

A close-up photograph of several soybean pods. The pods are heavily covered in dark, irregular spots and blotches, indicating a fungal or bacterial disease. The pods are brownish and appear to be on a stem. The background is a soft, out-of-focus green, suggesting a field setting. The text 'SOYBEAN DISEASES ATLAS' is printed in blue, bold, sans-serif capital letters in the upper right quadrant of the image.

**SOYBEAN
DISEASES
ATLAS**

ACKNOWLEDGMENTS

Information and photographs in this publication were contributed by Extension Service and Experiment Station plant pathologists and nematologists who are active in the Southern Soybean Disease Workers.

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Soybean Diseases Atlas

In recent years, soybeans have become a major cash crop in the southern U.S. Land once planted predominantly to cotton and other crops is now being used to grow soybeans.

Soybean production has its share of problems, the most serious being diseases which cause an estimated 26 percent loss annually. These losses will increase and render soybean production unprofitable unless growers learn to recognize and control certain diseases.

This publication has been prepared by members of the Southern Soybean Disease Workers. This group, organized in 1973, is dedicated to the success of soybean production in the South. It is hoped that the publication will aid producers in proper disease identification and create awareness of the importance of disease losses. The authors urge that its contents be studied thoroughly with these objectives in mind.

SEED DECAY AND SEEDLING DISEASES

Seed Decay and Seedling Diseases (fungi *Pythium* and *Rhizoctonia* spp.)

The fungi responsible for these diseases are primarily debris- and soil-borne. Poor quality seed is a major cause of seedling disease.

Inadequate stands, lack of uniform stands and death of young seedlings are characteristics of seedling disease. Damage may occur before the seed germinates or emerges, or young plants may die after seedling emergence. The presence of dark brown or reddish lesions on the stem and lower main root confirms seedling disease. However, microscopic examination of the damaged tissue is sometimes necessary to identify specific disease pathogens involved.

Other factors, such as improperly applied fertilizer or pesticides and poor soil environment, can cause similar damage.

Moderate to severe stand losses result in reduced yields and inefficient utilization of fertilizer and pesticides.



ROOT AND LOWER STEM ROT



Southern Stem Blight

(fungus *Sclerotium rolfsii*)

Southern Stem Blight damages a wide range of host plants, including soybeans. The fungus is most active during summer, and survives in the soil and on plant debris.

The typical symptom is a white cottony mold, often with brown "mustard seed-like" structures, on the main stem at the soil surface.

Soybean losses to the disease vary considerably, but generally the damage occurs as localized areas of dead plants scattered across fields. Economic losses occur in some instances.

Charcoal Rot

(fungus *Macrophomina phaseolina*)

This disease is caused by a soil and plant debris-borne fungus common in soils of the southern U.S. Charcoal rot is primarily a root and basal stem disease, but may be seen on above-ground parts of infected plants. Most of the overwintering inoculum is in the above-ground parts of diseased plants.

Infected soybean plants exhibit many tiny, black specks on the roots and lower stem just beneath the skin or bark. The affected area has a "charcoal" appearance. The disease often girdles the lower stem, causing wilting and death.

The disease is most severe when plants are under stress from moisture or nutrient deficiencies, soil compaction, nematodes or other diseases. Yield losses are difficult to measure because there are no known resistant varieties or fungicidal controls, and it is difficult to find a test site where the fungus does not already exist.



Fusarium Root and Stem Disease

(fungus *Fusarium* sp.)

This disease is caused by several species of the common soil-borne fungus *Fusarium*. Seedling damage appears as brown lesions or rot on roots and lower stems. Some plants, especially those under moisture stress, may wilt and die. Older plants are seldom killed, but often wilt so that yield is decreased.

Phytophthora Root and Stem Rot

(fungus *Phytophthora megasperma* var. *sojae*)

This soil-borne fungal disease is largely confined to poorly drained clay soils. Infection and damage may occur at any stage of growth. Seedlings turn brown, die and remain erect. Leaves on older plants become chlorotic between the veins and later the tissue dies. Lower stems have dark brown lesions that often extend beyond the first trifoliate leaves.

The disease can cause extensive yield losses. However, there are resistant varieties.



Brown Stem Rot

(fungus *Cephalosporium gregatum*)

This soil-borne fungus is found in crop residue in the Midwest. Temperatures must be low for disease development.

Symptoms include browning of the pith and xylem of the stem, starting at or below soil level and progressing slowly upward. At this stage external symptoms are slight, and may be seen only as occasional blighting of lower leaves. However, top leaves rapidly become chlorotic between the veins and this tissue quickly dies. In advanced stages the outside of the stem turns brown and the plant lodges badly because of internal rotting.



Red Crown Rot

(fungus *Cylindrocladium crotalariae*)

This is a new disease which causes root and stem rot to soybeans and other legumes in several southern states.

The earliest symptom is yellowing of leaves of individual plants or patches of plants across fields. Leaves of damaged plants usually develop yellow spots between the veins. This tissue then turns light brown and may shatter. Many of the leaves drop prematurely. The fungus spreads up from the roots, causing a grayish-brown discoloration of the internal stem. Stem tissues are killed and reddish-orange fruiting structures develop on the stem 1 to 3 inches above the soil surface. These fruiting structures are smaller and more orange in color than the fruiting structures of Southern Stem Blight.

It is too soon to predict how extensively Red Crown Rot will develop on soybeans. Economic losses to peanuts are presently occurring.

STEM AND POD ROT DISEASES

Pod and Stem Blight

(fungus *Diaporthe phaseolorum* var. *sojae*,
Phomopsis sp.)

Pod and Stem Blight occurs in every soybean-producing area of the U.S. and in many foreign countries. It is usually a late season disease, and is favored by warm, humid weather. It is a major cause of seed damage which results in poor seed quality. The fungus lives from season to season on seed or on crop residue.

The most characteristic symptom of this disease is the arrangement of black fruiting structures in linear rows on the stems. Infected seed may crack and shrivel and are often covered with white mold. Such seed may fail to germinate, or may produce weak seedlings with brownish-red pin-point lesions on the cotyledons. Another symptom is reddish-brown streaks on the seedling stem near or below the soil line.



Stem Canker

(fungus *Diaporthe phaseolorum* var. *caulivora*)

This fungal disease is similar to Pod and Stem Blight, but is potentially more destructive because it may kill plants from mid-season to maturity. The fungus overwinters on diseased stems and infected seed.

The first symptom of stem canker is the presence of small, reddish-brown lesions at the bases of branches or petioles on the lower part of the stem. These lesions enlarge rapidly into sunken areas which often girdle and kill the plant. At the time of death, stem tissue above the canker is brown and tissue below the canker is green. Leaves of dead plants wither but remain attached.



Anthracnose

(fungus *Glomerella glycines*)

Seedling infection can occur from overwintered fungus on infected seed or crop residue. Later infections usually occur during bloom or early pod development. The fungus produces an abundance of spores which infect and often kill lower branches, leaves and young pods, resulting in blank pods at maturity. Seed from infected pods may be shriveled or moldy, and may have dark lesions on the seed coat.

Anthracnose develops when conditions are wet and humid for a prolonged period. It has become an economically important disease in recent years.



LEAF BLIGHTS



Bacterial Blight

(bacteria *Pseudomonas glycinea*)

Bacterial Blight is widespread in the U.S., and is usually one of the first leaf spot diseases to appear on young plants. Small angular spots varying from yellow to brown develop on the leaves of infected plants. The central areas of these spots are usually surrounded by water-soaked margins. The spots later become brown and sunken with narrow yellow border "halos" that are more noticeable on the upper leaf surfaces. Under certain conditions the infection travels along the veins, causing death and breaking of the tissues. This is primarily a leaf disease, but sometimes stems and pods are affected.

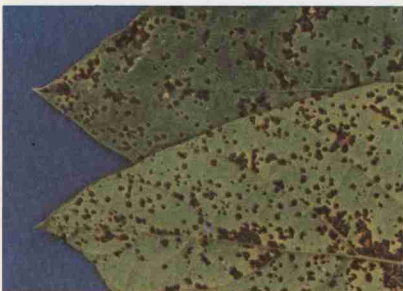
Bacterial Blight is favored by cool, rainy weather.

Bacterial Pustule

(bacteria *Xanthomonas phaseoli* var. *sojensis*)

Bacterial Pustule is sometimes difficult to distinguish from Bacterial Blight, and it is common for both diseases to occur together. Early symptoms of Bacterial Pustule are small, yellowish-green spots with reddish-brown centers, most noticeable on upper leaf surfaces. The centers of these spots appear slightly raised, and develop into small pustules, especially on the undersides of the leaves.

This disease is carried over from year to year in infected leaves and seed.



Wildfire

(bacteria *Pseudomonas tabaci*)

Wildfire symptoms are strikingly different from those of other soybean diseases. Prominent yellow haloes with well-marked margins develop around a large central area of brown, dead leaf tissue. The brown area may increase to cover a large part of the leaf. Wildfire is closely associated with Bacterial Pustule, and is seldom a problem unless Pustule is widespread.

FUNGAL LEAF DISEASES

Brown Spot

(fungus *Septoria glycinis*)

Brown Spot is one of the earliest leaf diseases to appear on young plants. Brown or reddish spots, varying from pinpoint-size up to 1/5 inch in width, occur on the primary leaves and later on other leaves. Severely affected leaves become yellow and drop. Brown discoloration also can be seen on stems, branches and pods.

Warm, moist weather and poor soil drainage favor the spread of Brown Spot. Fruiting bodies of the fungus overwinter on diseased plant debris.



Downy Mildew

(fungus *Peronospora manshurica*)

The first symptom of Downy Mildew, occurring about early bloom, is a series of small, indefinite, yellowish-green spots on upper leaf surfaces. As the infection progresses these spots enlarge and become yellowish-brown to dark brown. A grayish, downy tuft of mycelium develops on lower leaf surfaces beneath the upper surface spots. Severely infected leaves may drop prematurely. Spores produced on the undersides of leaves spread the disease to other plants throughout the season.

Initial infection usually is caused by spores that survive on diseased plant residue. However, the disease can be seed-borne.

Frog-eye Leaf Spot

(fungus *Cercospora sojina*)

This very destructive disease occurs late in the growing season. The fungus grows best in cool, humid conditions, and overwinters in infected seed and on infected crop debris.

The disease is characterized by "eye-spots" on the leaves. These spots usually have gray to tan centers and purplish-brown to red margins. Heavily infected leaves drop prematurely. Frog-eye also infects stems and pods, and may grow through the pod wall to infect the seed. One species, *C. kikuchii*, causes a purple stain on the seed.





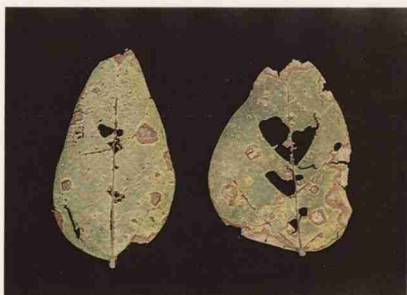
Alternaria Leaf Spot
(fungus *Alternaria* spp.)

This is a late season disease that develops on maturing leaves or injured leaves, and occasionally damages pods. Circular brown spots up to ¼ inch in diameter signal the presence of Alternaria Leaf Spot. The disease is usually a secondary invader, following mechanical injury, or injury by sun scald, insects or other diseases. Spores of the fungus are present in almost all environments.

Target Spot
(fungus *Corynespora cassiicola*)

Target Spot is similar to Alternaria in that it is a late season disease and thus far has caused little economic damage. It is characterized by reddish-brown concentric rings of dead tissue on leaves. The spots start small but often increase to ½ inch in diameter. Spots also may occur on stems, petioles and pods.

The fungus overwinters in diseased plant debris.



Aerial Blight
(fungus *Rhizoctonia* spp.)

Leaf blight, leaf spots and defoliation are symptoms of this disease. Leaf spots may be circular or irregular with reddish-brown margins. These spots of dead tissue usually occur on the lower third of one or more of the three leaflets. Petioles, stems and young pods also may be attacked by the disease.

Conditions favorable to Aerial Blight include high humidity and warm temperatures. The fungus can be found in soil and field trash, as well as on certain weed hosts.

Powdery Mildew

(fungus *Microsphaera diffusa*)

Powdery Mildew can be identified by a light-gray, superficial, powdery growth on upper leaf surfaces. Leaves yellow and then turn brown when the infection is severe.

This disease causes only minor damage in the U.S. The dry, hot weather of late summer and early fall favor the development of Powdery Mildew, while frequent rains limit the development and spread of the disease.



NEMATODE DISEASES

Root-knot Nematode

(nematode *Meloidogyne* spp.)

The Root-knot Nematode is the most common nematode pest of soybeans in the southern states, and has more than 2,000 plant hosts. Four different species attack soybeans. All cause similar symptoms, including severe stunting and formation of galls or knots on the roots. Also, plants may appear to suffer nutrient deficiencies and may wilt during hot periods of the day. Nematode damage reduces yield and lowers quality.

Nematodes have a fairly simple life cycle. Infected soil contains eggs and larvae. The larvae are ell-like, non-segmented round worms about 1/65 inch long. Larvae enter and feed within the roots of a host plant. There they develop into adults which lay eggs outside the root. Each egg mass may contain several hundred eggs. The life cycle requires only 3 to 4 weeks, so there may be several generations in one season.

Soil fertility, moisture and temperature influence the severity of Root-knot and most other nematodes. Therefore, damage may range from minor losses to complete crop failure with the same level of nematodes present.





Soybean Cyst Nematode
(nematode *Heterodera glycines*)

This relatively new soybean disease restricts root development and causes an absence of nitrogen-fixing nodules. Plants are stunted in an irregular pattern that may resemble manganese toxicity, or moisture or potash deficiency. High nematode populations often result in death of plants.

There are two important stages in the life cycle of the Cyst Nematode—egg and larva. When the female's body becomes filled with eggs, it erupts from the root and resembles a lemon-shaped cyst. These cysts contain 300 to 500 white eggs which turn yellow and then brown. The brown cysts are the overwintering forms of the nematodes. Unlike the Root-knot Nematode, Cyst Nematode eggs must be fertilized before they will hatch. A single generation of Cyst Nematode may be completed in about 21 days.

Lance Nematode
(nematode *Hoplolaimus columbus*)

Several species of the Lance Nematode attack soybeans, as well as cotton, coastal bermuda, sweet corn, snap and lima beans, tomatoes and cucumbers. Most of these species are presently limited to Georgia, North Carolina and South Carolina.

Lance Nematodes feed both on root surfaces and within the roots. Roots become sparse and die, and damaged plants are stunted and yellow. Yields can be greatly reduced.

The life cycle is similar to the Root-knot Nematode. The Lance Nematode can survive in very dry soil for long periods of time.

Sting Nematode

(nematode *Belonolaimus longicaudatus* and *B. gracilis*)

The Sting Nematode causes severe damage to soybeans. Fortunately, it occurs only in light, sandy soils and is presently confined to the Atlantic and Gulf coastal plains.

Sting Nematodes are aggressive external root feeders, but do not enter the roots. Affected roots are darkened and stubby with few feeder roots. Plants are seldom killed, but become stunted and appear malnourished or drought-stricken.

These nematodes overwinter in the soil as eggs and larvae.



Root-Lesion Nematode

(nematode *Pratylenchus* sp.)

This nematode is found over a large geographical area, and most soybean fields are infested.

Root-Lesion Nematodes create "ports of entry" for other soil-borne diseases, making field diagnosis difficult. However, close examination of infected roots often will reveal small lesions or dead areas. Plants are seldom killed, but often become stunted.

These nematodes overwinter in the soil and enter roots as larvae.

Reniform Nematode

(nematode *Rotylenchulus reniformis*)

Like the Lance Nematode, this pest is found primarily in the coastal plains and Gulf states.

Feeding of the Reniform Nematode is similar to that of the Cyst Nematode, except that no galls or cysts are formed. Heavily damaged plants are slightly yellow and stunted.

The life cycle is completed in about 25 days.



Spiral Nematode

(nematodes *Helicotylenchus*, *Scutellonema* and *Rotylenchus*)

The Spiral Nematodes are widespread and have a broad host range, including most soybean varieties.

These soil pests partially enter the roots during feeding. Root symptoms usually consist of small lesions at feeding sites. High populations cause soybean plants to be stunted and show symptoms of nutrient deficiency.

Information on the life cycle of these pests is very limited, and additional research is required.

VIRAL DISEASES

Soybean Mosaic

(caused by a virus)

Soybean Mosaic, one of the most common viral diseases of soybeans, is readily spread through diseased seed. Also, 16 aphid species are known vectors of the virus.

Symptoms are most noticeable when the temperature is between 68 and 75 degrees F. When the temperature climbs above 85 or 86 degrees F. symptoms become masked. The leaves of infected plants are distorted and narrower than normal, and the margins tend to turn downward. Leaves also have a yellowish cast and usually show dark green, blister-like puckerings along the veins. The internodes are usually shorter than normal, which may result in shorter plants. Pods may contain only one or two seeds, or no seeds at all.



Bud Blight

(caused by a virus)

Bud Blight, which occurs primarily in the mid-western states and southern Canada, can be a serious disease of soybeans. The virus is spread either by infected seed or by insect vectors from infected native plants around the field.

The name Bud Blight is descriptive of the symptoms of this disease. When plants are infected before flowering, the terminal buds become brown, curve downward, dry and become brittle. A rusty-brown flecking is noticeable on the youngest leaves. Diseased plants are stunted and the pods may contain no seeds. Diseased plants remain green after healthy plants have matured.



Yellow Mosaic

(caused by a virus)

Yellow Mosaic was only recently determined to be different from Soybean Mosaic. Like Bud Blight, Yellow Mosaic is primarily a northern viral disease.

The young leaves of infected plants develop a yellow mottling which may consist of spots scattered over the leaves. Rusty spots of dead tissue develop on the yellow portions of the leaves of mature plants.

Yellow Mosaic is not spread by planting infected seed, but by the movement of sap from diseased plants to healthy ones by insects and mechanical means.



Bean Pod Mottle

(caused by a virus)

This disease, first reported in Arkansas in 1958, often occurs in combination with other viral diseases. The virus is not spread by seed. It is transmitted mainly by the feeding of certain insects, particularly the bean leaf beetle.

In the field, diseased plants usually show a mild yellow mottling on the young growing leaves. As these leaves approach maturity the mottling becomes masked. Plants infected with both Soybean Mosaic and Pod Mottle are stunted and have distorted foliage, misshapen fruit and dead tissue. Seed from plants infected with Pod Mottle are smaller than normal.

NON-PARASITIC DISEASES

Temporary Top Yellowing

This chlorosis, which ranges from light green to nearly white, appears in the upper leaves of 6- to 8-week-old soybean plants. No chlorosis has been noted after the plants begin to bloom. The chlorosis disappears in a week or two, and the new leaves are a normal green.

The cause of this condition has been attributed to an inefficient strain of nodule-forming bacteria, and the condition is sometimes referred to as bacterial-induced yellowing. Temporary top yellowing appears in most soybean varieties, but the Lee variety seems most susceptible. Although this yellowing is quite common in some years, yield does not seem to be significantly lowered.

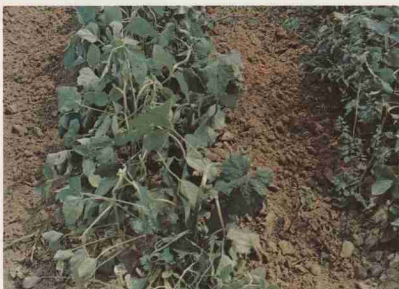
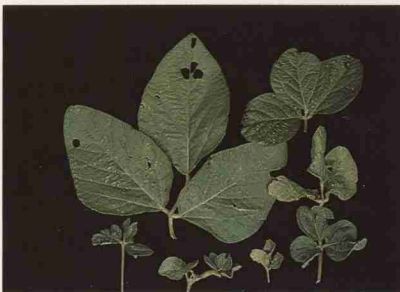


Potash Deficiency

Soybeans require relatively large amounts of potassium. Unless there is a medium to high level in the soil, deficiency symptoms are likely to occur. The primary symptom of potash deficiency is a greenish-yellow mottling of the leaf tissue between the veins, often followed by death of the leaf tips and margins. These symptoms occur most often from bloom to pod development.

Manganese Toxicity

Manganese toxicity causes stunted plants with dark green, wrinkled or puckered leaves. It is most common on lighter soils, particularly in the southeastern states, where the soil pH is below neutral (pH 7.0). Manganese toxicity is likely to occur when the soil pH drops below 5.0.



Phenoxy Herbicide Injury

Small amounts of phenoxy herbicides, such as 2,4-D, 2,4,5-T and related herbicides, can produce abnormal growth in soybean plants, especially prior to pod set. Injury can occur even when the recommended formulation for soybeans is used, especially if the recommended rate and timing are not followed closely.

Phenoxy herbicide injury may cause leaf distortion similar to that caused by Soybean Mosaic. The most common symptom is a slight narrowing of the leaves and crooking of the upper stem. In severe cases, the stem may have large lesions and numerous secondary roots may develop on the stem above the soil line.





Metribuzin (Sencor or Lexone) Injury

Metribuzin injury occurs on sandy or sandy loam soils with less than 2 percent organic matter, or on alkaline soils with a pH higher than 7.4. Injury also has occurred when excessive rain has fallen on unsettled beds after herbicide application.

Metribuzin injury is characterized by a browning of the leaf margins, followed by plant death. The varieties Tracy and Semmes are sensitive to metribuzin.

Lightning Injury

Lightning sometimes injures soybeans in the field. Lightning injury looks like a circular spot of dead plants. These damaged areas may be as large as 40 to 50 feet in diameter in young plants, which are easily injured. Lightning-damaged spots usually are much smaller in older plants. The clearly defined margins of the affected spots are a clue to lightning damage.

Since lightning damage can be mistaken for disease or insect injury, a careful examination of the field should be made before lightning injury is diagnosed.



BASIC PRINCIPLES IN CONTROL OF SOYBEAN DISEASES

As with most plant parasitic diseases, control of soybean diseases is largely based upon prevention. However, the need to treat soybean diseases will increase in the near future.

Following are some disease control suggestions producers should consider. Some apply in all soybean-growing areas, while others have limited use. These are not necessarily in order of importance:

- Plant high quality seed, preferably certified seed.
- Use a chemical seed treatment. Consult your state Extension Service recommendations.
- Use disease-resistant varieties when available. Also use varieties recommended for your state.
- Practice crop rotation with non-legume crops.
- Use nematicides when rotation is not practical or resistant varieties are not available.
- Use foliar fungicides in areas where they have proved effective and profitable.
- Use good management techniques, such as proper drainage, supplemental irrigation and weed and insect control.

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