



CABI PEST AND DISEASE PHOTOGUIDE TO

Potato disorders

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.

Contents

Sign or symptom	Box #
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Cutworm

Agrotis ipsilon



Photo: Devon, Flickr

- 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.

Tomato hornworm

Manduca quinque macula



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

- 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.

Fall armyworm (larvae)

Spodoptera frugiperda



Photo: Marina Young, Rural Agricultural Development Authority, Jamaica

- 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.

Eggplant fruit borer

Leucinodes orbonalis



Photo: R Mally, A Korycinska, DJL Agassiz, J Hall, J Hodgetts, M Nuss, Wikimedia Commons

- 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.

Wireworm (click beetle)

Conoderus spp.



Photo: Richmond Farm School, Flickr

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

Potato tuber moth

Phthorimaea operculella



Photo: P. Taylor, CABI

- 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



Photo: A. Reago & C. McClarreen, Wikimedia Commons

- 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.

Fall armyworm (adult)

Spodoptera frugiperda



Photos: Mark Dreiling, Bugwood.org, Lyle Buss, University of Florida, Bugwood.org

- 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 pale straw colour with a dark brown line around the edge.

Tomato hornworm

Manduca quinquemaculata



Photo: S. Swan-Scot, Flickr

- 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.

Eggplant fruit borer

Leucinodes orbonalis



Photo: T. Gilligan CSU, D Hobern, Flickr

- 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.

Potato tuber moth

Phthorimaea operculella



Photo: Wikimedia Commons

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

Whitefly

Bemisia spp.



Photo: V. Welling, Flickr

- 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.

Green leafhopper

Empoasca spp.



Photo: C. Quintin, Flickr

- 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.

Green peach aphid

Myzus persicae



Photo: David Cappaert, Bugwood.org

- 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.

Potato aphid

Macrosiphum euphorbiae



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

- 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.

Thrips

Thrips spp.



Photo: J.Christopherson, Flickr

- 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



Photo: Nancy Gregory, University of Delaware, Bugwood.org

- Tiny pest (circled), <math><0.5\text{ mm}</math> long, white, yellow or brown in colour, feed mainly on underside of leaves.

Mealybugs

Ferrisia virgata; *Planococcus citri*



Photo: Charles Olsen, USDA APHIS PPQ, Bugwood.org

- 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.

Fluffy white wax of mealybugs

Ferrisia virgata; *Planococcus citri*



Photo: Whitney Cranshaw, Colorado State University, 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.



Photo: Alain C, Flickr

- 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.

Bagrada bug (adult)

Bagrada spp.



Photo: J. Sullivan, Flickr

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

Bagrada bug (nymph)

Bagrada spp.



Photo: B. Ralph Clark Park, Buena Park, CA

- 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.

Colorado Beetle

Leptinotarsa decemlineata



Photo: C. J. Bakker, Flickr

- 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.

Blister beetles

Epicauta spp.



Photo: Andrew C, Flickr

- 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.

Tortoise beetle

Aspidomorpha spp.



Photo: leemt2, 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.

Epilachna beetle

Epilachna spp



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

- 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.

Tortoise beetle

Aspidomorpha spp.



Photo: B & M. Bell, Flickr

- 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.

Colorado Beetle (larvae)

Leptinotarsa decemlineata



Photo: D. Sipler, Flickr

- 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.

Colorado Beetle (eggs)

Leptinotarsa decemlineata



Photo: D. Sipler, Flickr

- 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.

Potato Virus X

PVX



Photo: P. Hamm, pnwhandbooks.org

- 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.

Potato Leaf Roll Virus

PLRV



Photo: The UK Potato Council

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

Fusarium and Verticillium wilt

Fusarium, Verticillium spp.



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

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

Black leg

Pectobacterium carotovorum



Photo: M. Willis, marksvegplot.co.uk

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

Herbicide damage

Herbicide damage



Photo: www.paddocks-allotments.org.uk

- Distorted leaves; weak shoot development.

Green leafhopper damage

Empoasca spp.



Photo: Umass Amherst

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

Whitefly damage

Bemisia spp.



Photo: www.allotment-garden.org

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

Yellow tea mite damage

Polyphagotarsonemus latus



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

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

Cutworm damage

Agrotis ipsilon



Photo: D. Sipler, Flickr

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

Epilachna beetle damage

Epilachna spp.



Photo: Learmonth Govn. W. Australia

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

Potato Virus X

PVX



Photo: www.donsgarden.co.uk

- 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.

Herbicide damage

Herbicide damage



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

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

Potato Virus Y

PVY



Photo: R.J. Reynolds Tobacco Company Slide Set, R.J. Reynolds Tobacco Company, 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



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

- 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.

Potato Virus Y

PVY



Photo: P. Taylor, CABI

- 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.

Bacterial wilt

Ralstonia solanacearum



Photo: P. Taylor, CABI

- 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.



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

- 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



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

- 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.

Late blight

Phytophthora infestans



Photo: R. Reeder, CABI

- 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.

Early blight

Alternaria solani



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

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

Early blight

Alternaria solani



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

- 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.

Septoria leaf spot

Septoria lycopersici



Photo: M. McGrath Cornell University, Bugwood.org

- 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.

Septoria leaf spot

Septoria lycopersici



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

- 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.

Common rust

Puccinia pittieriana



Photo: M. Talbot, Flickr

- 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



Photo: M. Garrett, www.ossettweather.co.uk

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

Powdery mildew

Golovinomyces orontii



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

- 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.

Sooty mould

Sooty mould



Photo: S. Wilson Bluejaybarrens, Flickr

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

Potato wart

Synchytrium endobioticum



Photo: Wikimedia Commons

- 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

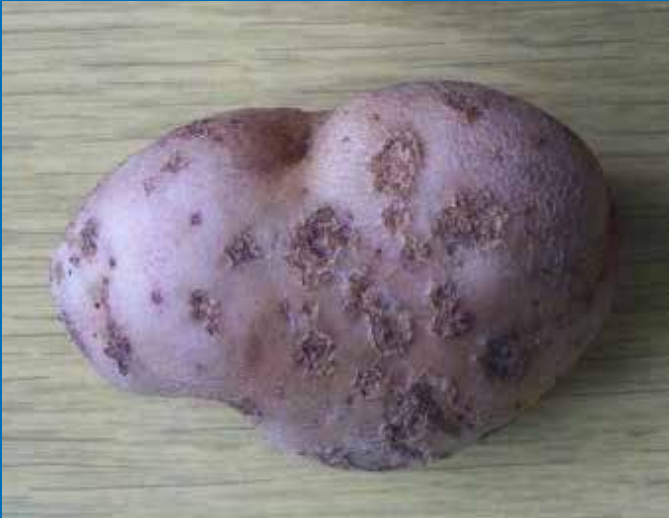


Photo: Wikimedia Commons

- 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.

Silver Scurf

Helminthosporium solani



Photo: SASA

- 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



Photo: Sandra Jensen, Cornell University, Bugwood.org

- 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.

Root Knot nematode damage

Meloidogyne spp



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

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

Black dot

Colletotrichum coccodes



Photo: S. Nelson, Flickr

- 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.

Early blight

Alternaria solani



Photo: S. Jensen Cornell University, Bugwood.org

- 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.

Bacterial wilt (Brown rot)

Ralstonia solanacearum



Photo: Plant Protection Service , Plant Protection Service, Bugwood.org

- 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.

Bacterial wilt (Brown rot)

Ralstonia solanacearum



Photo: Plant Protection Service, Plant Protection Service, Bugwood.org

- 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.

Black leg

Pectobacterium carotovorum



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

- 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.



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

- 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.

Tomato Spotted Wilt Virus

TSWV



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



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

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

Late blight

Phytophthora infestans

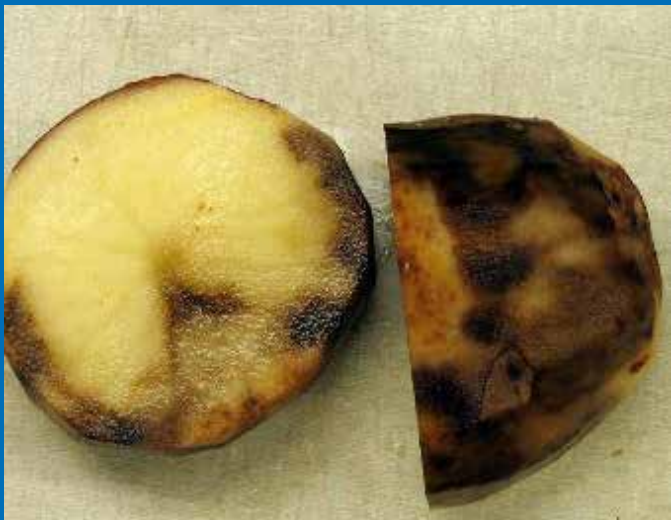


Photo: B. Millet, Flickr

- 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.



Photo: DAFF Archive, Bugwood.org

- 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.



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

- 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.

Slug damage

Tandonia budapestensis and many others



Photo: P. Taylor, CABI

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

Potato tuber moth

Phthorimaea operculella



Photo: P. Taylor, CABI

- 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.

Eggplant fruit borer damage

Leucinodes orbonalis



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

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

Herbicide damage

Herbicide damage



Photo: A. Robinson North Dakota State University, Bugwood.org

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

Black dot

Colletotrichum coccodes



Photo: www.ernaehrungswirtschaft.ch

- 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.

Late blight

Phytophthora infestans



Photo: S. Nelson, Flickr

- 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.

Early blight

Alternaria solani



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

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

Charcoal rot

Macrophomina phaseolina



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

- 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.

Common rust

Puccinia pittieriana



Photo: Talbot, Flickr

- 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.

Fusarium wilt

Fusarium spp



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

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

Powdery mildew

Golovinomyces orontii



Photo: K. Merrifield, pnwhandbooks.org

- 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.

Bacterial wilt (Brown rot)

Ralstonia solanacearum



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

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

Black leg

Pectobacterium carotovorum



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

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

Fusarium wilt

Fusarium spp.



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

- 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 discoloration although this is usually a light brown colour.

Cutworm damage

Agrotis ipsilon



Photo: S. Smith, University of Minnesota, Bugwood.org

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

Cyst and Root Knot nematode damage

Globodera and Meloidogyne spp.



Photo: C. Canale, www.rwandavillagemakeover.com

- Stunting, yellowing and wilting of plants and leaves.

Black dot

Colletotrichum coccodes



Photo: R. Foster, www.evergreenbootsleavetrails.co.uk

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

Fusarium and Verticillium wilt

Fusarium, Verticillium spp.



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

- 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.



Photo: Rick Machado

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

Charcoal rot

Macrophomina phaseolina



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

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

Blister beetles

Epicauta spp.



Photo: Adhikari, Shalik ram Plant Protection Directorate (PPD), Nepal

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

Cyst and Root Knot nematode damage

Globodera and *Meloidogyne* spp.



Photo: Florida Dept. of Agriculture and Consumer Services

- Stunting, yellowing and wilting of plants.

Potato Virus X

PVX



Photo: P. Hamm, pnw handbooks.org

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

Herbicide damage

Herbicide damage



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

- Stunted plants; weak shoot development.

Cyst and Root Knot nematode damage

Globodera and *Meloidogyne* spp.



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

- Patchy distribution of field damage.

Cyst nematode signs

Globodera spp.



Photo: Bonsak Hammeraas, NIBIO - The Norwegian Institute of Bioeconomy Research, Bugwood.org

- 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.

Root Knot nematode damage

Meloidogyne spp.



Photo: Clemson University USDA, Bugwood.org

- Galls on roots and tubers, can be tiny spheres, round humps or wart-like projections.

Root Knot nematode damage

Meloidogyne spp.



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

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

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