Crop Scout
Pocket Guide

r4 Solution

AFRICAN PLANT NUTRITION INSTITUTE

Soybean

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Pocket Guide
Soybean

African Plant Nutrition Institute (APNI)

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Introduction

Crop scouting is a valuable skill and an important part of crop management. Regularly checking on growth and development makes it possible to recognize whether a nutrient deficiency or another crop health problem is developing, and whether anything can be done to correct it. Early detection is key to success as it provides for more time to react and allows the crop a chance to recover.

This **Crop Scout Pocket Guide** is designed to be a hands-on resource to help agronomists, extension agents, and farmers recognize common symptoms of soybean nutrient deficiency, infectious diseases, pests, and other abnormalities in the field.

Tips for Successful Crop Scouting

Successful crop scouting begins with a regular presence in the field. It is recommended to have a walk through your farm at least once a week. Crop scouting is an applied skill that requires agronomic knowledge and experience. However, a trained eye with local knowledge of the field history is often invaluable. An understanding of the local soil, climate and weather, and awareness of disease and pest pressures all contribute to identifying the presence of a nutrient deficiency or other plant health problems.

One key to scouting is to watch for unusual patterns – comparing problem areas in the field with normal, healthy areas. The following are some key tips for successful crop scouting:

- Inspect fields several times during the season. Take notes on a field map if possible. If you are consulting for a farmer, a walk through the field with the farmer adds their perspective and familiarity with the field.

- Make detailed notes of what you see and where you see it in the field. Use your camera to document problem areas. Video allows the valuable opportunity to describe both the symptoms and field conditions as you are observing them.

- Pull or dig up some plants in normal and in problem areas. The differences you see will provide useful diagnostic information. Ask yourself if a physical limitation like soil compaction or

poor drainage is impacting growth? Too much or too little water? A nutrient limitation? A pest or disease infestation? Shallow or acidic soil?

- Carefully inspect the roots, split the stalks, and examine pod development. Watch for diseases, insects, or obvious damage on leaves, stalks, pods, or roots.

- Are weeds robbing nutrients and water from the crop? Any known or unknown deficiency symptoms? Tissue testing is especially useful to detect hidden hunger or help explain growth differences between areas.

- Harvest time is another opportunity to check the crop. Reduced numbers of pods and small seeds can indicate nutrient shortages that can be corrected before the next crop is planted.

Questions to Ask While Scouting

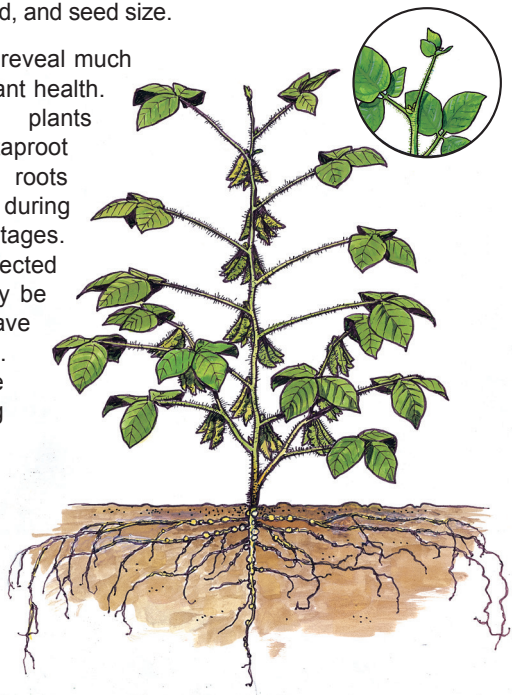
- ❑ What is the field's cropping history? What were the previous crops grown?
- ❑ Was the weather too dry? Too hot? Too cold? Too wet?
- ❑ How were the crops fertilized?
- ❑ Have other management practices or inputs been applied? If so, which ones?
- ❑ When were the crops planted? Too early? Too late?
- ❑ Were insects, weeds, and diseases controlled?
- ❑ Is the disease regularly distributed in the field?
- ❑ What types of symptoms are found in the leaves? Are they entirely or partly affected? Are aphids present?
- ❑ How has the crop looked until now?
- ❑ What variety was planted? What was the source of seed?

Soybean Crop Growth and Development

Soybean has two different growth habits depending on crop variety. Indeterminate varieties continue to grow after flowering begins. Determinate varieties have a a terminal leaf on the main stem (inset image), and finish most of their growth before the flowering stage begins.

Soybean yield is ultimately influenced by several plant characteristics including: number of seeds per pod, weight per seed, pods per plant, and plants per hectare. Yields are especially influenced by the number of seeds per pod, and seed size.

Plant roots can reveal much about soybean plant health. Healthy soybean plants have a branched taproot system and lateral roots develop rapidly during vegetative growth stages. Roots of plants infected with nematodes may be dark in colour and have few or no nodules. Nematodes damage the roots, reducing uptake of water and nutrients. Where roots are short and underdeveloped, this may be an indicator of difficulty in penetrating strongly compacted



soils. Since soybean roots grow close to the soil surface they can be damaged from in-crop cultivation or weeding.

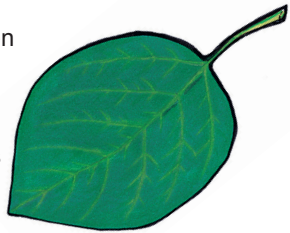
The N requirement of soybeans is largely met through N_2 fixation occurring in root nodules. The Bradyrhizobia that live inside the soybean nodules are typically added with the seeds before planting. Using healthy and properly matched inoculants is a critical part of supporting high yields. While the purchase of inoculants is an additional cost to the farmer, the increase in yield following inoculation far outweighs the additional inoculant cost.

An adequate supply of other essential nutrients, especially phosphorus (P) and molybdenum (Mo), are however required for the Bradyrhizobia to make their full contribution to soybean health and high yields. These nutrients need to be supplied in the form of fertilizer at planting.

An unrestricted, well nodulated soybean root system.

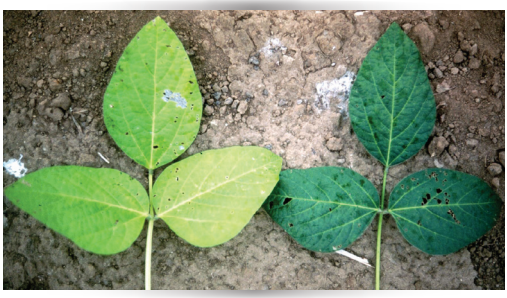
Symptoms of Nutrient Deficiency and Toxicity

Plant leaves are the most obvious indicator of nutritional problems. Experienced crop scouts can recognize the most common leaf traits as tell-tale signs of specific nutrient deficiency or toxicity.



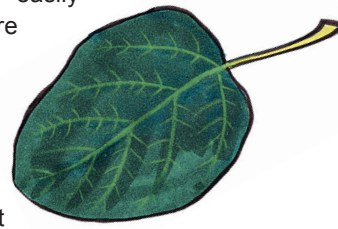
Plants with dark-green healthy leaves, strong stems, and vigorous roots will maximize the work of gathering sunshine and nutrients needed for photosynthesis.

Nitrogen-deficient soybean plants appear yellowish or pale green, although the symptoms are seldom seen. However, on acidic soils where molybdenum (Mo) deficiency interferes with nodulation, or on soils where soybeans have not been grown before, N deficiency is more likely without seed inoculation.



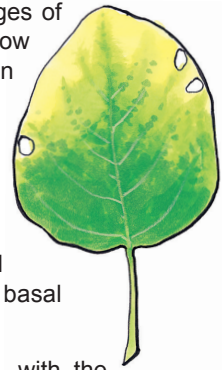
Nitrogen-deficient leaf (left); Healthy leaf (right)

Phosphorus (P) is an important nutrient for soybeans, but deficiency symptoms are not easily identifiable. Soybean plants require relatively large amounts of P at pod set. Uptake of P is reduced in cool, wet soils. Plants may be stunted and leaflets may appear blue-green. If P deficiency symptoms are seen, it is likely that N_2 fixation is not occurring at its full potential.



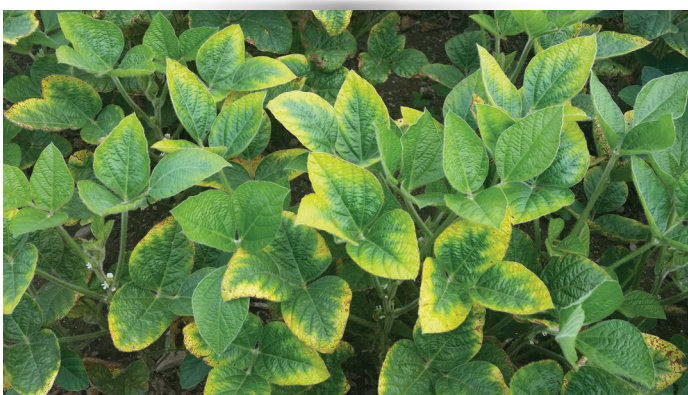
Phosphorus deficient soybean plants (right) are smaller and have small leaflets due to slow and stunted growth.

Potassium (K) deficiency symptoms in soybean are well-defined and appear first on older leaves. In early stages of growth, leaflet margins may show irregular yellow mottling. As these areas combine, they form an irregular yellow border (chlorosis).



This symptom may be followed by necrosis of chlorotic areas and downward cupping of leaf margins. Dead tissues may gradually drop away, so leaves appear ragged. The chlorosis and necrosis may spread inward to include half or more of the leaflet, while basal portions remain green.

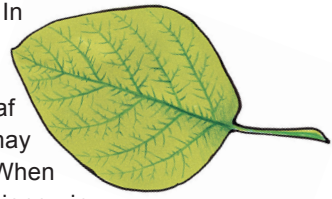
Soybean plants require large amounts of K, with the maximum uptake during periods of rapid vegetative growth. Deficient plants tend to have weak stems and are more susceptible to some plant diseases. Severe deficiency may result in misshapen and wrinkled seeds.



Magnesium (Mg) deficiency symptoms in soybean first appear as pale green to yellow interveinal tissues on the older leaves. Later symptoms may appear as purple-brownish lesions around the leaflet margins, sometimes giving older plants the appearance of early maturity. Magnesium deficiency is more prevalent on deep, sandy, acidic soils.

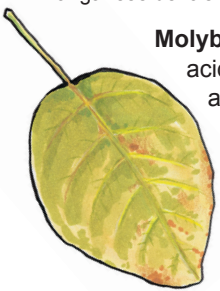
Sulfur (S) deficiency in soybean is characterized by small, yellowish-green leaves at the top of the plant. Stems are thin, hard, and elongated. Leaf symptoms may sometimes look like those caused by other nutrients, such as N and P, but stem elongation is characteristic of S deficiency. Availability of S is affected by the rate of release from organic matter, related to types of plant residues applied, soil pH, and moisture.

Iron (Fe) deficiency in soybean may first appear as yellowing of interveinal areas on younger leaves. In later stages, the veins may become chlorotic and entire leaves may turn ivory to white in colour. Near the leaf margins, brown, necrotic spots may appear, and plant growth will be slow. When leaf yellowing is caused by Fe deficiency in high-pH soils, it is sometimes called lime-induced chlorosis. The symptoms may also appear when plants are not using available Fe effectively, and large amounts of Fe accumulate in the leaves. Soybean varieties differ considerably in their tolerance to Fe deficiency.



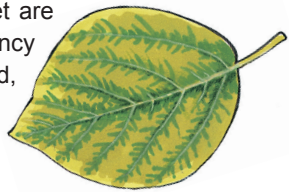
Manganese (Mn) deficiency symptoms in soybean are seen more frequently in cool weather, during dry periods, and at relatively high soil pH. Interveinal areas of leaves become light green to white, while veins remain green. Symptoms appear first in the younger leaves and may initially resemble early signs of Fe deficiency. Necrotic, brown spots develop as the deficiency becomes more severe, and leaves may drop prematurely.

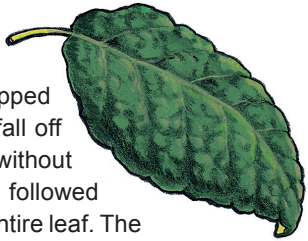
Manganese deficiency symptoms



Molybdenum deficiency in soybean is more likely in acidic soils that are highly weathered and leached, and in soils where the element is in unusable form. Symptoms of this deficiency resemble N deficiency. The young leaves are pale green or yellow, necrotic, and twisted. Necrosis is confined largely to the margins, midribs, and interveinal areas. Since Mo is essential for N_2 fixation, a deficiency can be confused with N.

Zinc (Zn) deficiency can reduce soybean yields, primarily due to the reduced number of seeds formed. Deficient plants may have stunted stems and chlorotic interveinal areas on younger leaves. Entire leaves may later turn brown and gray, and drop early. Few flowers are formed and the pods that set are abnormal and slow in maturing. Deficiency of Zn is most likely on strongly weathered, coarse-textured soils that are alkaline, on eroded soils, on low organic matter soils, or fields excessively fertilized with P.





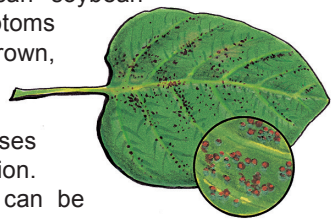
Boron (B) toxicity symptoms include crinkled leaves, with the edges of the younger leaves cupped either up or down. The older leaves fall off in extreme cases. Margins of leaves without previous yellowing may begin to die, followed by spreading of dead areas over the entire leaf. The growing point in soybeans may also die. Boron deficiency is not common in soybeans...the range between deficiency and toxicity is narrower than for other micronutrients.

Symptoms of Common Plant Growth Disorders

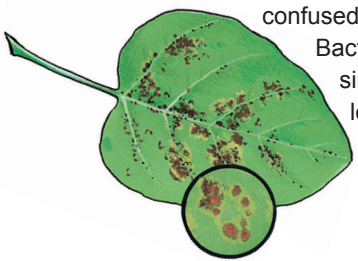
DISEASES

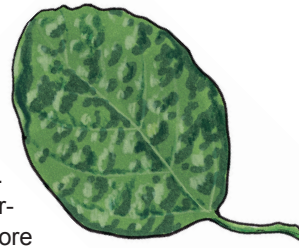
Identification of soybean diseases can be difficult, but awareness of the characteristics of the following diseases is important.

Soybean rust (*Phakopsora pachyrhizi*) is a major threat to African soybean production. First symptoms appear as small tan, brown, or red-brown lesions that rupture through the leaf epidermis. Severe infection causes premature defoliation and maturation. Early symptoms of soybean rust can be confused with bacterial pustule.



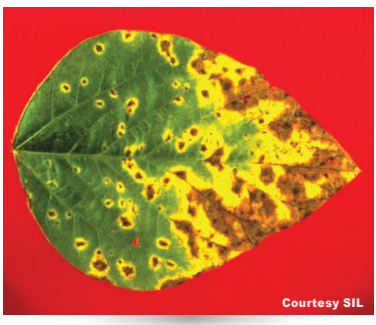
Bacterial pustule (*Xanthomonas campestris* pv. *phaseoli*) is a warm-weather disease which usually appears during flowering or later. Most lesions have prominent pustules on the underside of the leaf. The disease also occurs on pods, appearing as slightly raised spots with some discolouration on seeds. The disease may cause defoliation and often premature death under severe conditions. Bacterial pustule symptoms are easily confused with soybean rust pustules. Bacterial pustule symptoms are also similar to those of bacterial blight but lesions do not appear water soaked and will have raised centers.



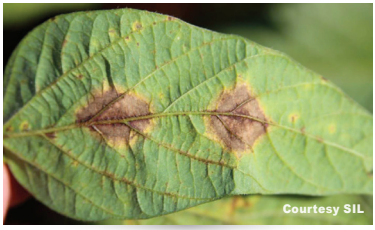


Bean pod mottle virus is transmitted by bean leaf beetles, and may be more severe near woody areas where the beetles overwinter. The upper leaves of infected plants are mottled. The virus may cause discoloured beans. Symptoms may be more severe in earlier-planted fields, and some varieties are more affected than others. Virus symptoms caused by many viruses are similar. Identifying virus and virus-like diseases using symptoms alone is unreliable.

Brown spot *(Septoria glycines)* disease appears early in the season, sometimes on the first trifoliate leaf. Lesions are angular and reddish to chocolate brown, often with a yellow halo surrounding a necrotic area. There is no water-soaked margin as occurs with bacterial blight. Lesions progress up the plant during wet weather, but do not usually reach the top leaves until plants are maturing. Symptoms may also occur on petioles, pods and stems.



Brown spot leaf symptoms with distinct yellow halos surrounding the lesions.



Red leaf blotch lesions occur on leaves, petioles, pods, and stems. Lesion colour can be variable and eventually form necrotic spots. Diagnostic fungal reproductive structures (sclerotia and pycnidia) may be found in older lesions.

Myrothecium leaf spot can resemble red leaf blotch. Lesions are roundish with white centers. Discovered in Ghana in 2016, little is known to date about the life cycle of the disease on soybean or its impact on soybean production.

Witches' broom causes multiple shoots to develop on infected plants. Plants develop apical necrosis and produce only a few poor quality seeds. Symptoms are associated with phytoplasmas spread by leafhoppers. Symptoms of viruses and those caused by phytoplasmas are difficult to distinguish.

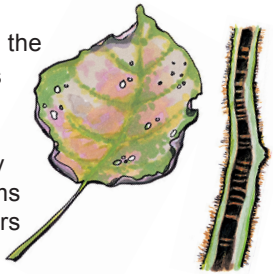
Anthracnose (*Colletotrichum truncatum*) is observed as irregularly shaped black areas on stems and petioles. In the advanced stages (usually late in the growing season), infected tissues are covered with black fruiting bodies (acervuli) that are easily seen. In severe cases, premature defoliation occurs.

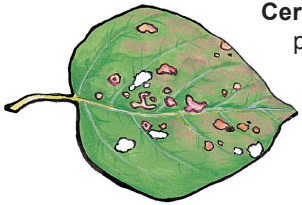
Sclerotium blight (*Sclerotium rolfsii*) infection occurs at or just below the soil surface and appears as light to dark brown lesions that girdle the stem. A sudden yellowing or wilting of the plant often occurs. Leaves turn brown and dry, often clinging to the dead stem. A leaf spot phase is characterized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

Charcoal rot (*Macrophomina phaseolina*) may cause premature death of the plant, often with leaves left dried on the plant. Symptoms include wilting and/or yellowing due to vascular plugging. Roots and stems of diseased plants have a charcoal or grayish coloured appearance due to the aggregated appearance of tiny fungal structures called microsclerotia.

Additional Resource: Hartman, G.L. and H.M. Murithi. 2019. Field Guide to African Soybean Diseases and Pests (v.1.1). Published by the Soybean Innovation Lab (SIL)-USAID-USDA-IITA. P. 64. http://soybeaninnovationlab.illinois.edu/soybean-disease-diagnostic-guide

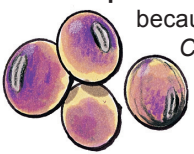
Brown stem rot attacks plants through the roots early in the season, but symptoms do not appear until pods begin to fill. About 3 to 4 weeks before normal maturity, leaves of diseased plants may turn brown and dry rapidly. When the stems of infected plants are split, the pith appears dark reddish brown.





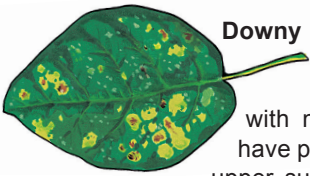
Cercospora leaf blight starts as light purple areas on upper leaf surfaces, which become leathery and dark reddish-purple and develop on both leaf surfaces. Leaf symptoms are most visible during pod fill, but may also occur on stems, pods, and seeds.

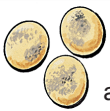
Frogeye leaf spot lesions (caused by *Cercospora sojina*) have gray to tan-coloured centers and dark purple, distinct margins. Older lesions are light to dark brown, with white centers (often fallen out). Lesions can also occur on petioles, stems, pods and seeds.



Purple seed stain is sometimes referred to as *Cercospora* because it is caused by one or more species of the *Cercospora* fungus. *Cercospora kikuchi* causes a purple discolouration of seed that may vary from pink to dark purple. Cracks often occur in the discoloured area.

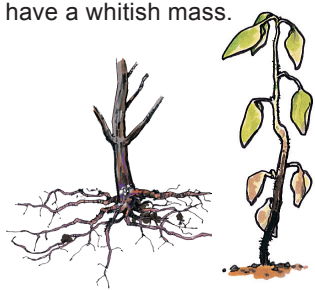
Damping off may be caused by either *Pythium* or *Phytophthora. Pythium* prefers cold soil and this disease strikes seedlings early. *Phytophthora* prefers warm soils (about 27°C) and this fungus disease can attack late-planted soybeans.



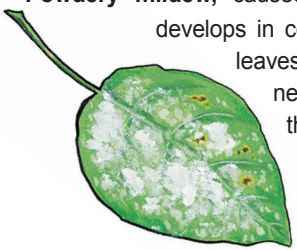


Downy mildew can occur when infected seeds are planted. The first leaves to open are sometimes covered with mildew growth. Infected leaves will have pale-green to light-green spots on the upper surface. White fungal growth may be evident on the underside of the leaf, opposite these spots. Seeds may be partly or completely encrusted and interior of beans may have a whitish mass.

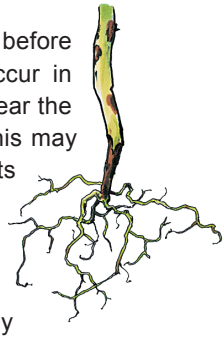
***Phytophthora* root rot** symptoms may include chocolate brown discolouration on the lower stems, especially in areas where the stand is thin as a result of plant loss from damping off. Affected plants will wilt and then die.



Powdery mildew, caused by the fungus *Microsphaera diffusa*, develops in cool (18 to 24°C) weather. Symptoms on leaves are green and yellow islands, interveinal necrosis, necrotic specks, and crinkling of the leaf blade, followed by leaf drop. White, powdery patches develop on upper surfaces of leaves and other plant parts.



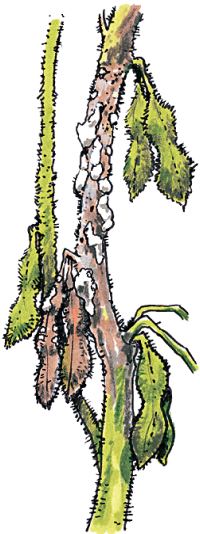
***Rhizoctonia* seedling blight** can develop before or soon after plants emerge and may occur in patches. A sunken area on the hypocotyl near the soil line is characteristic of the disease. This may make the plants prone to lodging later. Plants that survive the seedling blight phase may develop root rot later.



Sudden death syndrome (SDS) is a root disease favoured by cool, moist conditions early in the season. Symptoms of SDS include interveinal necrosis of leaves and typically appear in mid-summer when plants reach the full-pod stage. Well-fertilized fields, early planting, and early-maturing varieties favour SDS development. A heavy rain around early pod development promotes foliar symptom development. The pith inside stems remains mostly white with SDS and it is not similar to that of brown stem rot.

Stem canker infections early in the season are most destructive. Small, reddish brown lesions form on the stem at lower nodes after stage R3. These enlarge to become girdling cankers, which can kill the plant. Leaf symptoms may mimic those of root rot.

White mold (*Sclerotinia*) symptoms may appear soon after the beginning of flowering, especially in cool weather. Leaves become grayish green, turn brown, and die. The stem around the point of infection will be bleached nearly white. Cottony mycelial growth develops on stem lesions. Large, black, round to irregular-shaped sclerotia form within this mycelium.

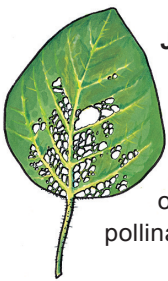


Symptoms of Common Plant Growth Disorders

INSECTS

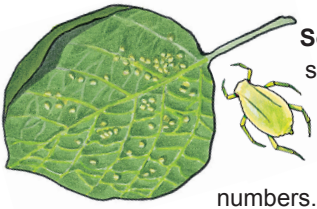
During various growth stages, soybean plants are targets of several insect pests. While many of these can be avoided with management, it is important to properly recognize and identify insects before taking control action. (Note: insect sizes are not to scale in these illustrations.)

Bean leaf beetle, banded cucumber beetles, and spotted cucumber beetles eat small round holes in soybean leaves. Bean leaf beetles may also cut off plants above the soil surface, similar to cutworm and fall armyworm damage. The damage shown here is due to bean leaf beetle. Adult bean leaf beetles are about 6 mm long and are yellowish to reddish with a black band surrounding the outer margin of the wing covers.



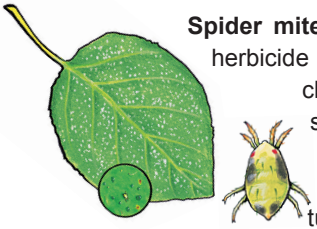
Japanese beetles feed on soybean leaves and flowers during the summer months. The adults have a green metallic head and reddish-bronze wing covers with a row of white hair tufts along the abdomen. Feeding also occurs on maize and may interfere with pollination.

Seed maize maggots (5 to 6 mm) are found most commonly in fields with lots of decaying vegetation under the soil surface, such as incorporated cover crops.



Soybean aphids suck plant sap from leaves and other plant parts. Symptoms include plant stunting, yellow and puckered leaves, and reduced pod numbers. Yield loss is greater the earlier in plant development infestation occurs.

Soybean cyst nematode (SCN) damage may be difficult to detect. When SCN is present and plants are under stress, symptoms may include leaf margin and general chlorosis, plant stunting, and even plant death. While white or yellow cysts may be visible on roots, testing by a nematology lab is the best course. Root-knot nematode causes gnarled galls on roots.



Spider mite injury on soybeans may resemble herbicide injury or foliar diseases. However, characteristic signs are tiny yellow spots, or stipples, on leaves. Hot, dry weather favours this pest. With severe injury, leaves turn yellow, then brown bronze, and finally die and drop off.

OTHER PROBLEMS

While conditions such as poor drainage or moisture stress are not diseases or nutrient deficiencies, they are often factors related to poor growth, disease, or insect infestation.

Soil compaction limits yield in many fields. It is usually a result of working soils that are too wet or from excessive traffic across certain field areas. Compaction prevents the taproot from fully developing.

Herbicide injury in soybeans can be related to carryover effects, improper rate or timing of application, and interactions of many other causes. Accurate field records are a valuable diagnostic tool. Symptoms can vary depending on the herbicide and whether plant exposure is from soil or foliar application.

Field Notes

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ABOUT **APNI**

The **African Plant Nutrition Institute** research and outreach activities focus on improving the understanding of spatial and temporal variability of nutrient needs for Africa's diverse cropping systems. APNI promotes balanced and site-specific soil nutrient management for greater crop yield and quality, and develops nutrient management strategies to improve soil health, reduce environmental footprints, and improve adaptation to climate change.

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