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report on
PLANT
DISEASE

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POD AND STEM BLIGHT, STEM CANKER, AND PHOMOPSIS SEED DECAY OF SOYBEANS

Pod and stem blight, stem canker, and Phomopsis seed decay of soybeans is caused by the *Diaporthe/ Phomopsis* complex of fungi. These fungi cause more losses in the United States than any other soybean disease or disease complex, with the possible exception of the soybean crown and root rot complex. Members of this fungal complex and the diseases they cause result in serious crop losses wherever soybeans are grown around the world.

Figure 1. Soybean seeds covered with mycelium and severely infected with the pod and stem blight fungus, Diaporthe phaseolorum f. sp. sojae (anamorph Phomopsis phaseoli).

The *Diaporthe/Phomopsis* complex involves several diseases, the three most important in the Midwest are: pod and stem blight, caused by *Diaporthe phaseolorum* f. sp. *sojae* (anamorph *Phomopsis phaseoli*); northern stem canker and dieback, caused by *Diaporthe phaseolorum* f. sp. *caulivora* (anamorph unknown); and Phomopsis seed decay, caused by *Phomopsis longicolla* (teleomorph unknown). Southern stem canker is caused by *D. phaseolorum* f. sp. *meridionalis* (anamorph unknown). These fungi can also be involved in the root rot complex of soybeans and cause damping-off of seedlings.

Losses due to the pod and stem blight and stem canker diseases can be locally severe. However, the greatest losses usually are associated with seed decay. When wet weather delays normal harvesting, a reduction of 10 percent in seed weight and 50 percent or more in seed germination are found in susceptible cultivars. Soybean seeds having more than two percent damage caused by members of the complex are reduced in grade, thus lowering the price per bushel and profit to the grower. Seeds infected with the fungi of this complex produce low-quality oil and flour and other value-added products, and are often unsuitable for vegetable or other food and feed uses. Liver damage in chickens, and possibly in other animals, can be caused by toxic compounds produced by these fungi.

Besides soybeans, these fungi may also colonize other crops including birdsfoot trefoil (*Lotus corniculatus*), garden or green bean (*Phaseolus vulgaris*), lima bean (*Phaseolus lunatus*), cowpea (*Vigna unguiculata*), garlic (*Allium sativum*) and onion (*Allium cepa*), lespedezas (*Lespedeza* spp.), lupines (*Lupinus* spp.), okra (*Hibiscus esculentus*), peanut (*Arachis hypogaea*), pepper (*Capsicum frutescens*), pigeon pea (*Cajanus cajan*), and tomato (*Lycopersicon esculentum*). Several common weeds including velvetleaf (*Abutilon theophrasti*) and wildbean (*Strophostyles helvola*) can also be infected.

SYMPTOMS

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Soybean plants may become infected at any time during the growing season, with visible symptoms appearing only on young seedlings or on maturing plants. Symptoms develop on seeds, seedlings, leaves, petioles, stems, and pods.

Seed and Seedlings

Heavily infected seeds are elongated, shriveled, severely cracked, flattened, and may be partly or completely covered by a whitish mold growth (Figures 1 and 2C). Seeds extensively colonized by the fungi usually do not germinate. Healthy-appearing seed may harbor the fungi within the seedcoat. During germination the fungi grow rapidly from seedcoat infection sites to cause either seedling wilt and damping-off (Figure 2D) or the production of low-vigor seedlings. On the outside of the cotyledons, necrotic lesions develop that range from pinpoint size to completely covering the cotyledons. At first, the lesions are chlorotic and water-soaked; later, they turn reddish brown and crusty (Figure 2D). In infected seedlings the seedcoat commonly adheres to the cotyledons, preventing their opening after emergence. A watery brown rot near the soil line disintegrates stem tissues and can cause young seedlings to collapse. Within two weeks after emergence, soybean seedlings become increasingly resistant to damping-off, and symptoms disappear.

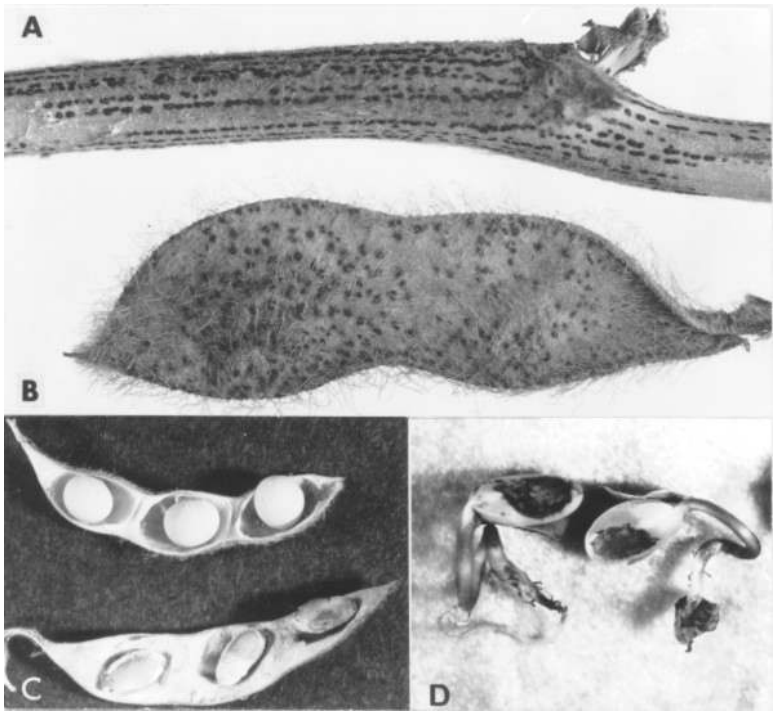

Figure 2. Pod and stem blight. A. Infected stem with pycnidia; B. Infected pod with scattered pycnidia; C. Moldy pod and seeds (bottom); healthy pod and seeds (top); D. Cotyledon lesions and radicle decay in infected seedlings.

Leaves and Petioles

Leaf symptoms usually caused by the pod and stem blight fungus, are commonly indistinct and unrecognized, becoming visible in early to mid-July in southern and central Illinois, and somewhat later in northern Illinois. Leaf infections are ash gray with a narrow, water-soaked margin; they usually develop first at the tips and margins of the lower leaves, which may be weakened by shading or attacks of other disease-causing organisms. The entire leaflet becomes ash gray and dies as infection progresses toward or into the petioles. Scattered pycnidia, the speck-sized, black, asexual reproductive bodies of the *Phomopsis* stage, form in large numbers on the surface of dead infected petioles. Diseased petioles can remain attached to the stem but usually fall prematurely. The presence or absence of pycnidia on petioles on the soil under plants may be important when deciding whether to apply a foliar fungicide.

Stems

Necrotic lesions usually appear after the mid-pod stage and are generally centered about the stem nodes and can be caused by the pod and stem blight and stem canker fungi. At first, they are bright red but later darken and become slightly sunken. Elliptical lesions are usually about an inch or more (2 to 3 cm) long. Occasionally, these lesions may enlarge and girdle the stem, killing the plant prematurely. Large numbers of minute black pycnidia are characteristically produced in rows on the stems (Figure 2A) and upper branches after the plant dies. The pycnidia may be clustered in small patches, usually near the nodes, or they cover a large portion of the stem. In hot, dry seasons they are found only on limited areas of the stems and branches near the ground. In addition to the pod and stem blight and stem canker pathogens, a number of other fungi are associated with dead stems including species of *Alternaria, Colletotrichum, Phoma,* and *Septoria.*

Pods

Pods growing on broken side branches and on the lower nodes are the first to show symptoms. Lesions develop around naturally occurring wounds and around pod hairs (trichomes). Spreading lesions that originate on infected pod stalks (peduncles) may move downward to invade pod tissues. Pod lesions are commonly chocolate brown in color. Early pod infections cause pod abortion. Later infections produce pod flattening because of reduced pod-fill. Infected pods "mature" prematurely and produce small, dull, infected seed. Pycnidia are scattered on the dry, dead, poorly developed pods and are not produced in rows as they are on the stems (Figure 2B). Pycnidia-covered pods usually contain rotted seed covered with a white fungal mycelium of the seed decay or pod and stem blight fungus (Figures 1 and 2C).

DISEASE CYCLE

The pod and stem blight and stem canker fungi survive the winter as dormant mycelia within infected seed or in soybean or other host debris. During the growing season, mycelia within the black fungal fruiting bodies (pycnidia and perithecia) form large numbers of asexual or sexual spores. Initial infections result from planting diseased seed or develop from rain-splashed spores, produced on infected plant debris, that land on susceptible soybean tissue. When a film of moisture is present, the microscopic spores germinate in 4 to 18 hours and penetrate the tissue. The fungi penetrate immature, senescent, or wounded tissues directly. Shaded or aging leaves and side branches damaged by wind, hail, insects, or the weight of pods are extensively colonized early in the growing season.

Pods may become infected any time during their development. Only infections initiated in pods can infect seeds and cause seed decay. Seed usually become invaded by the fungi during or after infected pods turn yellow. At first, seed infections are concentrated at the lower plant nodes; later, if harvest is delayed, infections spread throughout the plant. Pod deterioration associated with a delayed harvest favors infection. Invasion of the seed is often greatest on broken side branches, which commonly occurs in low-populated fields where large gaps between plants favor early and excessive branching. More seed decay occurs in plants deficient in potassium, infected with a virus, or heavily attacked by insects. Alternating periods of wet and dry weather favor pod deterioration and splitting. The number of seeds infected with the pod and stem blight, stem canker and Phomopsis seed decay fungi decreases with increased length of storage. However, the fungi can remain alive in seed for at least two years if the storage is cool and dry. This can not be considered a control measure, however, since seeds more than one year old should not be planted. Spread and development of disease are favored by prolonged wet periods and warm temperatures (more than 70°F or 21°C) after the soybean plants flower.

CONTROL

1. **Plant high-quality, certified soybean seed** germinating more than 80 to 85 percent in a warm germination test or over 70 percent in a cold germination test. High germinating seed usually harbor fewer and less severe pod and stem blight and stem canker infections. In a warm test, lightly infected seeds will often germinate, while the same seeds in a cold test will **not** germinate. Since the cold test may closely simulate unfavorable field conditions after planting, a cold germination test is recommended for all seed to be planted.

2. **Plant seed that has been thoroughly cleaned**. The pod and stem blight and stem canker fungi commonly colonize the bits of soybean stems, pods, and other debris that accompany noncleaned seed. Cleaning the seed before planting eliminates this infected plant tissue, thus eliminating a primary source of infection.

3. **Use a protectant fungicide or fungicide mixture to control *Diaporthe/Phomopsis* and other seed-and soilborne fungi that attack soybean seeds and young seedlings**. Treating the seed will not make good quality seed. Proper treating with a recommended fungicide, however, will generally produce a stand 10 to 15 percent higher than nontreated seed. When the seed are treated, the seeding rate can be lowered without sacrificing stand or yield potential. The money saved by reducing the seeding rate often pays for treating the seed with a fungicide. Seed treatment is an inexpensive way to ensure a stand. Information concerning seed treatment can be found in Illinois Agronomy Handbook which is available at your nearest Extension office or the University of Illinois Ag Service, P345, 1917 S. Wright Street, Champaign, IL 61820.

   Treatment can be done any time before planting. If a bacterial inoculant is also being used, it should be applied to the seed no more than two hours before the seed is actually planted.

4. **Plant a full-season cultivar for seed production**. Early-maturing soybean cultivars tend to produce seed of poorer quality than late-maturing ones. June-planted soybeans usually produce lower yields but have a higher proportion of germinating seeds with a lower percentage affected by the pod and stem blight, stem canker, and *Phomopsis* seed decay fungi than May-planted soybeans. If possible, select a planting time that allows maturation during a normally dry period.

5. **Strive for a stand of at least four to six equally spaced plants per foot of row**. Sidebranching, which is stimulated in widely spaced plants, promotes breaking of branches and lodging. Lodged plants, or those with broken branches, provide points of entry for the pod and stem blight and stem canker fungi. Extensive colonization by *Diaporthe/Phomopsis,* as a result of lodging or broken branches, contributes to the production of poor quality seeds.

6. **Fertilize to maintain a high level of potash**. Seed infection increases as the deficiency of potash increases. A soil analysis is needed to determine the level of potash and other major elements.

7. **Where feasible, rotate soybeans for one or two years with corn, sorghum, small grains, alfalfa, or forage grasses**. Exclude crop plants and weeds that are susceptible to the pod and stem blight, stem canker, and *Phomopsis* seed decay fungi.

8. **Where pod and stem blight and stem canker have been severe, make a clean and deep plow-down of infected soybean stubble after harvest, or before planting in the spring, to destroy a**

major source of primary inoculum. Where soil erosion (from wind or water or both) could be a problem, the use of a fall plow-down should be discouraged.

9. **Harvest soybeans when first mature**. The longer soybean seeds remain in the field after maturity, the greater are the chances of the seeds being invaded by the pod and stem blight, stem canker, and *Phomopsis* seed decay fungi and other microorganisms, especially if the weather is moist and warm to hot.

10. **Make a foliar application of an EPA-approved fungicide; this is suggested primarily for seed-production fields as insurance against pod, seed, stem, and petiole infections late in the growing season**. Spraying increases seed size, quality, and germination. Yield increases of two to six bushels or more per acre are not unusual in Illinois when August and September are unusually rainy and harvest is delayed after full maturity is reached.

    Proper and timely applications of a fungicide control pod and stem blight and stem canker as well as Septoria brown spot, anthracnose, Cercospora leaf blight (purple seed stain), and target spot. A checklist can be used at early bloom. It is based on a number of "risk factors," to determine whether fungicide applications should be made to soybeans. The presence of pycnidia on the fallen petioles when the first spray should be made is particularly important since the pycnidia indicate that the pod and stem blight fungus is present and active. Only brown, fallen petioles should be assayed, and more than two-thirds to three-fourths of these petioles should show pycnidia.

Checklist to determine whether foliar fungicide application should be made to soybeans

Risk factors	Point value if answer is yes
Rainfall, dew, and humidity up to early bloom and pod set are:	
Below normal	0
Normal	2
Above normal	4
Soybeans are grown in the field last yar	2 to 3
Chisel-plow, disk, or no-till was used	1
Pycnidia (black specks) are visible on fallen petioles, and Septoria brown spot is obvious on the lower leaves	2
Early-maturing variety (not full-season)	1 to 2
Soybeans to be used or sold for seed	6
Yield potential is better than 35 bushels per acre	2
Seed quality at planting time is less than 85 percent germination in a warm test	1
Other conditions that favor disease development (weather forecast with a 30-day period of greater than normal rainfall and a field history of disease	1 to 3

NOTE: If the total point value is 12 or more for seed-production fields, or over 15 for grain-production fields, application will likely mean increased yields and higher seed quality.

Two applications of fungicide are suggested. Make the first when the lower or oldest pods are 1/4 to 3/4 -inch long, and the second two to three weeks later. If this period is unusually rainy, apply the second spray two weeks after the first application; otherwise, stretch the spray interval to three weeks.

Aircraft (fixed-wing or helicopter) are the best vehicles for applying fungicides to soybeans. It is important to select an aerial applicator who is familiar with disease control and whose aircraft has been properly calibrated for uniform, thorough coverage of all above-ground plant parts. With equipment now available, a reasonable job of applying fungicides requires a minimum of five gallons of water per acre. Superior coverage may be obtained with more water, but the cost may be prohibitive. Five gallons of water per acre can be applied by using approximately 30 to 50 properly spaced nozzles, depending upon the aircraft. The nozzles should be D-8 or D-12, hollow core, with No. 45 or No. 46 cores. The final decision on nozzle number, size, and placement depends upon the air speed, pressure, and volume desired. Droplet size is also important. Ideally, droplets should be in the size range of 200 to 600 microns for thorough and uniform coverage. Do not graze or feed sprayed soybean vines or hay to livestock.

11. **Control weeds by chemical and mechanical means**. A weed canopy increases the humidity around soybean plants and slows the drying of leaves, petioles, stems, branches, and pods after a moist period.

12. **Select less susceptible soybean cultivars**. Soybean cultivars differ somewhat in their susceptibility to this disease complex, and several sources of resistant breeding material are known. It is hoped that agronomically desirable cultivars with high resistance to pod and stem blight and stem canker will be available in the future. The degree of resistance or susceptibility of public soybean varieties to this disease complex as well as to Phytophthora rot, bacterial pustule, powdery mildew, soybean cyst nematode, purple seed stain, downy mildew, and Sclerotinia white mold is given in the Illinois Agronomy Handbook. This circular and many other publications on soybean diseases is available at your nearest Extension office or from the University of Illinois Ag P345, 1917 S. Wright St., Champaign, IL 61820 (1-800-345-6087).