Introduction

This photo booklet has been produced by the CABI-led **Plantwise** programme (www.plantwise.org) to aid extension officers and other plant health advisors in diagnosing the most common pests, diseases and abiotic problems of coffee around the world. The symptoms presented on a real plant sample can be compared with the photos in this guide to identify possible causes.

The booklet is organized into two broad sections, one showing the common insect pests that attack the crop and the other showing the various symptoms of poor health. In the symptoms section, the images are arranged by plant part, with similar-looking symptoms displayed together. Some biotic and abiotic factors cause more than one type of symptom, so there may be multiple images in different parts of the photo booklet for a specific problem. The photos for a particular problem are cross-referenced to make it easy to find all the relevant photos.
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Cutworm
Agrotis ipsilon

- Large brown moth, wingspan 40-50 mm.
- Body and forewings grey with brownish black markings.
- The hindwings are almost white basally, with a dark terminal fringe.

Photo: Devon, Flickr
Tomato hornworm
*Manduca quinquemacula*

- Large green caterpillars, 12 cm long, with eight white “V-shaped” marks on each side.
- A black projection or “horn” is present on the last abdominal segment.
- Caterpillars chew irregular holes and defoliate.

Photo: Whitney Cranshaw, Colorado State University, Bugwood.org
Fall armyworm (larvae)
*Spodoptera frugiperda*

- Young larvae have green bodies with black lines and spots and the head is black.
- Older larvae may turn dark brown and have longitudinal stripes; the head is brown with white stripes.
- Mature larvae are approximately 30 mm long.

Photo: Marina Young, Rural Agricultural Development Authority, Jamaica
Eggplant fruit borer

*Leucinodes orbonalis*

- Newly hatched caterpillars are 1 mm long with a dark brown or black head and a pale pink to off-white body.
- The final instar caterpillars have a pink body colour, with a pale brown to yellow head and pale brown spots on the body, and are about 18 mm long.

Photo: R Mally, A Korycinska, DJL Agassiz, J Hall, J Hodgetts, M Nuss, Wikimedia Commons
Wireworm (click beetle)  
*Conoderus* spp.

- Larvae have slender, cylindrical, jointed bodies and are relatively hard.
- Yellowish to brown and about 20 mm long.

Photo: Richmond Farm School, Flickr
Potato tuber moth

*Phthorimaea operculella*

- The larvae are caterpillars and have short prolegs along their body.
- When fully grown larvae are about 15 mm long.
- Head dark brown, body greyish-white or pale greenish-grey.
Cutworm

*Agrotis ipsilon*

- Large brown moth, wingspan 40-50 mm. Body and forewings grey with brownish black markings.
- The hindwings are almost white basally, with a dark terminal fringe.

Photo: A. Reago & C. McClarreen, Wikimedia Commons
Fall armyworm (adult)
*Spodoptera frugiperda*

- The adults are medium sized moths, body length is 17 mm and wingspan 38 mm. The forewing is mottled (dark brown, grey). Rear wings are plae straw colour with a dark brown line around the edge.

Photos: Mark Dreiling, Bugwood.org, Lyle Buss, University of Florida, Bugwood.org
Tomato hornworm
*Manduca quinquemaculata*

- Large grey-brown moth with wingspan 90-130 mm. The abdomen has five to six pairs of yellow bands.
- Upperside of forewing is brown and grey. Hindwing is banded with brown and white and has two median zigzag bands. Forewing fringes are greyish, spotted with white.
- Eggs laid singularly on the underside of leaves.

Photo: S. Swan-Scot, Flickr
Eggplant fruit borer  
*Leucinodes orbonalis*

- Adult moths are small, with a wingspan of about 20 mm.
- The base colour of the wings is a semi-transparent white, with pale brown and darker brown patterns.
- The moths are active at night and typically rest on the underside of foliage with their abdomens curled upwards.

Photo: T. Gilligan CSU, D Hobern, Flickr
Potato tuber moth
Phthorimaea operculella

- Small elongate moths, measuring about 10 mm long when at rest.
- Coloured pale brown with darker marbling.
- Wingspan 15-17 mm.

Photo: Wikimedia Commons
Whitefly
*Bemisia* spp.

- Small (1 mm long) insect with a whitish-yellow body and white powder covered wings.
- Winged adults are seen almost exclusively on the underside of the leaves and fly when disturbed.
- Adults lay eggs at random.

Photo: V. Welling, Flickr
Green leafhopper
*Empoasca* spp.

- Small (3.5 mm long), pale green, wedge-shaped insects with inconspicuous white markings on the head and thorax.
- Nymphs are also wedge-shaped, green and move rapidly backward and forward.

Photo: C. Quintin, Flickr
Green peach aphid
*Myzus persicae*

- Adults are an oval shape, 2-3 mm long, smaller than the potato aphid.
- The colour is variable depending upon the species and may be green, black, brown, pink or almost colourless.
- Infestation generally occurs on the lowest leaves.
- Winged forms can develop.

Photo: David Cappaert, Bugwood.org
Potato aphid
*Macrosiphum euphorbiae*

- Common aphid which can be green or pink.
- Feelers (antennae) are extremely long usually with dark tips.
- Black knees are characteristic as are red eyes.
- Infestation is often spread throughout the plant.
- Often young and adults are clustered tightly together.
- Winged forms can develop.

Photos: Kansas Department of Agriculture, Bugwood.org Joseph Berger, Bugwood.org
Thrips

*Thrips* spp.

- Very small (up to 2 mm long), slender insects with a pair of thin fringed wings held over their backs.
- Adult thrips vary from grey to yellow, brown to black. Nymphs are wingless pale-white to yellow.
Yellow tea mite
Polyphagotarsonemus latus

- Tiny pest (circled), <0.5 mm long, white, yellow or brown in colour, feed mainly on underside of leaves.

Photo: Nancy Gregory, University of Delaware, Bugwood.org
Mealybugs
Ferrisia virgata; Planococcus citri

• Females wingless, oval, flattened insects, 1–3 mm long.
• Body segmented, yellow, coated with white wax.
• Planococcus citri has a characteristic faint grey stripe down the back.
• Short waxy filaments can be seen around the margin of the body.

Photo: Charles Olsen, USDA APHIS PPQ, Bugwood.org
Mealybugs produce fluffy white wax that accumulates on leaves and other sheltered places on the plant; can resemble fungal growth.
Epilachna beetle
*Epilachna* spp.

- One of the few ladybird beetles that are pests.
- Adults are oval-shaped, yellow/orange with black spots on their backs.
- Larvae and adults chew irregular leaf sections, producing skeletonized appearance.

Photo: Alain C, Flickr
Bagrada bug (adult)
Bagrada spp.

- Adult bugs are 5-7 mm long, and have black, shield-shaped bodies with orange and white markings; gathers in masses.

Photo: J. Sullivan, Flickr
Bagrada bug (nymph)

*Bagrada* spp.

- First instar nymph has reddish-brown head and thorax and bright red abdomen.
- Later instars become darker, adding black bands and white dots to their bodies, and develop wing pads.
- Feeding damage; small puncture marks and white patches on leaves; scorched appearance and wilting.

Photo: B. Ralph Clark Park, Buena Park, CA
Colorado Beetle
*Leptinotarsa decemlineata*

- Adults are oval, about 10 mm long, yellowish-orange with multiple black stripes down the back (five per wing case cover).
- The head has a triangular black spot in the middle and the thorax has irregular dark markings.
- Chews large holes in leaves; defoliators.

Photo: C. J. Bakker, Flickr
Blister beetles
_Epicauta_ spp.

- Long, slender-bodies, 9-20 mm long, head wider than first thoracic segment. Good fliers.
- Body colour varies with species from solid grey to black with pale wing margins; can appear metallic, and may have yellowish stripes or spots.
- Feeding on leaves causes a ragged appearance and stunting.

Photo: Andrew C, Flickr
• Adults are golden coloured, about 5-6 mm long with clear wing margins that cover the body and extend over legs.
• Domed body, with somewhat flatter areas along the edges, resembling a safari hat.
• When disturbed they press close to the leaf, similar to a tortoise withdrawing into its shell.
• Feeding causes membranes and round holes on leaves.

Photo: leemt2, Flickr
Epilachna beetle
Epilachna spp

- Larvae are soft bodied, pale yellow and have branched spines covering their backs and sides.
- The last body segment has a sucker-like structure for attachment to feeding surfaces.
- Larvae and adults chew irregular leaf sections, producing skeletonised appearance.

Photo: Whitney Cranshaw, Colorado State University, Bugwood.org
Tortoise beetle

*Aspidomorpha* spp.

- Larvae are flattened, spiny insects with elongated moveable fork at the end of the body, used to deposit skin and faeces on their back.
- Larvae feed on the underside of leaves by scraping the leaf surface leaving a see-through membrane.

Photo: B & M. Bell, Flickr
Colorado Beetle (larvae)
*Leptinotarsa decemlineata*

- Larvae are red, humpbacked and typically have two rows of black spots down the sides.
- Larvae have a terminal proleg at the tip of the abdomen as well as three pairs of thoracic legs.
- Chews large holes in leaves; defoliators.

Photo: D. Sipler, Flickr
Colorado Beetle (eggs)
*Leptinotarsa decemlineata*

- Eggs are bright orange and oval, 1.7-1.8 mm long and 0.8 mm wide.
- Eggs are deposited on the lower surface of leaves in clusters of 5-100.

Photo: D. Sipler, Flickr
Potato Virus X
PVX

- Reduced leaf size and crinkling; mild mottling or mosaic; severe infections can cause stunting of plants.
- Transmitted mechanically, e.g. foliar contact or on clothing, but in general not by insects.

Photo: P. Hamm, pnwhandbooks.org
Potato Leaf Roll Virus
PLRV

- Leaves rolled and curled upwards at edges; plants tend to be smaller than normal.
- Transmitted by aphids and through tubers used for seed.

Photo: The UK Potato Council
Fusarium and Verticillium wilt

*Fusarium, Verticillium* spp.

- Wilting, which may be more obvious on one side of the plant.
- Stunting; wilting of lower leaves.

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org
Black leg

*Pectobacterium carotovorum*

- Early foliage stunted and yellow.
- Water soaked lesions at base of stem.

Photo: M. Willis, marksvegplot.co.uk
Herbicide damage

- Distorted leaves; weak shoot development.

Photo: www.paddocks-allotments.org.uk
Green leafhopper damage

*Empoasca* spp.

- Yellow leaf veins; yellow then brown leaf margins; leaf curl; entire leaf death (damage known as hopper burn).
- The damage can resemble virus symptoms.

Photo: Umass Amherst
Whitefly damage
*Bemisia* spp.

- Yellow, curled leaves.
- Presence of nymphs and adults on plants is diagnostic.

Photo: www.allotment-garden.org
Yellow tea mite damage
*Polyphagotarsonemus latus*

- Scarring and twisting of the leaves and stems.
- Initial damage can appear as darkened, greasy areas that later turn brown and corky.

Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org
Cutworm damage
*Agrotis ipsilon*

- Chewed leaves which occur over night as these soil-living caterpillars are mostly active at night.

Photo: D. Sipler, Flickr
Epilachna beetle damage

*Epilachna* spp.

- Chewed, irregular leaf sections, producing skeletonised appearance.
- The leaf may be scraped away leaving a thin brown skin over the hole.

Photo: Learmonth Govn. W. Australia
Potato Virus X
PVX

- Reduced leaf size and crinkling; mild mottling or mosaic; severe infections can cause dwarfing of plants.
- Transmitted mechanically, e.g. foliar contact, but in general not by insects.

Photo: www.donsgarden.co.uk
Herbicide damage

- Yellowed areas of leaves often with weak shoot development and general poor growth.

Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org
Symptoms vary with strain, from a mild mosaic to plant death.

Transmitted mechanically to a small extent but mostly spread by aphids.
Heat damage
Abiotic stress

- Leaves with light green patches; affected areas may dry out, becoming thin and paper-like.
- Leaves that are in full sun most likely to be affected.

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org
Potato Virus Y
PVY

- Small distorted leaves develop (left).
- Symptoms vary with strain, can cause severe necrosis and plant death.
- Transmitted mechanically to a small extent but mostly spread by aphids.

Photo: P. Taylor, CABI
Bacterial wilt
*Ralstonia solanacearum*

- Common symptoms include: wilting, yellowing or bronzing of leaves, leaf browning, stunting and stem collapse.
- Sometimes the wilt is rapid and the plant initially does not turn yellow.
Fusarium and Verticillium wilt

*Fusarium, Verticillium* spp.

- Upward leaf curl; necrosis and drying of leaves, which will remain on the plant.
- The disease progresses from the lower leaves up the plant, with usually the uppermost leaves the last to show symptoms.
Tomato Spotted Wilt Virus
TSWV

- Irregular brown spots, first seen on young leaves.
- The spots can be necrotic rings with a central green area or solid necrotic spots with a target appearance, similar to early blight although the spots are smaller and clustered.
- Stem necrosis followed by stunting of plant will occur later.
- Transmitted by thrips.

Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org
Late blight
Phytophthora infestans

- Initially small black/brown lesions, irregular in shape, surrounded by collapsed green tissue.
- Disease progresses quickly and lesions rapidly expand to cover large areas of the leaf.
- In humid conditions sporulation results in a visible white growth at edge of lesions on the lower surfaces of leaves.

Photo: R. Reeder, CABI
Early blight
 Alternaria solani

- Dark, slightly sunken leaf spots, with yellow borders.
- Spots first develop on lower leaves and spread up the plant.

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org
Early blight
*Alternaria solani*

- Dark, slightly sunken leaf spots yellow borders.
- Develop first on older leaves.
- The lesions become angular (vein limited) with age and have concentric rings or ‘bullseye’ appearance (image above) with raised and depressed necrotic tissue; no fruiting bodies.

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org
Septoria leaf spot
*Septoria lycopersici*

- Brown, round/oval lesions up to 12 mm across; spots join to form large necrotic areas.
- Concentric rings can develop within the lesions and finny black dots (fruiting bodies) seen in lesions.
- Leaves become brittle, deformed and may drop from plant.

Photo: M. McGrath Cornell University, Bugwood.org
Septoria leaf spot

*Septoria lycopersici*

- Black dots (fungal fruiting bodies) can be seen with a hand lens.
- It is these visible fruiting bodies that distinguishes this disease from Early blight.

Photo: Bruce Watt, University of Maine, Bugwood.org
Common rust
*Puccinia pittieriana*

- Lesions are initially tiny, green-white, on underside of leaves.
- Lesions grow to 3–4 mm diameter, going from cream coloured with red centre, to tomato-red, rusty-red then coffee-brown.
- Lesions become raised, sometimes with chlorotic or necrotic halo; corresponding depressions on upper side of the leaves.
- Leaves will fall when hundreds of lesions form on a leaf.
Frost/cold damage
Abiotic stress

- Leaves become water soaked and dark green very suddenly.
- They do not recover will remain wilted and gradually rot.

Photo: M. Garrett, www.ossettweather.co.uk
Powdery mildew  
_Golovinomyces orontii_

- Greyish brown patches develop on leaves and stems with little surface growth of fungus, however white powdery patches can develop on leaves in humid weather.
- Yellowing of lower leaves followed by necrosis and leaf fall.

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org
Sooty mould
Sooty mould

- Black/brown velvety coating on leaves.
- Grows on insect honeydew.

Photo: S. Wilson Bluejaybarrens, Flickr
Potato wart
*Synchytrium endobioticum*

- Tumour-like outgrowths (or galls) on tubers; vary in shape but are generally warty spherical outgrowths 10-80 mm or more in diameter.
- Below-ground galls are white to brown/black.
- Tubers can be disfigured or completely replaced by galls.
Common scab
*Streptomyces scabies*

- Damage limited to tubers; circular to irregular shaped lesions on skin of tuber that may join to form large irregular areas.
- The lesions may be raised or have minor to deep pitting, rough in texture and tan to dark brown in colour.

Photo: Wikimedia Commons
Silver Scurf
*Helminthosporium solani*

- Only below-ground symptoms; small silvery grey spots, enlarging into circles with darker margins.
- The circles increase in size, and merge together, forming a pattern of overlapping discs.
- With a hand lens tiny, short, black threads may be visible.
Powdery scab
*Spongospora subterranea*

- Only below-ground symptoms; raised, wartlike, (not corky) lesions that gradually become darker with age.
- Mature lesions become shallow depressions surrounded by raised torn edges of skin, which contain olive brown to black powdery spore masses (seen with hand lens).
- Potatoes dry and shrivel in storage.

Photo: Sandra Jensen, Cornell University, Bugwood.org
Root Knot nematode damage
*Meloidogyne* spp

- Root and tuber galls, can be wart-like swellings.

Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org
Black dot
*Colletotrichum coccodes*

- Brown, slightly depressed lesions on the tuber surface, with poorly defined margins.
- Small black dots (microsclerotia) can be observed in the centre of lesions using a hand lens.

Photo: S. Nelson, Flickr
Early blight
*Alternaria solani*

- Dark irregular, slightly sunken lesions can develop on the tuber surface, sometimes with raised purplish border.
- Internally a dry dark brown rot develops, which is generally much shallower than that of late blight.
- Lesions are sharply divided from healthy tissue by a corky layer.
- However, tubers are not commonly attacked.

Photo: S. Jensen Cornell University, Bugwood.org
Bacterial wilt (Brown rot)
*Ralstonia solanacearum*

- Brownish-grey areas on the outside of tuber, especially near the point of attachment of the plant.
- Bacterial ooze often emerges from the eyes and stem end attachment of infected tubers. When the ooze dries, soil adheres to the tubers at the eyes.

Photo: Plant Protection Service, Plant Protection Service, Bugwood.org
Bacterial wilt (Brown rot)

*Ralstonia solanacearum*

- Cut tubers show pockets of white to brown pus or browning of the vascular tissue, forming a ring inside the tuber.
- Greyish white droplets of bacterial slime ooze out of the vascular ring when light pressure is applied to cross sections of infected tubers.

Photo: Plant Protection Service, Plant Protection Service, Bugwood.org
Black leg
*Pectobacterium carotovorum*

- Internally the infected tuber flesh appears cream coloured, then turns greyish and black with a mushy texture.
- Initially infected tubers have soft rot only in the pith region and are odourless. Later, secondary soft rot bacteria may take over producing a foul odour and a slimy texture.
Fusarium wilt

*Fusarium* spp.

- A variety of symptoms on tubers, including firm brown circular lesions on the tuber, sunken brown necrotic areas at the stem attachment and brown discoloration of the vascular tissues.

Photo: Bruce Watt, University of Maine, Bugwood.org
Infected tubers can be small and distorted and show sunken, black necrotic spots, however they may have no symptoms.

Internally tubers may have hollow necrotic centres, dark shadowing and necrotic spots. These spots may appear as concentric rings and sometimes visible through the skin.
Potato Virus Y
PVY

- Symptoms vary with strain, from no symptom on tubers to brown necrotic rings that show through the skin.
- Transmitted mechanically and by aphids.

Photo: Bruce Watt, University of Maine, Bugwood.org
Late blight

*Phytophthora infestans*

- Patches of brown to purple discoloration on the skin, which become darker and sunken with time.
- Internally, a reddish brown, dry, firm rot develops that extends up to 15 mm into the tuber. The rot often spreads unevenly into the tuber.
Root Knot nematode damage
*Meloidogyne* spp.

- Tiny brown spots seen within the vascular ring of tuber. Using a hand lens the nematode’s white body and egg sac can be seen in the centre of the brown spot.
Wireworm damage (click beetle)
*Conoderus* spp.

- Shallow to deep holes visible on tuber, made by burrowing wireworms.
- These tunnels are characteristically straight, the wireworms don’t turn corners but eat right through in a straight line.

Photo: A. Jensen NW Potato Research, Bugwood.org
Slug damage
*Tandonia budapestensis* and many others

- Slugs attack developing tubers creating large cavities inside. Secondary rots may then develop.

Photo: P. Taylor, CABI
Potato tuber moth
*Phthorimaea operculella*

- The caterpillar will eat leaves and cause minor damage to the plant before moving down to the tubers and begin to eat their way through them.
- They do not eat deep into the centre of the potato but remain mostly within the outside 10 mm.
- Frass is often seen in at the entry and exit holes.
- They can do significant damage in stored potatoes.

Photo: P. Taylor, CABI
Eggplant fruit borer damage
*Leucinodes orbonalis*

- Small dark holes visible on tuber surface and tubers hollowed inside, with frass.
- Shoots may wilt.

Photo: A. Jensen NW Potato Research, Bugwood.org
Herbicide damage

• Multi sprouting tubers is just one symptom herbicide damage may take.

Photo: A. Robinson North Dakota State University, Bugwood.org
Black dot
*Colletotrichum coccodes*

- Stem lesions appear often at the base of leaf petioles.
- Lesions develop white to straw-coloured centres with wide margins that vary in colour from brown to black.
- Black dots of fungal tissue develop in centre of lesions, often clearly visible against a pale background.
- Microsclerotia often appear at the base of the plant late in the season and after the plant has died back.

Photo: www.ernaehrungswirtschaft.ch
Late blight
Phytophthora infestans

- On stems, late blight causes irregular brown lesions that look greasy.
- The lesions commonly occur at the junction of the leaf and stem where water accumulates.
- There is always a very clear boundary to the stem lesion and are of uniform colour.

Photo: S. Nelson, Flickr
Early blight
*Alternaria solani*

- Lesions on stems often sunken and elongated, with a light centre.
- Older lesions have the typical concentric rings.

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org
Charcoal rot
*Macrophomina phaseolina*

- Leaves rapidly wilt and turn yellow.
- Stems have a soft, dark rot, dusty black in colour due to many small, black fungal structures (microsclerotia). This symptom distinguishes charcoal rot from other stem rots.
- Shrunken dark areas around tuber eyes and stolon attachment.
- Infection can occur pre- and post-harvest.

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org
Common rust
*Puccinia pittieriana*

- Raised, yellow, elongated lesions (pustules) on leaves, stems and petioles.
- Later the pustules become cream with reddish centres that turn tomato-red and finally rusty-red to coffee-brown.

Photo: Talbot, Flickr
Fusarium wilt
*Fusarium* spp

- The roots and lower stems turn brown and start to decay.

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org
Powdery mildew
Golovinomyces orontii

- Brown lesions of various sizes on stems and petioles.
- Lesions coalesce to form short streaks or stippled areas and appear water-soaked.
- The white powdery coating typical of powdery mildews frequently does not develop on potatoes.

Photo: K. Merrifield, pnwhandbooks.org
Bacterial wilt (Brown rot)
*Ralstonia solanacearum*

- White, slimy mass of bacteria exudes from stem ends when broken or cut and placed in water.
- Streaky brown discoloration of the stem.

Photos: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org
Black leg
*Pectobacterium carotovorum*

- The lower part of the below ground stem becomes dark brown to black, water-soaked and extensively decayed.
- Early foliage stunted and yellow.

Photo: Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org
Fusarium wilt

*Fusarium* spp.

- Red-brown discoloration in the vascular system in the lower stems of the plant, most easily seen when the stem is sliced through at a shallow angle.
- Verticillium wilt also causes stem discolouration although this is usually a light brown colour.

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org
Cutworm damage

*Agrotis ipsilon*

- Most damage is on seedlings, larvae chew stem at soil line and plant falls over.

Photo: S. Smith, University of Minnesota, Bugwood.org
Cyst and Root Knot nematode damage

Globodera and Meloidogyne spp.

• Stunting, yellowing and wilting of plants and leaves.

Photo: C. Canale, www.rwandavillagemakeover.com
Black dot  
*Colletotrichum coccodes*

- Yellowing and wilting of plant.
- Rotting of roots.

Photo: R. Foster, www.evergreenbootsleavetrails.co.uk
The first symptom of these diseases is often the plant’s pale appearance.

The disease begins on the lower leaves and progresses up the plant.
Bagrada bug damage

Bagrada spp.

- Scorched appearance and general plant wilting.
- Initial damage to leaves is observed along the margins as stippling.

Photo: Rick Machado
Charcoal rot
*Macrophomina phaseolina*

- Leaves wilt and turn yellow, then necrotic.
- Small brown to black flecks can be seen on the foliage, bearing a resemblance to early blight.

Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org
Blister beetles

*Epicauta* spp.

- Feeding on leaves causes a ragged/tatty/dirty appearance and stunting.
- In extreme situations the plants will have all their leaves eaten.

Photo: Adhikari, Shalik ram  Plant Protection Directorate (PPD), Nepal
Cyst and Root Knot nematode damage

*Globodera* and *Meloidogyne* spp.

- Stunting, yellowing and wilting of plants.

Photo: Florida Dept. of Agriculture and Consumer Services
Potato Virus X
PVX

- Severe infections can cause stunting of plants.
- Transmitted mechanically, e.g. foliar contact, but in generally not by insects.

Photo: P. Hamm, pnw handbooks.org
Herbicide damage

• Stunted plants; weak shoot development.

Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org
Cyst and Root Knot nematode damage
*Globodera* and *Meloidogyne* spp.

- Patchy distribution of field damage.

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org
Cyst nematode signs
*Globodera* spp.

- Reduced root system, abnormally branched and brownish rather than a healthy white.
- Small, white-golden-brown spheres or cysts, about the size of a pin head (0.5 mm) can be seen on the outside of roots.

Photo: Bonsak Hammeraas, NIBIO - The Norwegian Institute of Bioeconomy Research, Bugwood.org
Galls on roots and tubers, can be tiny spheres, round humps or wart-like projections.
Root Knot nematode damage

*Meloidogyne* spp.

- Galls on roots and tubers, can be large swellings or wart-like projections.

Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org
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