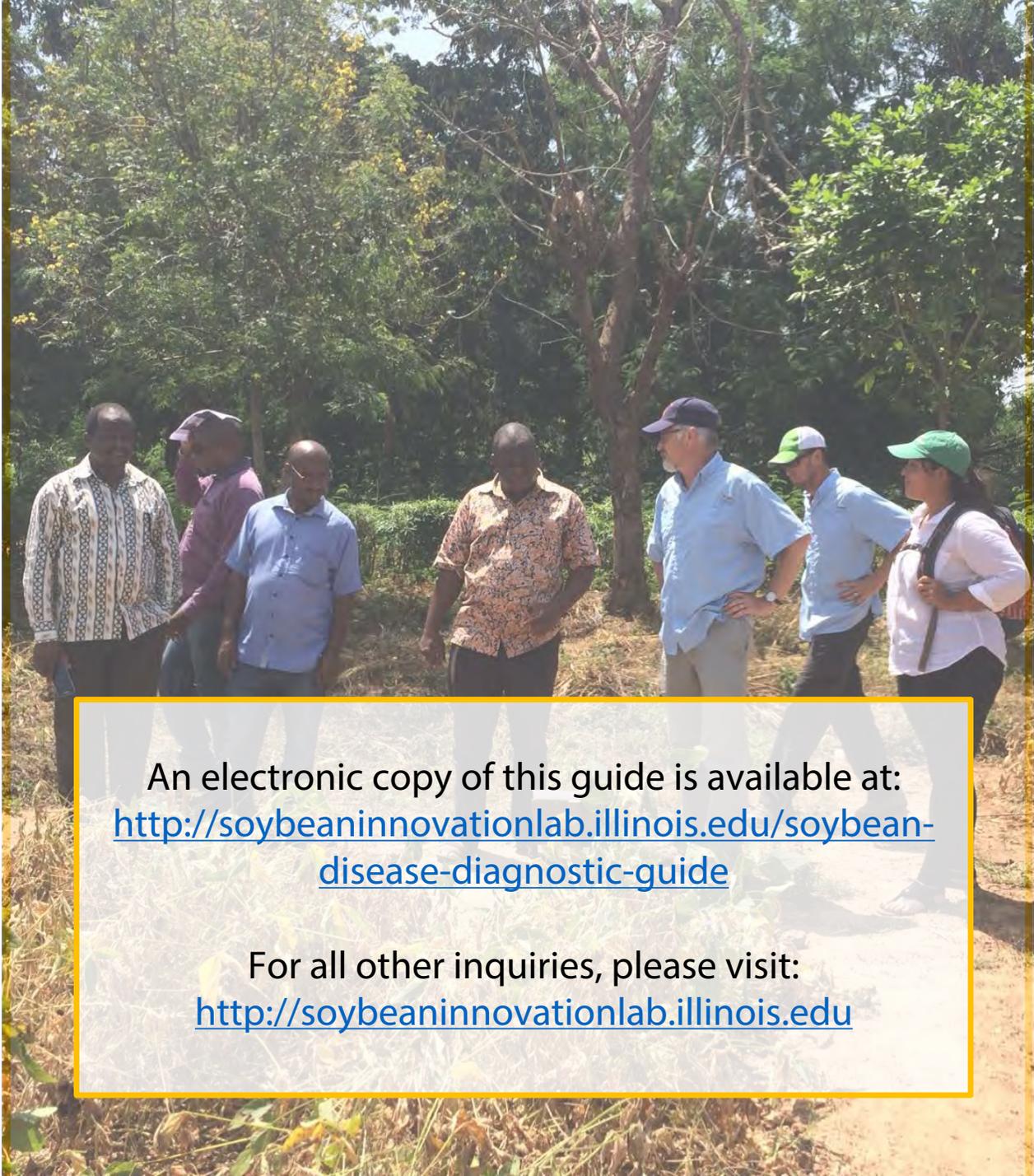


Field Guide to African Soybean Diseases and Pests

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An electronic copy of this guide is available at:
<http://soybeaninnovationlab.illinois.edu/soybean-disease-diagnostic-guide>

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*Front Cover: Research plots at the Jimma Experiment Station in Ethiopia
Back Cover: Researchers from Ethiopia, Ghana, Nigeria and the United States (Illinois and Missouri) in Tamla, Ghana.
Guide design: Rosemary Keane*



Introduction

The purpose of this soybean disease guide is to provide soybean growers, agronomists, consultants, and others a means to diagnose soybean disease as they are observed in soybean fields. Over time, we hope to expand this guide by adding information on more diseases, pests, and abiotic stresses relevant to the increasing soybean production in Africa.

Diseases of soybean are well documented in many places throughout the world. This guide highlights diseases commonly found in many soybean production areas as well as those that may be unique to Africa.

This guide is not all inclusive since there are many growing areas in Africa with diverse growing environments that when further surveyed may result in the identification of more disease and pests.

This guide is organized to enable important soybean diseases to be identified on leaves, stems, pods, seeds, and roots. Diseases are presented with images and symptom descriptions based on their most common occurrence on the plant. All images are courtesy of the authors unless otherwise stated.

Healthy Soybeans

The goal of producing soybean is to provide a healthy seed product for marketing whether it is for oil, meal, or direct consumption as soy milk or a vegetable.

Often times, the quality and quantity of seed production can be limited by diseases and pests and abiotic stresses such as nutrients and water.

Producing a healthy crop often requires some inputs including the recognition of problems affecting the health of the crop. The beginning of a healthy crop starts with good seed quality that is free of pathogens and has high percent germination.

Seed bed preparation is important to obtain optimum plant density. Further care of the crop includes monitoring and proper disease, pest, and weed control.

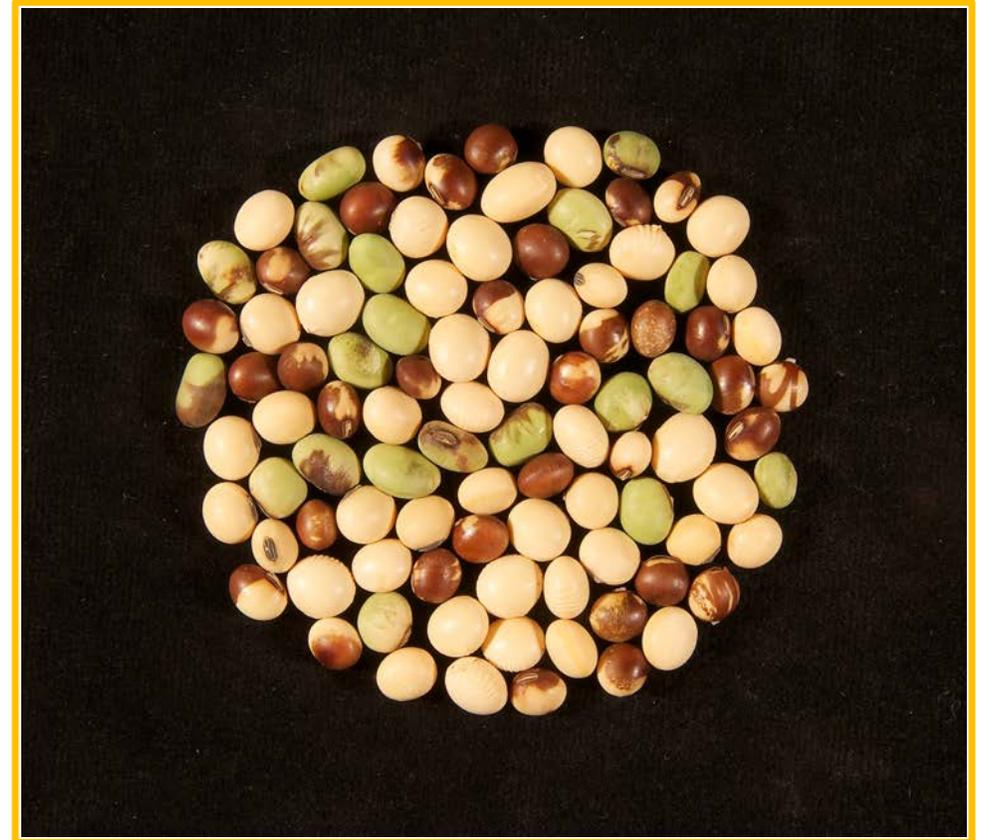


Healthy appearing soybeans in a research plot in Jimma, Ethiopia. Courtesy of Abush Tesfaye.

Healthy Soybeans



Soybean flowers (top) produce pods (bottom) four to eight weeks after sowing seeds. Soybeans seeds have variable color traits from yellow, green, brown to black depending on the soybean variety planted.



Healthy soybean seeds can be different colors from yellow, green, brown to black. This example just shows yellow, green and brown mottled seeds mixed from three soybean genotypes.

Soybean Diseases

Pathogens and pests that attack soybean infect all plant parts including root, shoots and stems, leaves, pods and seeds.

Most commonly, symptoms are observed first on leaves, then perhaps stems and pods. Roots are rarely observed for pathogens and pests even though many diseases can occur primarily or at least initially on roots.

Pathogens are caused by a wide range of organisms including bacteria, fungi, nematodes, phytoplasmas, and viruses. Pests vary widely too, from insects to mammals.

Management or control of a disease or pest problem often relies on the proper diagnosis. This guide will be useful for disease diagnosis.



Soybean pod damage (bottom left), and internal stem discoloration (top right). Roots discolored and rooted (bottom right). Leaves showing yellow and dead tissue due to a fungal infection (top left).

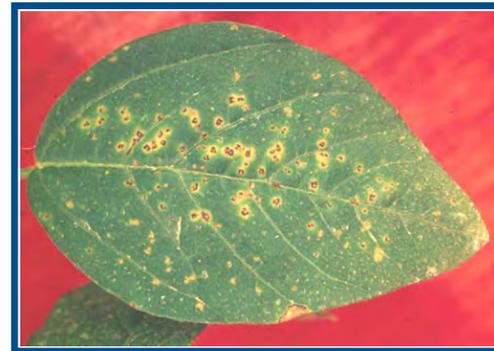
Leaf Diseases

Leaf diseases can be caused by a large number of pathogens, some of which cause diseases on roots, stems, pods, and seeds. Some only occur, or primarily occur, on leaves.

Many of the common leaf disease symptoms are well defined especially leaf spots and lesions caused by bacteria and fungi.

Symptoms caused by viruses include leaf mosaic, brittleness of leaves and stems, leaf turning yellow or red or brown and necrotic. The entire plant may be stunted while still green, and seeds may become misshapen and discolored.

Identifying virus and virus-like diseases using symptoms alone is unreliable. Other leaf diseases that are often said to be virus-like are caused by certain groups of bacteria, including those referred to as phytoplasmas, which are mostly transmitted by leaf hoppers. Symptoms of phytoplasmas infection include yellowing, dwarfing, proliferation of axillary shoots, green stems, and sterility.



BACTERIAL PUSTULE

- ▶ Symptoms most commonly occur on leaves as minute, pale-green spots that enlarge to irregularly shaped lesions.
- ▶ When the lesions join together, leaves become ragged and may drop from the leaf. Most lesions have prominent pustules on the underside of the leaf.
- ▶ The disease also occurs on pods appearing as slightly raised spots with some discoloration on seeds.
- ▶ The disease may cause premature defoliation and often under severe conditions cause premature death.



BROWN SPOT

- Symptoms most commonly occur on leaves as irregularly shaped lesions often times with a yellow halo surrounding a necrotic area.
- When the lesions join together, the spots enlarge, often covering much of the leaf surface.
- The disease also occurs on petioles, pods, and stems.
- The disease may cause premature defoliation starting from the lower leaves and moving upward.



CERCOSPORA LEAF BLIGHT

- ▶ Leaf symptoms are most pronounced during pod fill when upper surfaces of upper leaves exposed to the sun become discolored.
- ▶ The discoloration may be reddish-purple or bronze covering most of the leaf or can be contained to discrete irregularly shaped blotches.
- ▶ Severe symptoms may cause necrotic patches on the leaves which coalesce until the entire leaf dies.
- ▶ Blight may occur without the purple-bronze symptoms and may also occur on petioles, stems, pods, and seeds (see purple seed stain).



Leaf discoloration (left) and petiole lesion (right).

FROG-EYE LEAF SPOT

- ▶ Leaf lesions are circular to angular up to 5 mm in diameter, with ash gray to light brown centers.
- ▶ Older lesions are light to dark brown with white centers (often fallen out) contain minute, dark fungal structures called stromata may be observed.
- ▶ Lesions may coalesce to form larger, irregularly shaped spots and if numerous enough leaves wither quickly and fall prematurely.
- ▶ Lesions can also occur on petioles, stems, pods and seeds.



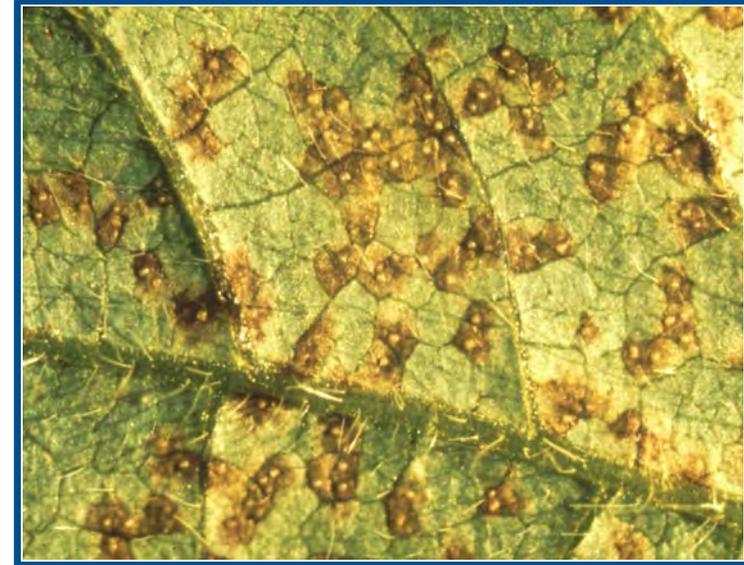
RED-LEAF BLOTCH

- Lesions occur on leaves, petioles, pods, and stems.
- Lesions are dark red on the upper surfaces of leaves and reddish brown on the lower surfaces.
- Lesions grow to form necrotic blotches up to 2 cm in diameter.
- Within older lesions, diagnostic fungal structures may be found. These include fungal structures called sclerotia (a resting structure) and pycnidia (a structure to produce spores).
- Severe infection causes premature defoliation and early maturation.



RUST

- The first symptoms may appear as small yellow, tan to dark-brown, or reddish-brown lesions.
- Later, one to many erupting volcano-like fungal structures called uredinia are just barely visible with the naked eye.
- On occasion, lesions occur on petioles, but not typically on stems or pods.
- Severe infection causes premature defoliation and maturation.
- Early symptoms of soybean rust can be confused with bacterial pustule.



MYROTHECIUM LEAF SPOT

- ▶ This disease was discovered in Ghana in 2016. It is still unclear if it is a widely occurring disease on soybean.
- ▶ Lesions somewhat resemble those of red leaf blotch, and lesions typically are roundish with the centers becoming white.
- ▶ There is nothing known to date about the life cycle on soybean or its impact on soybean production.



WITCHES' BROOM

- ▶ Bud proliferation is often the most obvious symptom observed. Often times multiple shoots develop. Plant may develop apical necrosis. Infected plants produce none or few poor quality seed.
- ▶ The cause of this abnormality are associated with phytoplasmas which are vectored by leafhoppers. Symptoms of viruses and those caused by phytoplasmas often overlap.



VIRUSES

- ▶ Leaves appear mottled and puckered leaves with sterile or plants with poor seed set that matured or died prematurely.
- ▶ Symptoms of viruses and those caused by phytoplasmas often overlap, but often time the whole plant is affected.
- ▶ Virus symptoms caused by many of the viruses are similar including those that cause bean pod mottle and soybean mosaic
- ▶ Viruses and phytoplasma are often vectored by insects, including aphids (top left), beetles (top right) and leaf hoppers.

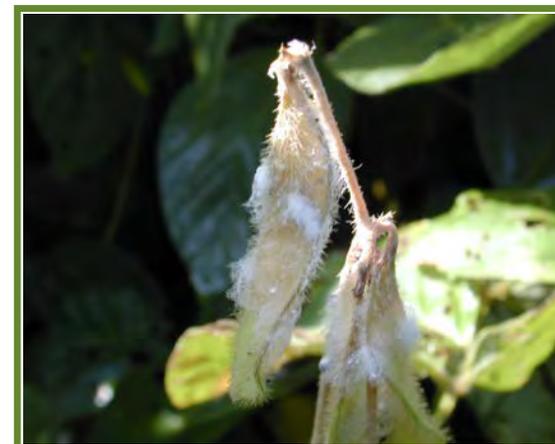


Stem Diseases

Diseases in the section are those that have the most characteristic symptoms for identification occurring on stems. However, the majority of pathogens producing symptoms on stems, also produce symptoms on other tissues.

For example, a fungal disease known as charcoal rot may be noticeable on stems, but it initiates infection in roots and for this guide is covered under root diseases.

Symptoms of green stem disorder (left), pod and stem blight (top right), and Sclerotinia stem rot mostly occur on stem but will sometime colonized pods (bottom right).



ANTHRACNOSE

- Irregularly shaped brown areas appear on stems and petioles.
- In the advanced stages of anthracnose (usually, the late reproductive stages), infected tissues are covered with black fruiting bodies (acervuli) that can be seen with the unaided eye.
- The fungus causing this disease also attacks pods and seeds (see pods and seeds).
- When the disease is severe, premature defoliation occurs and plants senesce earlier than usual.



GREEN STEM

- The term green stem is used to encompass all maladies related to stem delayed stem senescence.
- The cause of green stem is not known, but various abiotic stresses and biotic infections have been implicated.
- The term green stem disorder has been used to define plants with non-senescent stems mostly with petioles detached, but with normal, mature pods and seeds at harvest maturity.



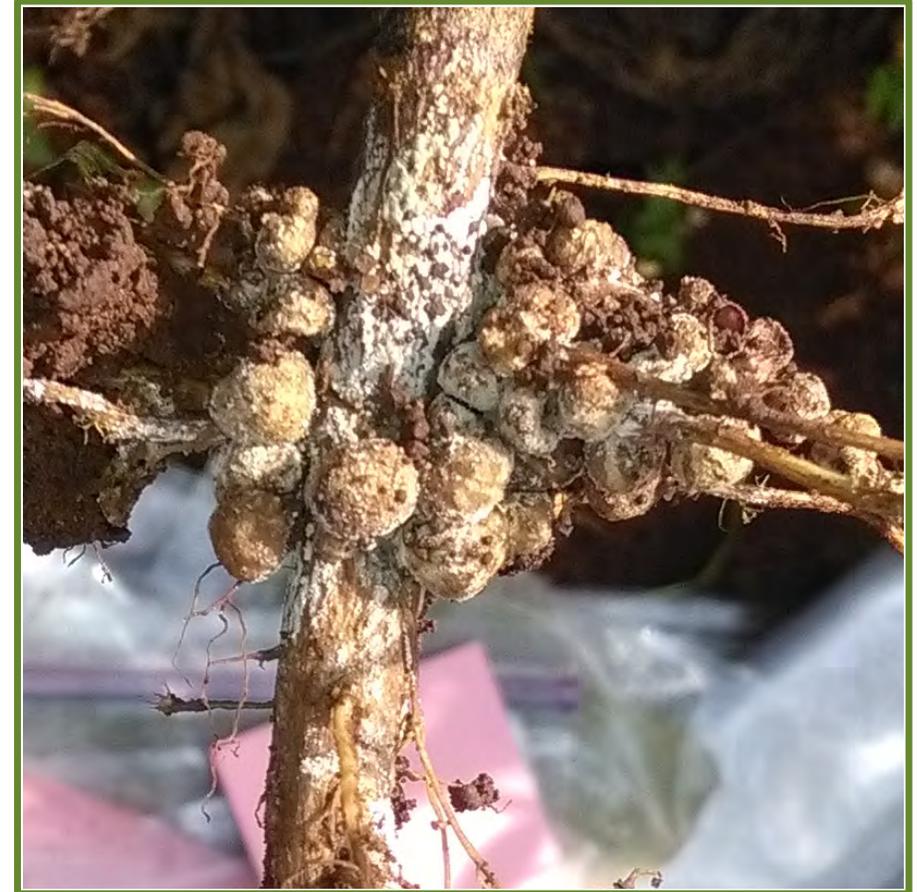
POD AND STEM BLIGHT

- Symptoms are not usually apparent on green growing tissue, even though the fungus may have colonized the area.
- Once the tissue dies, it rapidly is covered with speck-sized fruiting bodies of the fungus called pycnidia, usually arranged linearly.
- The pycnidia can also be found on petioles and pods.



SCLEROTIUM BLIGHT

- Infection occurs at or just below the soil surface and appears as light to dark brown lesions that girdle the stem.
- A sudden yellowing or wilting of the plant often occurs. Leaves turn brown and dry, often clinging to the dead stem.
- A leaf spot phase is characterized by circular, tan to brown lesions with dark-brown margins.
- Under moist conditions, a white, fanlike mat of fungal growth forms on and around the stem base.



*Symptoms most likely caused by the fungus *Sclerotium rolfsii* from Jimmi Ethiopia, although not verified. Courtesy of Abush Tesfaye*

SCLEROTINIA STEM ROT

- Infection occurs by spores produced in a fingernail sized cup shaped fungal structure that land and germinate on matured flower petals.
- The fungus grows into stems often times and may cause the plant to wilt, and also may infect the pods and seeds.
- Under moist conditions, white fungal growth forms on and around the stem and or pods.
- The fungus produced spores (ascospores) from disc shaped structures (bottom) that when airborne, infect and colonize flowers (top left) that have matured. The fungus continues to grow and colonize stems and pods (top right).



Pod and Seed Diseases

Soybean seed health is affected by many factors, including abiotic and biotic stresses. Plants stressed by too much or too little water or by nutrient imbalances often produce seeds that are abnormal. Biotic factors including bacteria, fungi, and viruses often affect seed health.

Disease symptoms on seeds may include mottling, shriveling, discoloration of part of or all of the seed coat, and decreased seed weight. Seed mottling often is caused by viral infection of the plant and viral symptoms especially on leaves also may be evident. Fungal infection of seed can be diagnosed somewhat by color; however seed infection can also be symptomless.



Pod (top) and seed discoloration (bottom) caused by fungal infections. Seed image courtesy of John MacRobert.

ANTHRACNOSE

- ▶ Necrotic lesions are first observed on pods. Seeds may be shriveled and discolored or symptomless.
- ▶ This fungal pathogen also infects other plant organs and is often associated with leaf and stem anthracnose causing vein and stem necrosis (see anthracnose on stems).
- ▶ Pre-emergence and post-emergence damping off may occur when infected seeds are planted. Dark-brown, sunken cankers often develop on stems and cotyledons killing the plant.



PHOMOPSIS SEED DECAY

- Seeds may show few symptoms or may be whitish and shrunken, severely shriveled, elongated, and cracked.
- Affected seeds may not germinate or may be slow to germinate resulting in pre- and post-emergence damping off.
- Soybean pods can be infected at any time after being formed and may be discolored or aborted.
- This disease can be important when seed is used for seed stock (perpetuating the disease), and when used for human consumption (discolored or non-marketable seed).



Note that the seeds in pods have whitish cast or growth over the seeds typical of Phomopsis seed decay. Courtesy of John MacRobert taken in Zimbabwe.

PURPLE SEED STAIN

- ▶ Seed discoloration varies from pink to dark purple, and discolored areas range from specks to the entire seed coat.
- ▶ This infection of seeds by this fungus can be important when seeds are used for seed stock (perpetuating the disease) and for human consumption where it may affect the quality of edible soy products.



SEED MOTTLING

- Seeds from virus infected plants may have tan to brown to black mottling.
- A number of viruses cause this symptom making specific diagnosis by symptoms alone impossible.
- Most virus-infected plants occur as a result of virus vectors, most commonly insects.
- These insects include sucking and chewing types of insects and in some cases fungi and nematodes.
- Seed bleeding from hilum may be characteristic of infected plant, although not all seeds may harbor the virus.



Root Diseases

There are many root diseases that occur widely including charcoal rot, Pythium root rot, Rhizoctonia root rot, and diseases caused by nematodes. Distribution of root disease in Africa based on surveys is lacking.

Many of these root diseases cannot be diagnosed by symptoms alone, although a few produce symptoms or life structures of the pathogen that are diagnostic.

Root pathogens often kill the roots of infected plants (left), but can also infect the plant and cause vascular browning (right).



CHARCOAL ROT

- This fungal pathogen may cause premature death of the plant often times with leaves left dried on the plant.
- Symptoms include wilting and/or yellowing due to vascular plugging.
- Roots and stems of diseased plants will have a charcoal or grayish colored appearance due to the aggregated appearance of tiny fungal structures called microsclerotia.
- The pathogen also infects seeds producing microsclerotia often in seed coats.



SUDDEN DEATH SYNDROME

- The most prominent symptoms occur on foliage and include interveinal chlorosis, necrosis, and premature death of the plant.
- Severely affected leaves detach from the petioles, which often remain attached to the stem.
- Although infection may occur earlier, visual symptoms become most noticeable on leaves when the plant reaches the full-pod stage.
- The root mass of affected plants is reduced and roots appear discolored, often preceding foliar symptoms. Severely infected plants can be easily pulled from the ground.

Image credit, bottom center: Carrie Miranda



ROOT-KNOT NEMATODE

- The primary symptom for identifying this disease is the presence of galls on infected roots.
- The galls vary in number and size depending on the intensity of the infection and the entire root system may appear greatly swollen.
- Because of the infection, plants may be stunted with yellowed wilted leaves that become more common under drought or heat stress.



Other Considerations

Not all abiotic and biotic stresses have been identified in Africa. However, it is known that drought and flooding can be problematic, and either condition can exacerbate occurrence of certain diseases. Additionally, macro and micronutrient imbalances can produce various symptoms.

Nitrogen deficiency, when inoculant is not used or is ineffective under certain environments, results in leaf yellowing especially of lower leaves. Other deficiencies like phosphorous or potassium may also be common with each causing their own specific symptoms.

Micronutrient deficiencies for toxicities may not so obvious, but soil tests in general show that certain nutrients like boron and zinc may be limiting in some areas.



Best Practices for Management

General principles of good management often help to reduce or alleviate problems related to abiotic and biotic stresses. Practices like crop rotation, planting healthy, vigorous seeds, and selection of soybean varieties may all be important.

Pesticides like fungicides and insecticides may be needed on occasion, but are generally not recommended except under certain conditions where an expert has provided guidance or product application.

Research in many countries in Africa is ongoing and includes breeding and selection for varieties that are locally adapted and that include resistance to some of the common diseases in the region. Disease resistance is known to be effective for bacterial pustule and soybean rust.



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