

Chapter 11

Soybean Diseases and Their Control

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Soybean diseases annually reduce yields in Arkansas by an estimated 10 percent. Disease development is dependent upon several factors including cropping practices, variety selection, rotation, temperature, moisture and fertility. Accurate disease identification and awareness of disease loss importance are essential for the continued success of Arkansas soybean production. The following symptom descriptions and color photographs of common diseases in Arkansas should help you identify and manage soybean diseases before they become a yield-limiting problem.

Stem and Root Diseases

Stem Canker

Since the first report of stem canker in a field in 1982, it is now in all Arkansas soybean production areas. This disease is considered one of the most destructive diseases, attacking vigorously growing soybeans and reducing yields by up to 90 percent. The frequency and severity of stem canker outbreaks have been erratic and unpredictable from year to year. Severe disease development strongly correlates with prolonged rainy periods and temperatures around 70°F to 85°F during early vegetative stages.

The fungus overwinters in infested stem debris and seeds and may survive up to 14 months in soil at temperatures from 4°F to 65°F. Susceptible plants can be infected at any stage of development. Spores are the primary means of infection throughout the growing season. Spores are splashed and dispersed onto wet plants in the spring or early summer during warm, rainy weather. Infected plants do not show symptoms until late flowering, and often plants infected late never show symptoms.

The name “stem canker” comes from the most characteristic symptom of this soilborne disease, which is the development of tan-brown lesions (cankers) with dark red-purple margins on the lower

stem. Cankers first appear as small reddish-brown lesions on the main stem near one of the lower eight nodes where leaves attach. As the disease develops, the cankers enlarge upward several inches along the main stem or up lateral branches. Lesions rapidly become definite, slightly sunken cankers which may completely girdle the stem and prematurely kill the plant. Scraping off stem epidermis reveals discolored tissue in the canker area, yet stem tissue surrounding the canker remains green. Lengthwise sections cut through stems of symptomatic plants will show internal brown discoloration of the stem and pith in the canker area.

Leaf symptoms begin as dull-colored leaves with yellowing, followed by death of interveinal leaf tissue, and may resemble those of sudden death syndrome upon casual inspection (Figure 11.1). Generally the interveinal discoloration develops from one leaflet to another primarily along one side of the mainstem. This one-sided symptom progression occurs on the same side of the plant as the developing canker. The canker disrupts water and nutrient flow to those plant sections as it girdles the plant. The main leaf veins remain green following interveinal tissue death. The leaves wilt, and the dead leaves generally remain attached to the plant.



Figure 11.1. Stem canker symptoms on foliage and stem.

Research indicates that stem canker is more severe with continuous soybean production and in no-till planting regimes. Stress appears to make the disease worse. Drought followed by rainfall increases sporulation of the fungus and may increase disease incidence. Extended dry periods may decrease disease severity.



Management Tip

Integrating disease management strategies 1, 3, 4, 5, 6, 8, 11 and 14 from Table 11.1 (later in this chapter) into current production practices minimizes yield loss from **stem canker**.

Sudden Death Syndrome

Sudden death syndrome is a mid- to late-season soilborne disease prevalent during cool, wet seasons. This disease is most often found in well-managed, high-yield potential, irrigated fields growing under optimal conditions. Sudden death syndrome was first observed in Arkansas in 1971.

Yield losses can approach 100 percent in severe situations. Yield reductions from this disease are the result of flower and pod loss, leaflet and pod drop, and reduced seed size. Outbreaks are as erratic in frequency and severity as those of stem canker. Hot weather also seems to stop this disease development.

Sudden death syndrome leaf symptoms resemble those of stem canker upon casual inspection. Symptoms first occur on leaflets during early flowering as scattered, interveinal yellow blotches which eventually become dead and brown. The yellow blotches often enlarge until only the leaf mid-vein and major lateral veins remain green (Figure 11.2). **Affected leaflets and pods are shed from the plant, unlike those on stem canker-affected plants which remain attached.** Leaf petioles without leaflets remain green, erect and attached to stems for a considerable time following defoliation and pod drop.

Examination of the roots of plants just beginning to show interveinal chlorosis reveals light-brown discoloration in the lower portion of the taproot. Significant foliar symptoms are evident before stem discoloration is visible. Greyish-brown discoloration of vascular tissues progresses up the root and into the stem. Discoloration often extends one-half to three-fourths up the stem of severely affected plants.

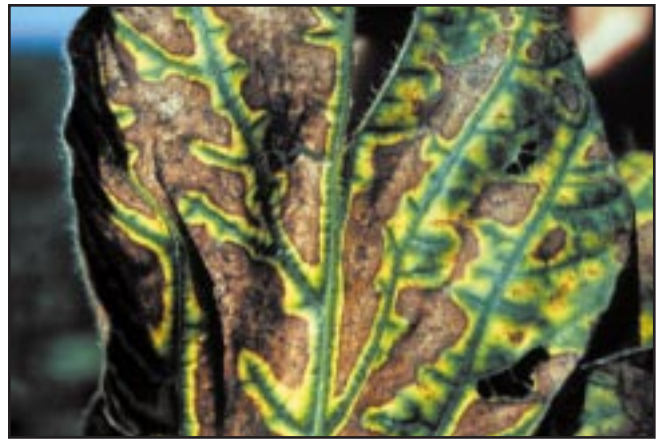


Figure 11.2. Foliar sudden death syndrome symptoms.

Vascular tissue, lateral roots and nitrogen-fixing nodules deteriorate as discoloration progresses into stem tissue. The pith remains white (Figure 11.3), the stem epidermis remains green and no stem cankers are apparent, even on severely defoliated plants.

Fields with a history of sudden death syndrome are likely to develop the disease in subsequent years if susceptible varieties are planted. Moderate to high populations of soybean cyst nematodes may increase severity of sudden death syndrome and are often, but not always, present in fields devastated by this disease.



Figure 11.3. White stem pith of a sudden death syndrome plant.



Management Tip

Integrating disease management strategies 1, 5, 6, 8 and 11 from Table 11.1 into current production practices minimizes yield loss from **sudden death syndrome**.

Charcoal Rot

Symptoms of charcoal rot appear in hot, dry weather or when plants are stressed by unfavorable environmental conditions. The fungus causing this disease is widely distributed in soils of all soybean production areas and can survive for several years in dry soils or in plant debris as minute sclerotia.

Charcoal rot is primarily a root and lower stem disease but may extend into upper stem tissue. While seedlings may become infected, this is considered a disease of older plants occurring at midseason. The disease is more severe when plants are under stress from moisture or nutrients, excessive plant population, soil compaction, improperly applied pesticides, nematodes or other diseases.

The fungus enters the plant through the root at an early growth stage, but disease symptoms are not easily recognized until plants are near death. Late plantings seem to be more susceptible to seedling infection because warm soil temperatures are necessary for infection. Foliar symptoms, progressing from the top of the plant down, first appear as smaller than normal sized leaves which turn yellow and wilt. Leaves on prematurely yellow plants remain attached as the entire plant takes on a dull greenish-yellow appearance prior to wilting.

This fungus colonizes the water transport tissues causing the plant to wilt. Diseased root and lower stem tissues first develop a light-brown discoloration, which soon takes on an ashy-grey discoloration as numerous charcoal-black fruiting bodies (sclerotia) develop within the affected tissues (Figure 11.4). Splitting the taproot and lower stem of dead infected plants reveals many tiny black sclerotia embedded throughout the vascular tissue. You may see them more clearly with a hand lens. Infected plants may have an abundance of sclerotia on the roots and lower stem just beneath the skin (epidermis) which gives a greyish-black cast to the affected tissues. The sclerotia resemble a sprinkling of powdered charcoal, hence the name “charcoal rot.”

Yield losses are difficult to estimate because this disease occurs at varying levels in nearly every field, and there are no known resistant varieties or fungicidal controls. This disease is associated with stressed plants, so maintaining healthy, vigorous plants reduces losses.



Figure 11.4. Small black fruiting structures of charcoal rot are embedded throughout infected plant tissue.



Management Tip

Integrating disease management strategies 3, 4, 6, 8, 11, 14 and 15 from Table 11.1 into current production practices minimizes yield loss from **charcoal rot**.

Phytophthora Root Rot

Plant and yield losses of 100 percent may occur in fields infested with this destructive disease and planted to a highly susceptible soybean variety. Phytophthora root rot infection and damage may occur at any stage of growth, but they are most common before pod set. Seed rot and seedling damping-off result in reduced stands. Young plants wilt and die quickly while older plants are killed gradually. Older plants turn yellow and wilt, wither and die at any age.

Symptoms consist of yellowing along margins and between veins of lower leaves. Upper leaves turn yellow, and the plant then wilts. Wilted leaves remain attached to the plant for weeks after plant death. Wilting symptoms are accompanied by a dark-brown discoloration which progresses up the stem, both externally and internally (Figure 11.5). Infected lateral and branch roots are nearly destroyed, and infected taproots are extensively discolored. The discoloration progresses from the roots into the lower branches, often as high as ten nodes, before the plant wilts and dies.

Figure 11.5. Dark-brown discoloration extends up the stem of *Phytophthora*-infected plants.



This disease is most common in poorly drained soils, but may appear in any soil type if the soil is wet for several days. The disease is often misidentified as water damage or nitrogen deficiency. The optimum temperature of 86°F for disease development is much higher than for most other root-rotting fungi. Flooding rains within one week of planting result in the most disease development. Reduced tillage, especially no-till cropping and mono-cropping of soybeans, increases *Phytophthora* root rot.

A dry period before or after planting may reduce disease development. The fungus survives from season to season in soil or in crop debris and can survive several years in the absence of soybeans. The disease pattern varies within a field. Frequently, it may correspond to the poorly drained areas, but it may also occur as a dead or dying individual or group of plants.

Twenty-five races of the fungus have been described, and many isolates have been found that do not fit any of the races based on their reaction against differential varieties. Few soybean varieties are resistant to all known races of this pathogen. Field tolerance, defined as varieties that are susceptible to the pathogen but show little yield loss, has been effective against all races and is an alternative to race-specific resistance.



Management Tip

Integrating disease management strategies 1, 3, 4, 5, 6, 8 and 11 from Table 11.1 into current production practices minimizes yield loss from *Phytophthora* root rot.

Pod and Stem Blight

This seedborne disease is in all soybean-growing areas of Arkansas. Losses to both quality and quantity can be serious. The stem phase of pod and stem blight is most important as a source of spores for field infections in later cropping years. Lower branches of plants are infected during the growing season by spores produced on infested soybean residue and splashed into plant wounds during warm, rainy periods. A hidden infection spreads systematically throughout the plant via the vascular system. No definite lesions develop on stems under field conditions, but the fungus can be isolated from healthy appearing tissue. The first presence of this disease in the field is detected as characteristic speck-sized, black, flask-shaped structures (pycnidia) arranged in rows along dried petioles and stems of shed leaves or broken branches (Figure 11.6). Large numbers of pycnidia develop over the entire plant and appear at the same time after maturity during a wet harvest season.



Figure 11.6. Pod and stem blight fruiting structures on stems.

Pycnidia are limited to areas near the soil or clustered close to nodes during dry seasons. Cross-sections of dried lower stem and root tissue reveal an extensive black marbling or random ribbon-like streaking of tissues.

Seed infection during the pod blight phase of the disease is enhanced by delayed harvest during warm, wet weather. Seeds are invaded anytime after pod formation. Infected seeds may produce diseased seedlings.

Pycnidia are also scattered on dry, poorly developed pods. Mature pods with pycnidia always contain infected seeds. Heavily infected seeds are badly shriveled and cracked and are frequently covered with a white mold. Severely infected seeds often do not germinate.



Management Tip

Integrating disease management strategies 2, 3, 4, 6, 8, 9 and 10 from Table 11.1 into current production practices will minimize yield loss from **pod and stem blight**.

Anthracnose

This is a systemic disease of soybeans similar to pod and stem blight. The fungi that cause anthracnose overwinter in infected seeds and soybean residues. The fungi infect all aboveground plant parts, but it is most common on the pods and stems. Symptoms of anthracnose vary. Infected petioles develop lesions below the leaflets (Figure 11.7). Trifoliolate leaves wither and drop, leaving the upper portion of petioles bent into a characteristic “shepherd’s crook.” Diseased petioles are shed from the plant within a few days after the leaves wither. Defoliation within the lower plant canopy during periods of high humidity and warm temperatures may become extensive. Anthracnose will be reduced in severity during “dry” seasons.

Anthracnose is a serious stem disease in Arkansas. Stem and pod symptoms include indefinite, enlarging, blotchy areas of reddish- or dark-brown discoloration, which usually turn grey after the infected plant tissue matures and dies. Often stems are without the blotchy discoloration, but infected areas develop black fruiting bodies (acervuli) that resemble tiny pincushions with black spine-like projections (setae). These fruiting

structures closely resemble pod and stem blight, except they are not lined up in rows, and the black setae can be easily seen with a hand lens (Figure 11.8).

Stems, pods and leaves may be infected without showing external symptoms until weather conditions become favorable for further disease development. Infected seeds may be shriveled and moldy or show no visible signs.



Figure 11.7. Leaf symptom of anthracnose.



Figure 11.8. Tiny, black, pincushion-like fruiting structures of anthracnose are easily seen with a hand lens.



Management Tip

Integrating disease management strategies 3, 4, 7, 8, 9, 10 and 14 from Table 11.1 into current production practices minimizes yield loss from **anthracnose**.

Southern Blight

Soybean losses due to this disease vary greatly with damage occurring as scattered localized areas of dying plants. This soilborne fungal pathogen produces a variety of symptoms including pre- and post-emergence damping-off and a lower stem rot.

Soybeans are susceptible to southern blight anytime from germination through pod fill. Sudden yellowing or wilting of entire plants is usually the first noticed symptom. An infection lesion occurs at or just below the soil surface and quickly enlarges until the stem is girdled. Leaves on infected plants turn brown and remain attached to the dead stem.

The fungus produces a typical white, cottony mold/mat over the lower stem surface, leaf debris and the soil surface around infected plants. Small, rounded fruiting bodies (resembling mustard seed) are abundantly produced in the mycelial growth. The fruiting bodies begin as a light cream color and darken to yellowish-tan, to reddish-brown, and eventually dark brown as they mature (Figure 11.9). Southern blight develops similarly on a range of crops/host plants exceeding 100 plant species. Soybean yield losses in Arkansas seldom surpass 1 percent in affected fields.



Figure 11.9. Sclerotia of southern blight on the lower stem.

Hot, humid weather, monocropping and heavy plant residue encourage development of this disease, but drought restricts its development.



Management Tip

Integrating disease management strategies 2, 3, 4, 6, 8, 11 and 14 from Table 11.1 into current production practices will minimize yield loss from **southern blight**.

Foliar Diseases

Frogeye Leaf Spot

This destructive disease occurs sporadically in Arkansas, but it can be severe in years with abundant rainfall during the growing season. When severe, yield losses of 10 to 15 bushels per acre are common. These losses can be prevented with resistant cultivars or a timely application of a fungicide.

The fungus overwinters in infected seed and crop residue. Germination is slightly reduced in infected seeds. These seeds may produce seedlings with lesions on the cotyledons.

Plant residues or infected cotyledons produce conidia (fungus spores) that infect young leaves more rapidly than older leaves. Nine to twelve days after infection, the “eye-spot” lesions develop and produce more spores.

Spores are carried short distances by the wind and splashing rain to infect leaves, stems and pods. During favorable conditions, all leaves may become infected and the fungus may grow through lesions on the pod wall to infect seeds.

Infection and disease development are favored by warm, moist weather at optimum temperatures of 81°F to 85°F.

Leaf symptoms begin as dark, water-soaked spots and develop into lesions with tan to grey centers with narrow reddish-brown to purple margins (Figure 11.10). These characteristic “eye-spots” are usually angular and vary in size from pin points to 1/5 inch in diameter. Older lesions are translucent and have whitish centers containing minute black dots.



Figure 11.10. Typical frogeye leaf spot symptoms.

Several lesions may merge to form large, angular or irregular spots. Heavily infected leaves with numerous lesions wither and shed prematurely.

Lesions on pods are circular, slightly sunken and reddish-brown. They may become grey to light brown with a narrow dark-brown border.



Management Tip

Integrating disease management strategies 1, 3, 4, 6, 8, 9 and 10 from Table 11.1 will minimize yield loss from **frogeye leaf spot**.

Cercospora Leaf Blight

This common foliar disease of soybeans in Arkansas is caused by the same fungus responsible for Purple Seed Stain. Most soybean fields in Arkansas experience some damage from this disease every year. Extensive damage is reported in some years. *Cercospora* leaf blight is considered a late-season disease because premature defoliation of the upper canopy occurs during the pod-filling stage in large areas or entire fields. Accurate yield losses have not been determined.

The fungus overwinters in debris and infected seedcoats. Diseased seeds are often dull, cracked and rough. Seeds may be infected without symptoms, but a pink to purple coloration of the seedcoat is

diagnostic. The seed infection phase of this disease is known as “purple seed stain,” and some reduction in seed germination has been reported. Spores produced on infected debris and seedcoats give rise to seedlings with infected cotyledons. Spores from these infected plant tissues are windborne or splashed by rain or dew onto other plant parts.

Infection and disease development are favored by extended periods of high humidity and warm weather. Optimum temperatures are 82°F to 86°F. The disease is most prevalent in early-maturing varieties.

The first symptoms of *Cercospora* leaf blight are observed at the beginning of seed development. The initial symptom of infection is a light purpling of exposed upper leaves. The infected leaves develop a leathery, bronze-highlighted to reddish-purple appearance (Figure 11.11). This discoloration can deepen and extend over the entire upper leaf surface to upper stems, petioles and pods.



Figure 11.11. Early symptoms of *Cercospora* leaf blight.

Reddish-purple, irregular lesions later develop on both sides of the leaf surface, on major veins, petioles, stems and pods. The lesions vary from pinpoint spots to irregular patches which may merge to form large necrotic areas.

Numerous leaf infections cause rapid yellowing and death of leaf tissues, resulting in severe early defoliation of the upper leaves, whereas lower leaves can remain green. This symptom is often mistaken for early senescence. By contrast, normal senescence

begins in the lower canopy with leaf yellowing, followed by leaf loss progressing from the lower to the upper plant canopy.



Management Tip

Integrating disease management strategies 2, 3, 4, 8, 9 and 10 from Table 11.1 into current production practices will minimize yield loss from **Cercospora leaf blight**.

Downy Mildew

This foliar disease is consistently found scattered throughout Arkansas fields, but it is rarely a serious problem. However, severe infections causing defoliation will result in reduced seed quality and size.

The fungus overwinters in leaf debris and less often on encrusted seeds. Although rare in Arkansas, infested seed and debris may give rise to systemically infected plants (mycelium growing within the plant and into pods). Pod infections occur without external symptoms. Mycelium growing within pods results in a whitish, encrusted growth on seeds containing oospores of the fungus (thick-walled resting spores).

The disease name, “downy mildew,” comes from the fuzzy, felt-like growth on the lower leaf surface of lesions. This down-like growth is composed of sporangia (spore containers) and sporangiophores (spore stalks). Sporangia are dispersed primarily by the wind to infect other plants.

Disease development is favored by cool, wet weather and high humidity at optimum temperatures of 68°F to 72°F. Increased resistance to infection of older leaves and higher temperatures during midsummer generally stop disease development in Arkansas before extensive damage occurs.

Early symptoms of downy mildew may be found on young plants, but it does not become widespread in a field until late vegetative or early reproductive growth stages. The sporangia can infect only young leaf tissue; therefore, leaf spots of the disease will be typically found in the upper canopy.

Early upper leaf surface symptoms begin as large, easily visible, pale yellow, indefinite spots, dependent upon leaf age and unrestricted by leaf veins (Figure 11.12). Greyish downy tufts of fungal growth develop on lower leaf surfaces (beneath upper leaf surface spots) during cool, moist weather.

Leaf spots enlarge as infection progresses, become bright yellow and eventually dark brown, surrounded by a yellow margin. Up until the downy tufts on the lower leaf surface are observed, leaf spot symptoms are often confused with similar symptoms of brown spot or bacterial pustule. Old weathered lesions are often confused with mature lesions of frogeye leaf spot. Severe infections may result in premature leaf drop.



Figure 11.12. Characteristic yellow leaf spots on upper leaf surfaces of downy mildew-infected plants.



Management Tip

Integrating disease management strategies 1, 3, 4, 7, 8, 9 and 10 from Table 11.1 into current production practices minimizes yield loss from **downy mildew**.

Brown Spot

This is one of the earliest leaf diseases to develop on young plants in Arkansas. It is generally confined to lower leaves. Brown spot is apt to be severe when soybeans are planted early, grown continuously in the same field, grown in poorly drained fields or after extended periods of rainfall.

Premature defoliation can cause serious yield loss when conditions favoring disease development continue well into the growing season or recur before soybean maturity. Sources of resistance in soybeans have not been found, but differences in susceptibility among varieties have been observed, especially among cultivars within maturity groups III and IV in which high incidence of brown spot is often observed.

The fungus overwinters as pycnidia (flask-shaped fruiting structures) and mycelium in leaf and stem debris and in diseased seed. Initial infections develop on cotyledons and unifoliate leaves from conidia discharged from pycnidia.

The spores readily germinate in water on leaf surfaces and enter the plants through stomata (natural openings). The spores are distributed from infected cotyledons and unifoliate leaves. Spores are moved upward to trifoliate leaves, petioles, stems and pods by wind or splashing rain.

This disease may occur on plants at any time during the season. Infection and disease development are favored by warm, wet weather. The optimum temperature ranges from 79°F to 83°F. Hot, dry weather halts its spread.

Initial brown spot symptoms develop as numerous irregular brown spots varying from pinpoint specks to small areas 1/5 inch in diameter with distinct margins (Figure 11.13). The spots rarely expand beyond the boundaries of the leaf veins and are more pronounced on the under leaf surface. The lesions gradually darken to blackish brown and often develop a yellow halo around the leaf spots.



Figure 11.13. Brown spot lesions are dark brown on both the upper and lower leaf surfaces.

A visual examination of infected leaves by holding them to the light reveals that brown spot leaf lesions are dark and opaque. In contrast, bacterial blight lesions are translucent leaf spots.

Infected leaves yellow rapidly and prematurely drop. Infection and the resulting leaf defoliation progress in the plant canopy from lower to upper leaves.

Irregular brown lesions with undefined margins may form on the stem, petioles and pods, but they are not sufficiently distinct from symptoms of other diseases to be diagnostic.



Management Tip

Integrating disease management strategies 2, 3, 7, 8 and 10 from Table 11.1 into current production practices will minimize yield loss from **brown spot**.

Aerial Blight

This soilborne disease is most prevalent during prolonged periods of high humidity and warm temperatures. It generally develops in localized, somewhat circular areas in fields involving only a few plants per blighted area. However, entire fields may become affected, and losses have been as heavy as 40 to 50 percent.

The fungus causing this disease has a wide host range, including rice, corn and sorghum, upon which it can survive and increase inoculum. Soils are infested with long-lived sclerotia which germinate to infect plants.

Fungal mycelium also grows freely through soil in the absence of susceptible plant tissue and colonizes all types of plant debris. This fungus is also responsible for sheath blight in rice. Soybeans rotated to fields with a history of sheath blight can be expected to have a high incidence of aerial blight.

Disease symptoms first appear during late vegetative growth following canopy closure on the lower portion of the plant. The disease can affect any aboveground plant tissue and favors high density populations, narrow rows and lodged plants (Figure 11.14). Entire trifoliate leaves become water soaked, turn brownish or blackish-green, collapse and adhere to pods and stems below. Aerial

mycelium envelops pods and leaves resulting in a “webbed” appearance.



Figure 11.14. Presence of sclerotia and “webbed foliage” are key diagnostic features of aerial blight-infected plants.

Affected petioles, leaf scars, stems and pods may develop dark reddish-brown lesions. The formation of large (1/16 to 3/16 inch) dark brown sclerotia upon diseased leaves or on lesions of pods or stems is a key diagnostic feature.



Management Tip

Integrating disease management strategies 2, 6, 10, 14 and 15 from Table 11.1 into current production practices minimizes yield loss from **aerial blight**.

Bacterial Blight

This is the most common bacterial disease in all areas where soybeans are produced. Although a disease of limited importance in most Arkansas production areas, it is one of the first leaf spot diseases to appear on young plants. Bacterial blight can cause significant yield reductions on susceptible cultivars under heavy disease pressure.

The seedborne bacteria overwinter in seed and infected soybean residue. The causal bacteria enter the plant through stomates and wounds.

Initial infections occur during seedling emergence. The bacterium is also spread from infected cotyledons and leaves of nearby diseased plants or soil during windy rainstorms and during cultivation while the foliage is wet. Seeds can be infected through the pods during the growing season, or they may be invaded during harvest.

Windy, cool, rainy weather at optimum temperatures of 75°F to 79°F favors the development of bacterial blight. Hot, dry weather stops its development.

Bacterial blight is primarily a leaf disease, but stems, petioles and pods may be affected. Leaf symptoms begin as small, angular, translucent, water-soaked, yellow to light-brown spots. Leaf spot centers darken to reddish-brown, become sunken and are surrounded by a water-soaked margin bordered by a yellowish-green “halo.” The halo is more noticeable on the upper leaf surface. Under certain conditions, the infection travels along the leaf veins. The lesions enlarge and merge to produce large irregular necrotic areas (Figure 11.15). The large dead areas of the leaf lesions often fall out or tear away after strong winds and beating rains, giving leaves a ragged appearance. Early defoliation of leaves may occur.



Figure 11.15. Typical “ragged” leaf symptoms of bacterial blight.

Leaf spot symptoms of bacterial blight may at times resemble those of the fungal disease brown spot. However, upward movement of bacterial blight within the canopy is more rapid than for brown spot. The leaf spots of bacterial blight only appear solid. Holding infected leaves to the light reveals the translucence of these spots.



Management Tip

Integrating disease management strategies 1, 3, 8 and 14 from Table 11.1 into current production practices will minimize yield loss from **bacterial blight**.

Bacterial Pustule

Although common in most soybean production areas, bacterial pustule is not as prevalent as bacterial blight. Bacterial pustule was once a serious problem in Arkansas, but it is now of minor importance due to the high level of resistance in most commercially available varieties.

The bacteria overwinter in infested seed, soybean residue, the soil immediately around wheat roots and some weeds. The bacteria spread from plant debris in the soil or nearby diseased plants via splashing water, windblown rain and during cultivation when the foliage is wet. The bacterium enters the plant through stomates and wounds.

Bacterial pustule develops during warm, wet weather at optimum temperatures of 86°F to 91°F. Unlike bacterial blight, bacterial pustule development is not reduced by high temperatures. New infections may occur throughout the growing season whenever wet or rainy conditions prevail.

Early symptoms are characterized by small yellow-green spots with elevated reddish-brown centers (most conspicuous on upper leaf surfaces). Later, a small, slightly raised, pale-colored pustule (Figure 11.16) usually develops at the lesion center (most noticeable on lower leaf surfaces).

Spots vary from very small specks to large, irregular, mottled necrotic areas. Diseased leaves develop a ragged appearance when the necrotic areas are torn away by stormy or windy weather. Severe infection often results in some premature defoliation that may decrease yields by reducing seed numbers and size.

Symptoms of bacterial pustule may at times resemble those of bacterial blight, and it is common for both diseases to occur together. Pustule formation and the absence of a water-soaked appearance during the early stages of lesion development (before the leaf spots turn yellow) distinguish bacterial pustule from bacterial blight.



Figure 11.16. Slightly raised lesion centers are difficult to see in bacterial pustule-infected plants.



Management Tip

Integrating disease management strategies 1, 3, 8, 12 and 13 from Table 11.1 into current production practices will minimize yield loss from **bacterial pustule**.

Seed and Seedling Diseases

The organisms responsible for these diseases adversely affect germination and seedling vigor. The pathogens primarily come from seed, infested debris or are soilborne. Disease organisms may enter the seed and cause decay through cracks or natural openings in the seedcoat. Prolonged storage, especially under high moisture (above 14 percent), deep planting and planting into cold or wet soils reduce seedling vigor and lead to excessive exposure to several damping-off fungi. Planting seeds infected with any of the pathogens of the diseases mentioned in this publication or exposed to any of the pathogens in an environment unfavorable to seed germination may result in thin, irregular stands and seedling death (Figure 11.17).

Infection by these pathogens may occur before or after germination or emergence and cause seedling death. Lesions on the stem or the lower taproot or decayed roots confirm seedling disease. Microscopic examination of the infected tissue is necessary to identify the specific pathogens. Other factors, such as improperly applied fertilizer or pesticides, poor



Figure 11.17. Diseased seedlings.

seedbed preparation and poor soil environment (usually including fertility, moisture and temperature), may cause similar seedling damage or increase seedling disease. Chemical seed treatments can reduce seedling loss to specific disease pathogens, but they will not improve poor germination or vigor in the absence of seedborne organisms.



Management Tip

When in doubt about proper disease identification, contact your local county Extension agent. He or she should be your first resource, both in obtaining an accurate diagnosis and in helping select appropriate control measures.

Disease Management

Developing a disease management program involves an integrated approach using several efficient and economical disease management practices. Correct disease identification is by far the single most important disease management strategy. The combined use of several disease management strategies which complement other “best farming” production practices will be more effective than any single control method. Some disease management procedures apply in all soybean-growing areas of Arkansas, while others may be effective in specific situations. Consult your local county Extension agent for recommendations and incorporate as many of the following disease prevention strategies as possible into your disease management program.



Management Tip

Correct disease identification is by far the single most important disease management strategy.

Good crop management promotes plant health and vigorous growth which enable the soybean plant to be more tolerant to most disease-causing organisms and often escape yield-limiting damage. This involves an integrated approach which includes proper seedbed preparation, correct planting depth, balanced soil fertility, good internal and surface soil drainage, and effective weed and insect management.

Planting resistant soybean varieties is the most efficient and least expensive disease management practice. But, resistance to all known diseases is not available, and pathogens may develop new races which overcome plant resistance. Many high-yielding resistant soybean varieties are available for use against a number of potentially devastating soybean diseases and should be planted wherever a serious soybean disease has been a continuous problem. Knowing which damaging disease problems occur regularly in your local area and in each field on your farm is essential information you need prior to selecting top-yielding varieties for production.

Consult your county Extension agent for variety selection recommendations. Use the Extension computerized soybean variety selection program to determine which variety is best suited to each field, especially if your disease situation includes stem canker or soybean cyst nematodes. Some diseases such as frogeye leaf spot, sudden death syndrome and Phytophthora root rot may not be consistently yield-limiting in some areas of the state. In these situations, a less resistant variety with a higher yield potential may be suitable for you.

Loss from disease depends upon its severity. The production of no-till soybeans or continuous soybeans, especially the same variety in the same field, provides an environment in which diseases can be very damaging, even in areas where they have not been a recent problem.

An effective disease management program is essential for control of most soybean diseases and is based largely upon disease prevention strategies.

Table 11.1 Disease Prevention Strategies

1	Plant adapted, resistant varieties.
2	Plant the least susceptible, adapted variety.
3	Plant high-quality, disease-free seed.
4	Treat seeds with an appropriate fungicide.
5	Delay planting to escape early vegetative infection during rainy periods.
6	Rotate with non-host crops for two years.
7	Rotate to a non-host crop for one year or more.
8	Plow under all crop residue immediately after harvest.
9	Harvest soybeans promptly at maturity.
10	Apply a foliar fungicide when weather conditions favoring disease development are forecast – between early pod development and initial seed formation, when yield potential is high and disease is present.
11	At present, no foliar applied fungicides are registered that provide cost-effective control.
12	Do not cultivate when the foliage is wet.
13	Foliar antibiotic sprays have not been successful in controlling bacterial pathogens, and copper-based materials have not been adequately tested.
14	Avoid narrow row widths and high plant populations.
15	Avoid rotations with rice, corn or sorghum where feasible.

Plow under infected soybean debris as soon after harvest as feasible. Many plant pathogens survive between planting seasons on plant debris. Without this debris, many pathogens will not survive from one growing season to another. Burying plant debris brings it in contact with soil moisture and a wide array of organisms in the soil which hastens crop residue decay.

Foliar disease control using **aerial applied fungicides** is the most expensive disease management procedure; however, when weather conditions favor disease development and disease

incidence is high, a properly applied fungicide is often cost effective. Soybeans produced for seed often have a market “premium” high enough to return the cost of a fungicide application by ensuring high seed quality.

Fungicides increase seed quality by reducing the incidence of seedborne pathogens and allowing soybean plants to mature more naturally and uniformly. Foliar fungicides applied between early pod and full seed can prevent yield reduction by 10 to 15 percent, and under severe disease conditions much more.

Application cost of a fungicide normally ranges from \$11 to \$18 per acre per application. Consider a single foliar fungicide application cost-effective if production fields have a historical yield potential of more than 40 bushels per acre, soybean prices are greater than \$5 per bushel, symptoms of diseases (such as frogeye leaf spot, brown spot, anthracnose or Cercospora leaf blight) are widespread in the upper half of the canopy, and the environment is favorable for disease development (rainfall has been average or above from full bloom to early seed fill). For best results, apply fungicides with 5 to 10 gallons of water per acre at a height of 8 feet or less above the top of the plant canopy in winds less than 3 mph, either in early morning or evening. Thorough plant coverage is essential; therefore, some type of communication is needed between the applicator and an observer at the field. Consult your county Extension agent for a fungicide recommendation. Always read and follow label instructions. Fungicides will not control disease agents other than the fungi.

Inadequate germination, poor emergence and/or inferior vigor often result in damping-off caused by seed and seedling disease organisms. The causal agents of these diseases are assorted fungi and bacteria that reside in seed, soil and/or crop residues. Seeds frequently become infected with fungi and bacteria just before harvest, especially when harvest is delayed by wet weather. Mechanical



Management Tip

Foliar fungicides do not increase soybean yields, but they may protect your crop against yield loss and may improve seed quality.

damage can nick or crack the seedcoat and provide sites through which seedborne and soilborne pathogens may enter and cause decay.

Properly **treating seed with a fungicide** before planting may be beneficial in establishing and maintaining a stand. Seed treatments may improve germination and seedling vigor by reducing seed decay and protecting seed from damping-off organisms if planting under the following adverse conditions:

- Low seeding rates (less than two seed per square foot).
- Planting prior to May 1 or into cold (below 65°F) and/or wet soils.
- Planting below recommended planting depth.
- Planting after June 15 or into adversely hot and/or dry soils.
- Planting seeds with excessive number of cracked and/or nicked seedcoats.
- Planting in fields with a history of poor stands in three out of past five years.
- Planting in heavy residue situations, such as double-cropped behind small grain, no-till regimes or excessive rice stubble.



Management Tip

Seed treatments cannot make up for poor seed quality and low germination rates.

Seed treatment is of little or no value when planting high-quality seed with 85 percent or greater germination, at high seeding rates, at the correct depth into a well-prepared seedbed and when environmental conditions favor rapid germination and emergence. Poor-quality seed with a germination below 80 percent or vigor below 60 percent should generally not be treated or used for seed.

Seed treatment fungicides formulated as liquid, flowable or slurry materials provide the best protection from fungal decay organisms by providing uniform seed coverage. “Hopper-box” treatments provide the least desirable seed coverage, are somewhat ineffective and may interfere with planter operation if using “air planters.” Consult your county Extension agent for seed treatment recommendations. Always read and follow label instructions when using any pesticide.



Management Tip

Seeds treated with a fungicide can be used only for planting. They cannot be used or processed for food, feed or oil. Also, treated soybean seed cannot be stored and carried over to the following year in many cases.