



VIRUS DISEASES OF SOYBEANS

Several viruses attack soybeans in Illinois, including soybean mosaic, bean yellow mosaic, tobacco ring-spot, cowpea severe mosaic, and bean-pod mottle. The cowpea mosaic and bean-pod mottle viruses have been found only in the southern half of the state. Soybean mosaic virus occurs throughout Illinois with a low incidence present most years. Several strains of the virus have been identified in Illinois. Tobacco ringspot virus and bean yellow mosaic viruses occur sporadically and their prevalence varies from year to year.



Figure 1. Soybean mosaic. Right: healthy leaves; left and center: soybean mosaic.

SOYBEAN MOSAIC (SMV)

A plant's reaction to SMV infection depends on the cultivar, the strains of the virus, plant age at time of infection, and environmental conditions (especially temperature). Mosaic is generally a minor disease appearing to a limited extent throughout Illinois. Infected plants are somewhat stunted and bushy, and have distorted leaves. The leaves may be dwarfed, crinkled, or ruffled and are narrower than normal, with margins curling downward. They may have a yellowish cast and usually show a dark-green, blister-like puckering along the veins (Figure 1). The youngest and most rapidly growing leaves show the most severe symptoms. Nodules on the roots of plants infected with soybean mosaic virus are fewer, smaller, and lighter-weight than those found on healthy plants. Reduced nodulation and leaf distortions are thought to be the primary cause of smaller, lightweight beans in mosaic-infected fields.

The pods are often stunted, flattened, or curved with less pubescence; also, they contain fewer seeds. Mosaic-infected plants may produce seed with a black or brown mottling of the seed coat. Badly mottled beans are subject to downgrading, especially in overseas trade, where soybeans are used primarily in food products.

The leaf symptoms of mosaic are sometimes confused with 2,4-D injury. Herbicide damage, however, is much more uniform in a field or area than that caused by mosaic. The injury usually becomes progressively less as the distance from the site of application increases. Herbicide injury is most apparent along sprayed roadsides and near sprayed fields of small grain and corn when the ester form of 2,4-D has been applied on a windy day. Mosaic-infected plants are scattered at random in soybean fields. Some strains of the virus delay the maturity of infected plants, resulting in green plants that stand out in the field after healthy plants have matured. Soybean mosaic is transmitted from one season to the next through

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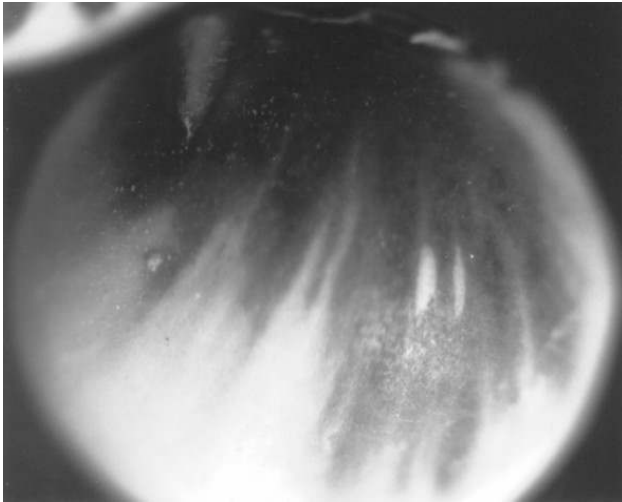


Figure 2. Dark brown mottling of a soybean seed due to infection by the soybean mosaic virus as seen under a high-power microscope.

seeds. Virus-infected plants can produce virus-infected seeds that are a mottled dark-brown or black when the plants become infected before flowering (Figure 2). However, seed may be mottled and not carrying the soybean mosaic virus, and virus-infected seeds may not be mottled. SMV-infected seeds may fail to germinate or may produce diseased, spindly seedlings with mottled, crinkled unifoliate leaves. Infection after flowering ceases may reduce the yield somewhat (Table 1), but transmission of the virus by seeds to the next generation does not occur. Infection by SMV can predispose some cultivars to infection by pod and stem blight, stem canker, and Phomopsis seed decay resulting in a loss of seed germinability.

The incidence of seed transmission varies from less than 1 percent to 30 percent or more depending on the soybean cultivar, the virus strain, and the time of infection. Transmission of soybean mosaic in the field occurs when certain species of aphids feed on an infected soybean plant and then on a healthy plant nearby. No aphids colonize soybeans in Illinois, but transient aphid species are plentiful (over 60 species have been identified in soybean fields, of which at least 31 species are able to spread the virus in a nonpersistent manner), especially late in the growing season. Aphids become viruliferous by feeding on infected stems, stem tips, and old or young leaves. Soybean mosaic is a minor disease in full-season soybeans in Illinois because the principal aphid flights occur before planting and after flowering. Soybean mosaic is more prevalent in soybeans planted late, such as after winter wheat.

Table 1. Yield, seed coat mottling, and seed transmission in Williams Soybeans inoculated with the Soybean Mosaic Virus (SMV) at various times after planting

Inoculation (days after planting)	Yield (percent of control)	Mottling (percent)	SMV seed transmission (percent)
Healthy	100.0	2.2	0.1
9	22.7	99.6	8.1
19	44.8	90.3	5.2
34	52.3	98.8	3.8
57	61.6	99.7	0.3

Control

1. Plant virus-free seed.
2. Do not plant seed produced in late-season plantings.
3. In seed-producing fields, remove (rogue) plants suspected of being virus-infected as soon as they are found.
4. Since SMV is transmitted mechanically, avoid handling or brushing up against infected plants whenever possible.

Although resistance to soybean mosaic virus has been identified (due to one or more dominant genes), resistance to SMV is not yet available in commercial soybean varieties.

BEAN YELLOW MOSAIC (BYMV)

The bean yellow mosaic virus is widely distributed in Illinois, but has not caused evident damage. Affected plants are not noticeably stunted. Usually, the leaves are not distorted and puckered like those affected by soybean mosaic but some strains of BYMV produce severe mottling and crinkling of leaves. Younger leaves on plants infected with bean yellow mosaic show a scattered yellow mottling or indefinite yellow bands along the major veins (Figure 1). Rusty, dead spots develop in the yellowed areas as the leaves mature. Mixed infections of bean yellow mosaic virus and soybean mosaic virus are common in soybeans. Bean yellow mosaic virus has a wide host range, is easily transmissible mechanically, and by more than 20 species of aphids in a nonpersistent manner.

Control

Bean yellow mosaic is not seed-transmitted, thus roguing is of no value. No control is warranted.

BUD BLIGHT (Tobacco Ringspot Virus [TRSV], Soybean Mosaic Virus [SMV])

Bud blight usually appears first at the border of a field, advancing inward as the season progresses. The disease is common after clover or alfalfa fields have been harvested and when pastures dry up. Sporadic but serious losses have occurred in some soybean fields, especially in southern and south-central Illinois. Yields may be reduced by 25 to 100 percent. In general, losses are greatest when young plants are infected or when seeds with a high percentage of TRSV are sown.

The symptoms vary with the stage of development at which plants become infected. In young plants, the terminal bud turns brown and bends sharply downward forming a crook. Later, other buds become brown. Such buds become dry and brittle (Figure 3) and may fall off at the slightest touch. The leaf just below the tip bud may be bronzed and flecked in a rust color. A reddish brown discoloration of the pith, especially at the nodes (joints), is often evident inside the stem. Brown streaks are sometimes evident on petioles and along large leaf veins.



Figure 3. Bud blight.

Plants infected **before** flowering time are severely dwarfed and produce few or no pods. The pods that do form remain small and are mostly one-seeded. About 90 percent of the seed is infected with virus and will produce virus-infected plants if sown. Infected plants usually remain green until harvested or killed by frost, and they stand out conspicuously in soybean fields at harvest. Plants infected **after** flowering are much less dwarfed and may produce an almost-normal number of pods. Many pods may drop when



Figure 4. Bud blight.

they are still small, or may develop dark purple blotches (Figure 4). The seeds on plants affected after flowering do not contain the virus and will produce healthy plants when sown. The virus also significantly reduces root and nodule growth.

In instances of severe bud blight, both tobacco ringspot and soybean mosaic viruses have been isolated. Apparently, an interaction between these viruses may induce the leaf to extend its veins beyond the margin of the leaf blade (enations).

Many common weeds (e.g., dandelion, wild carrot, purslane, jimsonweed, nettleleaf goosefoot, lamb's-quarters, pigweed, velvetleaf, horse-nettle, sourdock, ragweed, horseweed) and some forage legumes are symptomless hosts of the tobacco ringspot virus. The virus is spread from these plants to soybeans and later from soybean to soybean by unknown vectors. Thrips, grasshoppers, and several other insects have been implicated as well as dagger nematodes.

Control

1. Removing infected plants from fields intended for seed production is of limited value, except in preventing the dissemination of the virus(es) to new areas. Infected plants produce so little seed and so much of it is lost in threshing that it is of no consequence the next year, and is practically self-eliminating in the second year.
2. Grow 4, 6, or 8 rows of corn, forage sorghum, or other tall-growing crop as a barrier between soybean and clover or alfalfa fields and between soybeans and noncultivated areas, such as roadsides, ditch banks, and pastures.
3. Apply 2,4-D or other herbicide to kill broadleaf weeds in noncrop areas that adjoin soybean fields **before** the soybean plants emerge or in the fall after the field has been harvested.

OTHER VIRUS DISEASES OF POTENTIAL IMPORTANCE

1. **COWPEA SEVERE MOSAIC (CSMV).** Symptoms typical of bud blight can also be caused by infection of soybeans with the cowpea severe mosaic virus. The virus, which causes severe mosaic and stunting, is transmitted by seeds in cowpeas but not in soybeans. Numerous leaf-feeding beetles transmit the virus to soybeans, but much less efficiently than to cowpeas. Cowpea severe mosaic was first discovered in Illinois soybeans in 1978 and is not believed to be widespread. Growers who also grow cowpeas should be sure to plant healthy cowpea seeds and to remove virus-infected plants in order to minimize the spread of the virus to soybeans.
2. **BEAN-POD MOTTLE (BPMV).** The bean-pod mottle virus is present sporadically in Illinois soybeans. It causes a mild and generally unimportant disease (green and yellow mottling of the younger leaves, decreased pod formation and a reduction in seed size, weight, and numbers) in this crop unless the plants are also infected with the soybean mosaic virus. Doubly infected plants are severely stunted with malformed, bronzed leaves, produce few if any pods or seeds, and have a delayed maturity. Bean-pod mottle can spread to soybeans via the feeding of bean leaf beetles

(*Cerotoma trifurcata*), and other beetles including *Colaspis brunnea*, and *C. lata*, *Diabrotica balteata*, and *D. undecimpunctata howardi*, and *Epicauta vittata*) that have fed recently on infected weeds or garden (snap) beans. Maximum losses occur when plants are infected at the seedling stage. Yield losses from BPMV alone may reach 2 to 20 percent depending on planting date, but in association with SMV, losses may exceed 60 percent.