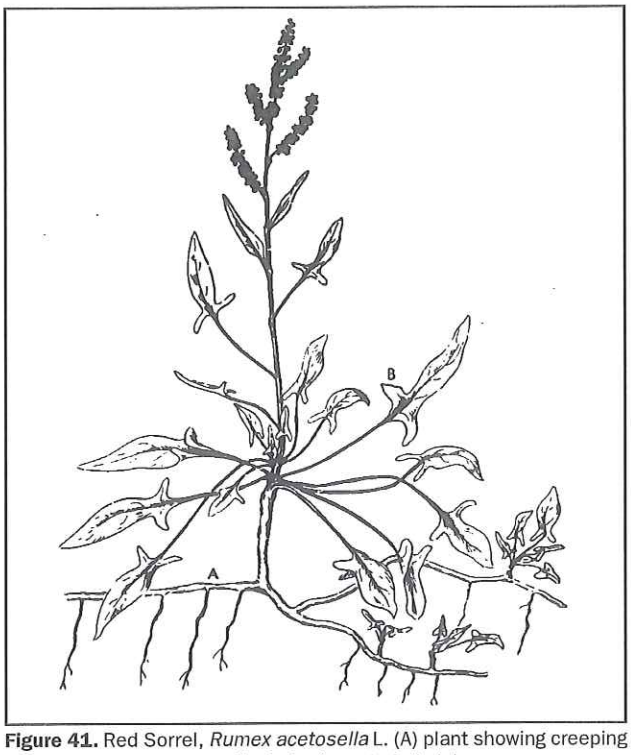


Figure 41. Red Sorrel, *Rumex acetosella* L. (A) plant showing creeping root system. (B) leaves with their characteristic lobes.

Turf Diseases

Numerous disease problems occur on turfgrass in Kentucky and these frequently cause extensive damage. In many cases, a disease is blamed for poor quality turf when, in reality, it may be only a contributing factor or not involved at all. Frequently, dead and dying grass is caused by improper fertilization, chemical burn, mower problems, dog or insect injury, dry or wet spots, thatch, competition from other plants, or from any other improper management. Accurate diagnosis of the problem is essential for proper control.

Two types of pathogens (fungi and nematodes) are found in turf in Kentucky. Observation of symptoms is an important aid in determining which pathogen is causing a disease. The following information will explain the identification and biology of some common turf diseases.

Helminthosporium Disease

Helminthosporium leaf spot (Figure 42) is a common disease problem of Kentucky bluegrass and is often referred to as "melting-out." Other *Helminthosporium* leaf spots are important on fescues and bermudagrass. From a distance, leaf spot-affected areas appear chlorotic or yellowed. Individual spots on the leaves have dark margins with tan centers. The spotting is most noticeable in spring and early summer. Infection in the crown of the plant during the summer can lead to the death of plants (thus "melting-out"). Cool, wet weather during spring followed by drought during summer accentuates the damage from this disease.

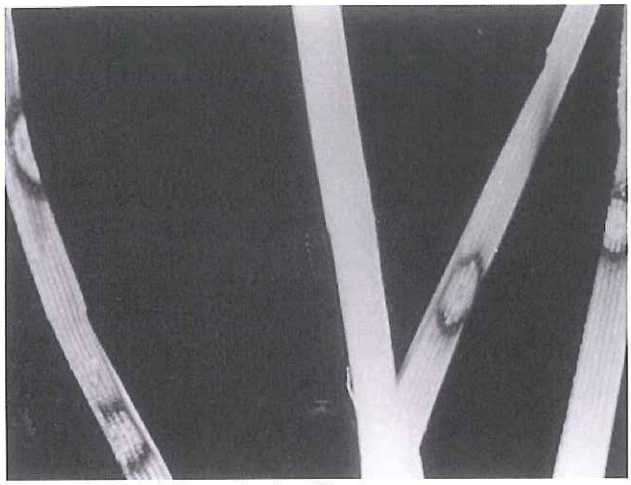


Figure 42. *Helminthosporium* Leaf Spot

Dollar Spot

Dollar spot affects a wide variety of grasses, including Kentucky bluegrass, bermuda, perennial ryegrass, zoysia, tall fescue, and bentgrasses. The fungus is active throughout the growing season, especially when there is low soil moisture and an excess of dew or fog. It is most prevalent in the spring. The disease is characterized by small white patches, one to three inches in diameter (Figure 43). A large number of spots can come together and form larger dead areas. Leaf spots are usually found along the edges of the grass blade and may come together across the blade, causing the tip to die. Individual leaf spots are tan with reddish margins.

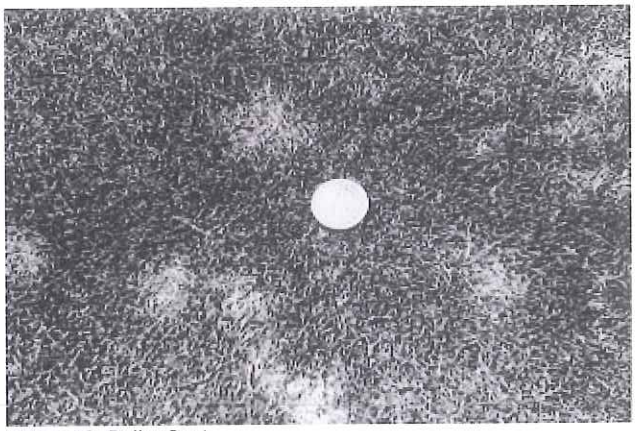


Figure 43. Dollar Spot

Pythium Blight

Pythium blight is caused by a number of species of the fungus *Pythium*. The fungus primarily attacks perennial ryegrass and bentgrass although other grasses can be affected. Conditions that favor *Pythium* blight include abundant moisture and poor air circulation. The disease is most active in hot, humid weather when the night temperature does not go below 70°F. The blight appears first as small spots a few inches in diameter. Diseased leaves are at first water-soaked, soft, and slimy, and may mat together (Figure 44). Dense, cottony fungal growths often are apparent in affected areas during a heavy dew. The leaves soon shrivel and the color of the patch soon fades to light brown as dew dries. The shape of the diseased area may be streaked following the drainage flow of water over the turf.

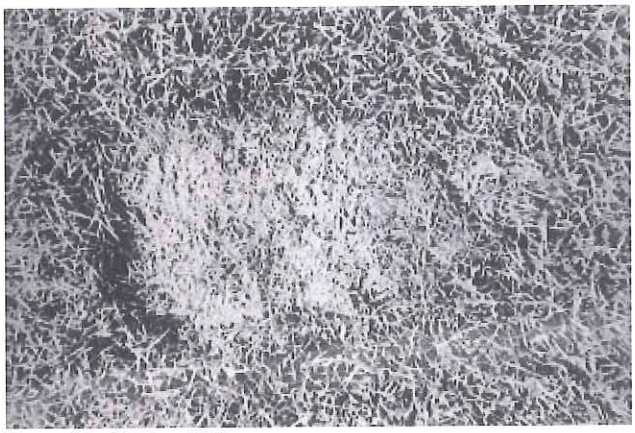


Figure 44. *Pythium* Blight

Brown Patch

Brown patch is a common fungal disease of fescues, perennial ryegrass and bentgrass. The disease develops most readily when daytime highs exceed 80°F and nighttime lows are in the mid- 60's°F or higher. Brown patch is one of the more common turf diseases, especially in tall fescue (Figure 45). In addition to ideal temperatures and humid weather, heavy applications of nitrogen fertilizer favor disease development. Brown patch is characterized by nearly circular areas of dead leaves that may be a few inches to several feet in diameter. On closely mown turf, the edges of the dead area may have a gray, smoky color, particularly in early morning. Affected areas are generally tan or brownish in bent and ryegrass. Affected fescues usually have straw-colored leaves.

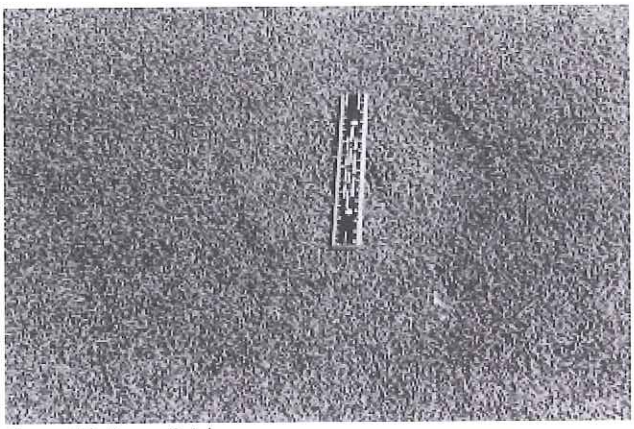


Figure 45. Brown Patch

Summer Patch

This disease affects Kentucky bluegrass and annual bluegrass. Circular to irregular patches of dead turf up to 1-2 feet in diameter develop during hot weather in mid- to late-summer (Figure 46). Below ground, roots and crowns of affected plants are brown and decayed, a result of fungal colonization. A tuft of healthy, green grass is sometimes evident in the center of affected patches, giving them a characteristic "donut" appearance.

Necrotic ring spot is another disease of bluegrasses with symptoms similar to summer patch. In contrast to summer patch, symptoms of necrotic ring spot can develop following cool, wet weather in late spring or mid-autumn. Necrotic ring spot is less common in Kentucky than summer patch.

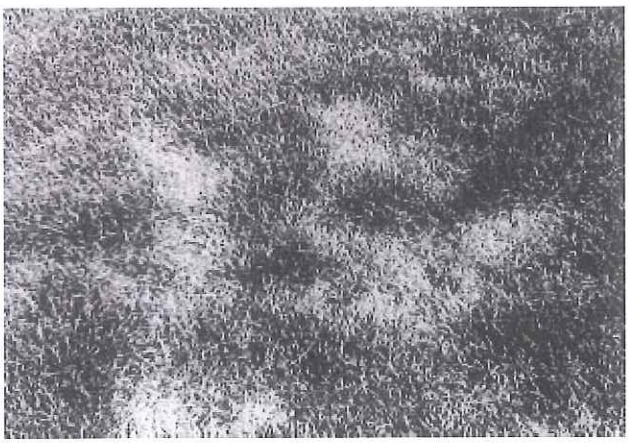


Figure 46. Summer Patch

Rust

Rust is sometimes a problem on Kentucky bluegrass, fescue, zoysia, perennial ryegrass, and bermuda grasses. Rust infection results from rust spores which are blown to the plant from distant areas or from nearby alternate hosts. Large numbers of spores are produced in the leaf spot (pustule). These spores are then the source of new infections. The disease is most frequently found during cool, humid weather during autumn. Grass varieties differ in susceptibility to rust.

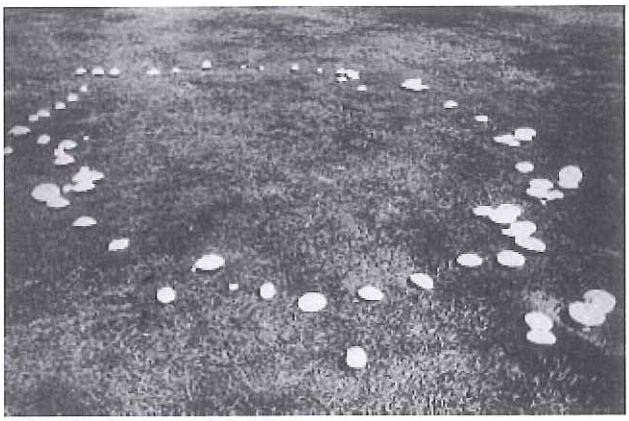


Figure 47. Mushroom Fairy Ring

Red Thread

Red thread is seen as irregularly shaped patches of blighted turfgrass, ranging from a few inches to a few feet in diameter. Often, as diseased leaves turn brown, pink or reddish fungal growth can be observed on the leaf surface or emerging from the cut ends of leaves. This disease affects most of the common grasses grown in Kentucky and is often found during spring and early summer. The disease is favored by conditions of low nitrogen fertility.

Mushroom Fairy Ring

Fairy ring can occur in any turf. The ring appears as a circular discoloration of grass from several inches to many yards in diameter. Mushrooms (toadstools) may appear at the edge of the ring during warm, moist periods (Figure 47). The ring of grass is generally a darker green than the grass inside and outside the ring. During periods of moisture stress, the grass inside the ring may die. This general decline of grass inside the ring adds to the unsightliness of the fairy ring problem. Fairy rings gradually increase in size.

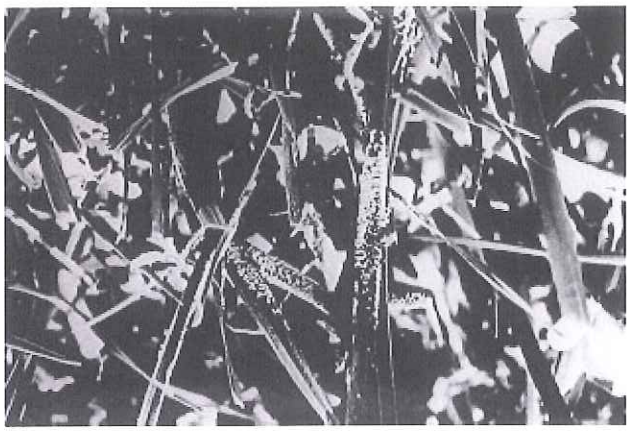


Figure 48. Slime Mold

Slime Mold

Slime molds are commonly found on lawns in warm, moist weather (Figure 48). This fungal growth on grass leaves may be either a small, crust-like, light to dark mass with a sooty appearance, or a tan to orange shapeless mass. The fungus causing this unsightly problem does not infect the grass blade; it simply uses it for support. The only effect it has on the plant is to temporarily reduce food production by the grass leaf as a result of shading.

Nematodes

Nematodes weaken and reduce the vigor of turfgrass by restricting the development of the root system. The symptoms of nematode injury may be confused with nutritional problems, insufficient water, hardpan, or any factor that restricts root development. Symptoms commonly associated with nematode injury include thinned or completely killed areas, pale green to chlorotic color, excessive wilting during drought stress, poor response to fertilization, and a greater weed problem due to sparse grass. The intensity of the symptoms will vary with the grass variety, the kinds of nematodes present, the nematode population level, and the fertilization-watering program being practiced. The most reliable method for determining whether a nematode problem exists is by a soil assay. Nematode damage to turfgrass is uncommon in Kentucky.

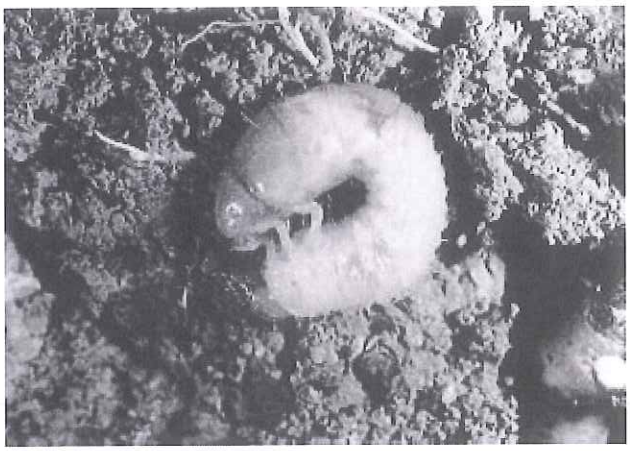


Figure 49. White Grub

Insect Pests of Turf

Lawn ecosystems often include a variety of insects, some of which are direct pests of grass, or nuisances and pests to humans and pets. Some may be predators or parasites of other insects, or harmless scavengers. Through complex interactions between the insects and other factors, the lawn ecosystem becomes more or less balanced. If we are not satisfied with the balance, we may use maintenance practices to improve our lawns. However, the solution may trade one problem for another. For instance, fertilization to increase grass lushness may favor the development of certain insect and disease problems. Insecticidal control for one kind of insect may kill predators or alter competition, allowing a different insect pest to flourish. Often, the side effects of management practices cannot be precisely predicted, so lawn situations need to be monitored over time and maintenance practices modified, if necessary. Some of these interactions and problems are demonstrated in the case of white grubs as lawn pests in Kentucky.

White Grubs

White grubs are the larval stages of scarab beetles such as masked chafers, rose chafer, May beetles, green June beetle, and Japanese beetle. White grubs look more or less alike (Figure 49). They have brown distinct heads and thoracic legs, and the body is whitish, fat, and usually curled into a C-shape. Size varies from 1/8 to 1-1/2 inches long depending on the age and species. The grubs occur in large patches of sod an inch or so below the soil line where they consume the anchoring roots of grass. During dry weather, the infested sod may die for lack of water.

Soil insecticides for white grub control should be applied in August before the grubs cause serious damage. Most instances of control failures are a result of poor timing or techniques of insecticide applications.

Although masked chafer and Japanese beetle white grubs are the most widespread and prevalent lawn problem in Kentucky, other insects occasionally cause serious damage.

Small scarab beetles, *Ataenius* spp., that normally develop in cow dung have recently become problems in certain kinds of sod. Bluegrass and bentgrass turf with thick thatch are the most frequently attacked. The damage is like that of typical white grubs, except *Ataenius* white grubs are only about 1/5-inch long when full grown, and there may be as many as 500 grubs per square foot of sod. There are two generations per year, with the first generation grubs being most numerous in June, and the second generation in August.

Both the larvae and adults of billbugs attack grasses. The adult is a snout beetle that eats grass blades and burrows into stems near the crown. The larvae are about 2/5-inch long, resemble legless white grubs and feed on the crown roots. The pattern of billbug damage resembles that of sod webworm damage, but the dead grass is easily pulled loose from the soil.

Sod Webworms

Sod webworms graze baseball-sized patches of grass that turn brown and die. Patches of grass that are clipped off at the soil surface may be numerous and run together to form large dead areas. Dirty silk tubes containing the inch-long caterpillar or pupa can usually be found in the thatch of killed spots. The adult stage of the pest is a small buff moth that is often seen fluttering over lawns at dusk and at night around lighted doorways about two weeks before larvae become numerous. There are up to three generations per year (Figure 50).

Other Insect Pests

Armyworms, including the true armyworm and the fall armyworm, are characteristic caterpillars about 1-1/2 inches long when full grown. They vary in intensity from year to year, but during outbreaks they may move across an area in army fashion completely stripping grasses in their path.

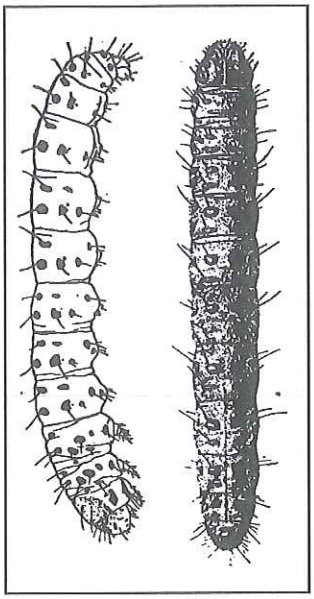


Figure 50. Sod Webworms

Fescue is more often attacked than bluegrass. These insects are also important pests of grain crops.

Various species of cutworms occur in turf and some are hard to distinguish from armyworms based on body characteristics. However, they never occur in large numbers as do armyworms.

Greenbug, a small species of dark green aphid, is a relatively recent bluegrass pest that is not as yet widely distributed in Kentucky. However, this may change if it becomes transported on infested nursery sod. Infestations often begin next to trees and structures that partially shade the grass. Infested grass turns yellow and dies, and large numbers of aphids can be seen in the affected area. The aphids remain active into fall when most other foliar pest insects have abated.

Insects and their relatives that are annoyances to humans may also require control. These pests include ticks, chiggers, clover mites, millipedes, sowbugs, ants, ground nesting wasps, fleas, mosquitoes, and gnats.

Vertebrate Pests

Skunks damage turf when they discover abundant white grub populations. Skunks dig through the sod and feed on the white grubs, thereby uprooting the sod and aggravating the damage already begun by the grubs. Skunks also may spray a disagreeable smelling substance on unwary people or pets who disturb them.

Birds, especially crows, starlings, and grackles, commonly tear up infested turf in search of grubs. Flocks of blackbirds frequenting a turf site, or holes left in the turf by their beaks, may indicate a grub problem.

Moles feed primarily on earthworms, but they may also feed on white grubs, wireworms, beetles, and many other invertebrates. They do not feed on plant roots or other underground plant growth. However, as they tunnel along in their surface runs, moles damage turf roots and may destroy newly seeded lawns. In established turf, the mower may skin the tops of the runs and dull the mower blade as well as create gaps in the sod. Moles also tunnel deep, throwing the excavated soil out of surface openings, thus forming mole hills.

Operator/Applicator Study Topics

- What are symptoms for disease identification?
- Are fungicides usually used for disease prevention or cure?
- Are earthworms beneficial?
- What are the details of Kentucky's posting law concerning applications to turf?
- What environmental concerns affect pesticides?
- How will varying the application rate (walking speed) affect amount of pesticide applied over a given area?
- For what reasons do skunks, moles and birds damage turf?
- What factors are needed for diseases to develop?
- What kind of mouthparts do insect pests have?
- What stages of insect life cycles are easier to control?
- Are certain insect pests found on specific host plants?
- Is timing of insecticide applications important?
- What are the different types of herbicides?
- What are the weed life cycles?
- Are herbicide application methods important?
- What does LD50 stand for?
- What are signal words? What does each mean?
- What other information is included on pesticide labels?

Additional Applicator Study Topics

- Know how to figure treatment areas and application rates.
- Be familiar with more important pests and the types of damage they cause, especially those listed and illustrated in this manual. You may be required to identify them from brief descriptions and/or line drawings.
- How do cultural practices affect pests, such as white grubs?
- How do pests become resistant to pesticides?
- How can the hazard of drift be reduced?

Appendix

Useful Publications for Ornamental and Turf Applicators *(Available at your county Extension office)*

Agronomy

AGR-12 Weeds of Kentucky Turf
AGR-50 Lawn Establishment in Kentucky
AGR-51 Renovating Kentucky Bluegrass & Fescue Lawns
AGR-52 Selecting the RIGHT Grass for Your Kentucky Lawn
AGR-53 Lawn Fertilization in Kentucky
AGR-54 Mowing, Dethatching & Watering Kentucky Lawns
AGR-55 Turf Care Calendar for Kentucky Bluegrass & Fescue Lawns
AGR-72 Maintenance and Renovation of Football Fields
AGR-73 Establishment of Football Turf
AGR-78 Weed control Recommendations for Kentucky Bluegrass and Tall Fescue Lawns and Recreation Turf
AGR-115 Lawn Irrigation with Automatic Systems
AGR-139 Herbicide Persistence and Carryover in Kentucky

Entomology

ENT-5 The Japanese Beetle
ENT-7 Controlling Sod Webworms
ENT-8 Controlling Bagworms
ENT-9 Insect Pests of Conifers
ENT-10 Controlling White Grubs
ENT-32 Insect Pests of Shade Trees & Woody Ornamentals
ENT-33 Insecticide Recommendations and Spray Calendar for Shade Trees and Woody Ornamentals
ENT-43 Insect Borers in Trees and Shrubs
ENT-51 Mites on Ornamentals
ENT-52 The Periodical Cicada in Kentucky
ENT-53 Vendors of Beneficial Organisms in North America
ENT-54 Vendors of Microbial & Botanical Insecticides & Insect Monitoring Devices
EIH-1 Ants Around the Home
EIH-3 Cankerworms
EIH-6 Fungus Gnats
EIH-10 Orchard Voles or Mice
EIH-12 Saturniid Moths
EIH-13 Crayfish Control in Lawns
EIH-14 Insect Galls on Trees
EIH-15 Whiteflies in Gardens
EIH-17 Houseplant Insect Control
EIH-26 Elm Leaf Beetles
EIH-27 How to Decontaminate Accidental Spills
EIH-32 Cicada Killer Wasp

Forestry

FOR-13 Controlling Wildlife Damage in Kentucky

Horticulture

HO-55 Guidelines for Choosing Hedges for Kentucky Yards
HO-59 Pruning Landscape Shrubs
HO-61 Trees, Shrubs, Ground Covers and Vines Recommended for KY Landscapes

Interprogram

IP-13 Protecting Kentucky's Groundwater; A Grower's Guide

Interdepartmental

ID-44 Chemical Weed Control in Nurseries and Commercial Landscape Plantings of Kentucky
ID-50 Shade Tree Decline and Related Problems
ID-51 Leaf Scorch and Winter Drying of Woody Ornamentals
ID-52 What's Wrong with my Taxus?
ID-55 WARNING: Topping Trees is Hazardous to Your Tree's Health
ID-71 Woody Plants Under Stress
ID-79 Home Lawn Irrigation
ID-87 Guide for Control of Annual and Perennial Flower and Ground Cover Diseases in the Landscape
ID-88 Woody Plant Disease Control Guide for Kentucky
ID-92 Principles of Home Landscape Fertilization
ID-100 Understanding Pesticide Labels and Labeling
ID-103 Kentucky's Endangered and Threatened Species
ID-105 Disease Management in the Home Lawn
ID-109 Disease Management in the Home Lawn
ID-112 Brown Patch Disease in Kentucky Lawns

Plant Pathology

PPA-1 Chemical Control of Turfgrass Diseases
PPA-16 Important Pine Diseases in Kentucky Landscapes
PPA-17 Anthracnose Disease of Shade Trees
PPA-18 Verticillium Wilt of Woody Ornamentals

Other

Insects That Feed on Trees and Shrubs. Second Edition. Warren T. Johnson and Howard H. Lyon. 1988. Cornell University Press, Ithaca, NY.

Insects and Other Pests Associated with Turf.Ed. James R. Baker. 1982. North Carolina Extension Service, Raleigh, NC.

Diseases of Woody Ornamental Plants and Their Control in Nurseries. Ed. Ronald K. Jones and Robert C. Lambe. North Carolina Extension Service, Raleigh, NC. Diseases and Pests of Ornamental Plants, 5th Edition. 1978. P. P. Pirone. John Wiley and Sons, Inc., NY.

Diseases of Trees and Shrubs. W. A. Sinclair, H. H. Lyon, W. T. Johnson. 1987. Cornell University Press, Ithaca, NY.

Turfgrass Insects of the United States and Canada. H. Tashiro. 1987. Cornell University Press, Ithaca, NY.

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