Common Diseases of Leafy Greens

Production of leafy greens in Alabama and the Southeast can be affected by a variety of plant diseases. Damage can range from minor spotting on leaves to complete loss of a crop depending on the pathogen involved. Because leaves are typically the marketable product in greens production, even a minor leaf spot can result in a significant loss in yield. This publication provides information on the most common diseases affecting leafy greens production in Alabama. Each section gives a detailed description of symptom development, the life history of the pathogen, and control practices for each disease.

Downy Mildew

Downy mildew, caused by the fungus *Peronospora parasitica*, can be damaging to collards, kale, mustards, and turnips. The disease can damage young seedlings and rot produce in transit. Downy mildew can destroy a field of greens in a few days.

**Symptoms.** Plants can be infected anytime during the growing season. In wet weather, a grayish-white fluffy mold develops in spots on the underside of infected leaves. A faint yellowing appears on the corresponding upper leaf surface, eventually developing into yellow to tan spots that enlarge and become papery in texture (Figure 1). Infected leaves on young plants may drop, and plants may eventually die. Early leaf infection may allow the fungus to enter the plant’s vascular system, turning it black. Infected leaves on older plants usually remain attached. Downy mildew can predispose infected plants to bacterial soft rot.

**Transmission and Persistence.** The fungus overwinters on seed, in cruciferous weeds, in infected plant debris, in stored crucifer organs like cabbage heads and turnip roots, and on old tops left in the field. The disease can enter a field on infected transplants or by windblown spores. Spores of the fungus float long distances in cool moist air. Heavy fogs, light rains, prolonged dews, and cool night temperatures between 46 and 61 degrees F, with day temperatures below 75 degrees F, greatly favor development of downy mildew.

**Control.** Plow under crop residue after harvest and eradicate cruciferous weeds and volunteer crucifers to eliminate potential overwintering sites for the pathogen. Do not use overhead irrigation, and avoid overwatering. A fungicide with the active ingredient fosetyl-al (e.g., Alliette) can be used to control downy mildew on most cruciferous crops. See the current Extension publication ANR-500A, *Alabama Pest Management Handbook—Volume 1* for more information on chemical recommendations for this disease.

Alternaria Leaf Spot

Alternaria leaf spot is caused by several species of the fungus *Alternaria* and is a common problem on collards, kale, mustards, and turnips. The disease can reduce plant vigor resulting in an unmarketable crop where the leaf is the edible portion of the plant.

**Symptoms.** The initial symptoms are small pinpoint-size dark circular spots on the surface of older leaves (Figure 2). With age, spots enlarge to 2 to 3 inches in diameter and are black, brown, or tan. Concentric rings may develop within the lesion, and a yellow halo may be

![Figure 1. Faint yellow to tan spots on the upper surface of a collard green leaf caused by downy mildew](image1)

![Figure 2. Symptoms of Alternaria leaf spot (the pinpoint-size dark circular spots and the larger tan to brown spots) on a collard green leaf](image2)
present around the lesion edge. The center of a spot may eventually drop out, producing a shot-hole appearance or, under wet conditions, become covered with a greenish-black or brown velvety fungal mold. If left uncontrolled, the disease can defoliate a plant. Roots of turnips can become infected, especially after harvest. Wounding of roots promotes infection. Root spots are circular, zonate, and various shades of brown to black. These firm textured root lesions may extend into the center of the root.

Transmission and Persistence. The disease can overwinter on or in crop debris, seed, and possibly cruciferous weeds. Spores are produced on old crop debris and in leaf spots and can be spread by wind and in water. The disease is most damaging under wet (rain, dew, or irrigation water) and warm conditions (68 to 81 degrees F).

Control. Bury, remove, or destroy plant debris following a season when the disease was present. Never grow collards, kale, mustards, or turnips in a field where a cruciferous crop was grown in the past three years. Plant disease-free seed or transplants. Begin a fungicide spray program at the first sign of the disease and continue at 7- to 10-day intervals with a registered fungicide. See the current Extension publication ANR 500A, Alabama Pest Management Handbook—Volume 1 for more information on chemical recommendations for this disease.

Cercospora Leaf Spot, White Spot, and Anthracnose

These three fungal leaf diseases are common on greens in Alabama and can be easily confused for each other. Development of Cercospora leaf spot (Cercospora brassicicola), white spot (Pseudocercosporella capsellae), and Anthracnose (Colletotrichum bigginianum) are favored by wet conditions.

Symptoms. Cercospora leaf spot causes leaf lesions that vary in color from pale green to gray to white and generally have a brown border (Figure 3). Lesions may be circular or angular in appearance. Severely infected plants may become defoliated. The disease is also known as frogeye leaf spot.

White spot causes circular spots with gray, brown, or nearly paper-white centers with slightly darkened margins (Figure 4). Spots form on the cotyledons, leaves, and petioles. Infected foliage may turn yellow and drop prematurely. Seedlings can be killed when the disease is severe.

Anthracnose can be a serious problem on collards, kale, mustards, and turnips. Anthracnose leaf spots are small, pale gray to straw colored, dry, and circular. Spots can also appear on stalks and are elongated, sunken, gray to brown, and have a black border. The fungus can also attack turnip roots, causing small dry sunken areas that become tan to gray in color and deeper in depth as they enlarge. The disease often predisposes infected roots to bacterial soft rot.

Transmission and Persistence. All three diseases are favored by wet conditions and are usually spread by wind or rain, but their activity varies based on temperature. Cercospora leaf spot and white spot can be seed borne but more commonly survive in volunteer plants and perennial weeds. Cool temperatures (55 to 64 degrees F) and abundant moisture favor both diseases.

Anthracnose can survive in dead leaves, in volunteer plants, and possibly in certain related weed hosts. The disease is most severe at temperatures between 79 and 86 degrees F when plenty of moisture is present.

Control. Eradicating cruciferous weeds and volunteer cruciferous plants will help control Cercospora leaf spot, white spot, and Anthracnose. Follow a long (2- to 3-year) crop rotation scheme using noncruciferous crops. Improve soil drainage and avoid using overhead irrigation. Scout fields and apply a registered fungicide when disease first appears. Copper- containing products (e.g., Kocide) are registered for leaf spot control on collards, kale, mustards, and turnips. Fungicides with the active ingredient Benomyl (e.g., Benlate) are registered for fungal leaf spot control on turnips only.
See the current Extension publication ANR 500A, *Alabama Pest Management Handbook—Volume 1* for more information on chemical recommendations for this disease.

**Wirestem, Bottom Rot, Damping-Off, and Root Rot (Rhizoctonia solani)**

Various cruciferous crops are subject to attack by the common soil fungus *Rhizoctonia solani*. Damping-off causes seed decay and seedling wilt. Wirestem can be a problem in transplant beds as well as in the field. Bottom rot is a midseason disease as a carryover from seedlings suffering from wirestem. Root rot is a field and storage rot of turnips.

**Symptoms.** Damping-off causes seeds to decay in cold wet soils. Young stems on infected plants become light brown and water soaked near the soil line. Infected seedlings wilt, collapse, and die. Damping-off usually appears as circular patterns in plant beds or down rows.

Wirestem is the most common and destructive phase of the disease. Plants infected with wirestem often have a reddish-brown discoloration to their stems near the soil line. The discolored area is often severely constricted. The outer stem tissue sloughs off, leaving a dark, wry, and woody inner stem. Plants may be bent or twisted but do not break, hence the name *wirestem*. Plants are stunted and weak, and some may die.

Bottom rot occurs as a midseason disease as a carryover from wirestem seedlings that survive or from new infections that can occur when outer leaves touch moist infested soil. Lower leaves wilt, decay, and turn black, but do not drop off. *Rhizoctonia solani* can rot turnip roots in the field and in storage. The rot is dark brown, sunken, and spongy, and the affected tissue separates easily from the advancing edge of the rot.

**Transmission and Persistence.** The fungus can persist indefinitely in all soils but will be more common on soil with infected plant debris that has not decomposed. Prolonged, overly moist soil will favor development of the disease. The amount of *Rhizoctonia* present is greatly influenced by the recent cropping history. The disease is more of a problem on slowly growing or deeply seeded plants.

**Control.** For damping-off and wirestem phases of the disease in seedbeds, the soil needs to be disinfested. A fungicide with the active ingredient pentachloronitrobenzene (e.g., Terralcor) can be used in the transplant water. For bottom rot control, all seedlings with symptoms of wirestem must be discarded before transplanting to the field. Crucifers should not be planted in fields where a cruciferous crop was grown in the past three years. During cultivation, care should be taken to avoid throwing soil onto plants. Remove plant debris following a season when the disease was present.

**Yellows (Fusarium Wilt)**

The soilborne fungus *Fusarium oxysporum f. sp. con-glatinum* causes yellows. Many members of the cruciferous family are susceptible to yellows including collards, kale, mustards, and turnips. The disease is often confused with black rot because of similar symptoms.

**Symptoms.** The first and most obvious symptom is a dull yellowish green color to the foliage. Symptoms are visible in fields within 2 to 4 weeks after transplanting. Young plants can turn yellow and die rapidly in warm soils. Plants that do not die become stunted, often with their lower leaves developing a one-sided curling. The yellowing of the leaves is more intense on one side of a midrib than on the other. Stems are often twisted to one side. Yellowing, browning, and drying of leaves progress up the plant. Infected leaves drop prematurely.

**Transmission and Persistence.** *Fusarium* can live for a number of years in the soil in the absence of a host. Yellows is a warm-weather disease and does not develop well at temperatures below 61 degrees F. It reaches maximum development at temperatures between 80 and 85 degrees F and is inhibited by temperatures above 90 degrees F. Soil moisture has little effect on the development of yellows disease. The fungus invades the roots and moves through the vascular system into the stem. The fungus can be spread by rain or by equipment moving from one field to another.

**Control.** Plant only disease-free seedlings.

**Clubroot**

Clubroot, caused by the fungus *Plasmodiophora brassicae*, can cause substantial losses to leafy greens. The disease is more common in fields with high soil moisture and neutral to acid pH.

**Symptoms.** The aboveground symptoms of the disease are difficult to distinguish. The leaves on infected plants are pale green to yellow and may wilt in the middle of a hot sunny day, only to recover at night. Plants can die from an early infection, whereas plants that survive are stunted and are unable to produce a marketable crop. The most distinctive symptom is an abnormal enlargement of the roots, resulting in clublike mal-
formations (Figure 5). Severely distorted roots are unable to absorb water and minerals from the soil. Consequently, the tops become stunted, yellowed, and wilted. Infected roots are susceptible to rots by other soilborne organisms.

Transmission and Persistence. The pathogen can survive in the soil for up to 10 years. The fungus invades plants through root hairs or wounds. The fungus then develops within host root cells and stimulates cell division and growth, which results in the clublike formation of roots. Acidic soils and temperatures ranging from 54 to 81 degrees F allow rapid disease development. The fungus can be spread on infected transplants originating from diseased seedbeds, in irrigation water, and on infested soil clinging to machinery, people, or animals.

Control. Several management practices must be used to reduce losses to clubroot. These include the use of resistant varieties, the use of disease-free seed or certified disease-free transplants, the use of a long crop rotation free of cruciferous crops, and the use of a fungicide with the active ingredient pentachloronitobenzene (e.g., Terraclor). Control also consists of planting on well-drained soil that is free of the fungus, maintaining a soil pH of 7.3 or higher, and eradicating cruciferous weeds in and near the production field. In addition, avoid moving soil or plant material from infested areas to disease-free fields. When moving equipment from an infested area, all equipment, including boots, tires, etc. should be washed clean of soil and plant debris.

See the current Extension publication ANR-500A, Alabama Pest Management Handbook—Volume I for more information on chemical recommendations for this disease.

Black Rot

Black rot, caused by the bacterium Xanthomonas campestris, is a problem on crucifers, including collards, kale, mustards, and turnips.

Symptoms. Seedling infection first appears as a blackening along the margins of the cotyledons. Cotyledons shrivel and drop off. Infected seedlings may be stunted and yellowed and may eventually wilt and die. Seedling infection can be difficult to diagnose since only a few plants in a lot may be infected.

The disease is easily recognized on most crucifers by the presence of yellow, V-shaped, or U-shaped areas extending inward from the margin of the leaf (Figure 6). The bacteria usually infect the plant through water pores at leaf margins. As the disease progresses, the yellow lesions turn brown and the tissues die. Veins darken and the midrib of leaves turns black within the affected leaf area. This vein discoloration progresses toward the base of the leaf as the bacteria spread through the leaf veins. Eventually, the bacteria spread into the main stem. When infected stems are cut in cross-section, a black vascular ring may be evident where bacteria have moved into the water-conducting vessels. The vascular discoloration extends from the stem to the upper leaves and down into the roots. In later stages of the disease, all central tissues of the main stem turn black.

Black rot is usually most severe in low wet areas of fields or along windbreaks where plants remain wet for long periods. Black rot can also be seen moving down rows as the bacterium is spread during cultivation. However, distribution of the disease often is quite uniform across production fields.

Disease cycle. The black rot bacterium may be carried over from year to year in or on the seeds of infected crucifer host plants, on overwintering cruciferous weeds, or in partially decayed infected plant material in the soil. The bacterium can persist in residue for one to two years or as long as the plant debris remain undecomposed. Black rot is spread on seed, seedlings, by movement of contaminated plant material, in irrigation water or splashing rain, by insects, by cultivation equipment, and by field workers. The organism can also survive on numerous weed hosts found in the cabbage family, including black mustard, field mustard, wild turnip, wild radish, shepherds purse, and Virginia pepperweed.

In the spring, when seedlings emerge, bacteria are typically carried from diseased plant refuse to leaf edges by splashing rain. Bacteria invade young leaves through natural openings
or wounds. From the infected leaves, the bacteria move through the waterconducting vessels to the main stem, down into the roots, and up into leaves. Plant-to-plant infection in the field usually occurs through the hydathodes at leaf margins or through wounds. Clipping oversized transplants with rotary or flail mowers will allow spread of the disease if the bacterium is present. Root infections can occur through wounds and are most common when infested soil is saturated with water.

The disease develops best under warm wet conditions. Temperatures of 80 to 86 degrees F favor growth of the bacterium. Free moisture in the form of rain, dew, or fog is required for infection to occur and for the disease to develop.

Control. Only purchase and plant certified disease-free transplants. Always examine plants thoroughly before purchasing. Plants that are discolored, have visible lesions, or appear unhealthy should not be purchased. Grow plants in fields that have not been in cruciferous crops for at least three years. Rotate with plants from other plant families that are not hosts of the disease. Only plant in areas that provide good soil drainage and free air movement. Provide a balanced soil fertility program based on recent soil test information. Control all cruciferous weeds in and around the production field. Do not work in fields when plants are wet to avoid spread of the disease. Control cabbage root maggots, cutworms, cabbage-worms, and other insects using recommended control practices. When possible, clean up and burn or cleanly plow all crop debris immediately after harvest. Removing plant residue from the field surface will greatly reduce the bacterium’s ability to survive the winter. A copper-containing product (e.g., Kocide 2000) will reduce damage from black rot. Begin to apply the material when weather conditions favor disease development. Be aware that copper-containing products may cause plant injury. See the current Extension publication ANR-500A, *Alabama Pest Management Handbook—Volume 1* for more information on chemical recommendations for this disease.

**Root-Knot Nematode**

Root-knot nematode (RKN) is the only nematode of economic importance that affects crucifers. All species of RKN are considered pests of crucifers.

**Symptoms.** When RKN populations are high, infected plants are often stunted and yellowed. Infected plants may wilt during dry conditions or during the hottest part of the day with symptoms more pronounced on plants grown in sandy soil. The nematode causes knots or galls to form on both large and small roots (Figure 7). Knots vary in size from the size of a pinhead to an inch in diameter. Superficially, the disease appears like clubroot on crucifer roots, but clubroot causes larger, more continuous swellings on the older affected portions of infected roots. RKN on crucifers produce clumps of root branches above the point of infection, so bushy root systems covered with galls are common.

Secondary infection by other soil-dwelling pathogens also occurs frequently. RKN damages the root system by disrupting the flow of water and nutrients to aboveground parts of infected plants.

**Transmission and Persistence.** Root-knot nematodes survive in the soil from year to year and become active as soil temperatures rise in the spring. A female RKN produces up to 600 eggs in one generation. In south Alabama, RKN can pass through five or more generations in one season.

**Control.** To reduce RKN populations, rotate cruciferous crops with grasses or nematode suppressive crops or clean fallow. RKN populations can also be reduced by soil fumigation or soil solarization. Refer to Extension publication ANR-713, “Soil Solarization for the Control of Nematodes and Soilborne Diseases” for more information on this technique.

**Figure 7.** Root-knot nematode infection results in the formation of knots or galls on roots.
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