



Pests, diseases and disorders of babyleaf vegetables

A FIELD IDENTIFICATION GUIDE

Jenny Ekman, Len Tesoriero and Stuart Grigg

Second Edition published March 2023
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National Library of Australia Cataloguing-in-Publication entry

Author: Jenny Ekman (AHR), Len Tesoriero, Stuart Grigg.
Title: Pests, diseases and disorders of babyleaf vegetables: a field identification guide
ISBN: ISBN: 978-0-9925251-8-7 (paperback)
Subjects: Babyleaf Vegetables—Diseases and Pests—Australia.
Dewey number: 635.5

This project has been funded by Hort Innovation, using the vegetable research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Guide produced by Applied Horticultural Research.

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This project has been funded by Hort Innovation using the vegetable research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

Acknowledgements

This project was made possible by funding from Hort Innovation using the national vegetable levy and matched funds from the Australian Government.

Production of the guide would not have been possible without the generous assistance of fellow researchers, agronomists, extension officers and interested amateur photographers who have allowed us to use photographs from their collections.

Special thanks are due to Sandra McDougall, Valerie Draper, Tony Napier and Lowan Turton, NSW DPI; Andy Ryland, IPMC; Ben Winter, Ag-Hort Consulting; Helena Whitman, VGA Vic; John Damicone, Oklahoma State University; Lindsey DuToit, Washington State University; Mike Tittley, AHR; Rob Dimsey, DEPI Vic.

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Pest icons



Beneficial



Damaging



Exotic



Pre-harvest



Post-harvest

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Insects

Aphid – brown sowthistle

Uroleucon sonchi

DESCRIPTION

Nymph: Solid yellow-green to pale brown.

Adult: Wingless adults are one of the largest aphids (3 to 4.5mm long), shiny and a distinctive dark reddish brown colour. Adults have pale legs with black joints and black antennae.

Reproduction is through females bearing live young.

DAMAGE

Sucks sap from lettuce leaves, causing them to become distorted, wilted and shrivelled. Whole plants may be severely damaged. Can transmit viruses and is a potential contamination issue.

MOST COMMON

Although most commonly found on sowthistle weeds, this aphid is also a major pest of lettuce. Removing potential hosts from around the crop is an important control measure.



Brown sowthistle aphids (O Long)



Brown sowthistle aphids (A Mihoric)

Aphid – cabbage

Brevicoryne brassicae

DESCRIPTION

Nymph: Young nymphs are bright green, but soon develop a waxy coating, giving them a grey, mealy appearance.

Adult: Wingless adults are also waxy, appearing similar to nymphs and up to 2.5mm long. Winged adults are greyish with black head and thorax.

Reproduction is through females bearing live young.

DAMAGE

Often form colonies on the youngest leaves, which become stunted and distorted. Can spread cauliflower mosaic virus to brassicas and is also a potential contamination issue.

MOST COMMON

Mainly a pest of leafy brassicas. Numbers tend to peak in spring and autumn.



Cabbage aphid winged adult (J Ekman)



Cabbage aphid feeding causing leaf distortion on young gai lan (J Ekman)

Aphid – currant lettuce

Nasonovia ribisnigri



DESCRIPTION

Nymph: Yellowish to light brown.

Adult: Wingless adults are greenish with brown markings and up to 3mm long. The dark markings are more distinct in winged females, which have blackish heads and leg joints.

Currant lettuce aphids tend to be scattered rather than forming dense colonies. They burrow deep into the rosette in loose leaf lettuce varieties, making them hard to detect.

DAMAGE

Can transmit cauliflower and cucumber mosaic viruses, but is primarily a contamination issue.

MOST COMMON

A major pest of lettuces at all times of year.



Currant lettuce aphid nymph (W Cranshaw CSU, Bugwood.org) and mature aphid with developing wing buds (S Ausmus)

Aphid – green peach

Myzus persicae



DESCRIPTION

Nymph: Varies from yellowish to green.

Adult: Wingless adults are pale yellow to green and around 2mm long. Winged adults have black heads with dark red eyes and patterned bodies. Females can produce up to 100 live offspring, completing a generation in only eight days.

DAMAGE

Causes leaf distortion through feeding, contaminates the product and potentially acts as a vector for many viruses.

MOST COMMON

Found during warmer months on a wide range of host plants.



Winged adult (S Bauer USDA ARS)



Green peach aphid adults and nymphs (J Ekman, S Grigg)

Aphid – sowthistle

Hyperomyzus lactucae



DESCRIPTION

Nymph: Solid yellow-green to pale brown.

Adult: Wingless adults are 2 to 3mm long, solid green with dark tips to their legs and antennae. The winged form is similar in size and colour, but with black patches on the head and abdomen.

Appears similar to currant lettuce aphid, but distinguished by the slightly club shaped siphunculi (tubes) on its abdomen.

Reproduction is through females bearing live young.

DAMAGE

Feeds on the undersides of lettuce leaves causing them to become curled and shrivelled. Sowthistle aphids spread lettuce necrotic yellows virus and are a potential contamination issue.

MOST COMMON

Primary hosts are sowthistle and rubus species; this aphid cannot breed on lettuce alone.



Sowthistle aphids (J Rorabaugh)

Cabbage centre grub

Hellula hydralis



DESCRIPTION

Egg: Oval, creamy, laid on young leaves or the soil surface.

Caterpillar: Chunky, cream coloured caterpillar up to 12mm long with indistinct reddish brown stripes.

Pupa: Brown, often formed within webbing on the plant.

Adult: Mottled brown moth, wings held in a flattened tent over body, around 12mm long.

DAMAGE

Caterpillars feed on new growth, producing webbing as well as frass. Leaves can be webbed together.

MOST COMMON

Usually a minor pest of brassicas during summer through to autumn in Queensland and New South Wales. High numbers occasionally occur in southern states during spring.



Adult moth (D Hobern) and larva (DNRE Victoria)

Cabbage white butterfly

Pieris rapae

DESCRIPTION

Egg: Laid singly, yellow to orange, bullet shaped.

Caterpillar: Velvety green with a thin yellow stripe on their sides and top. Mature caterpillars are approx 30mm long.

Pupa: Yellow green, ridged with prominent spines near the midpoint, attached to a leaf or stem.

Adult: Immediately recognisable white butterfly with one (male) or two (female) black spots on the forewing. Wings held folded upward at rest.

DAMAGE

Large, irregular chewing damage to leaves and leaf edges, dark green droppings on leaves and in leaf angles.

MOST COMMON

Warmer months. Caterpillars can attack all brassicas, including Asian leafy greens and rocket.



Cabbage white egg (J Ekman)



Cabbage white caterpillars and adult butterfly (J Ekman)

Cluster caterpillar / Tropical armyworm

Spodoptera litura

DESCRIPTION

Egg: Laid in large mass of creamy spheres usually covered with fluffy white hairs and scales.

Caterpillar: Initially greenish and feed as a group but separate as they mature. Caterpillars become dark grey to black with red, yellow and cream markings, reaching 50mm length. Tend to curl into a ball if disturbed.

Pupa: Reddish brown, found in the soil.

Adult: Wings held in a tent over back, patterned with brown, cream and grey.

DAMAGE

Caterpillars skeletonise leaves.



Newly emerged (A Ryland) and young caterpillar (K Law)



MOST COMMON

Spring-autumn in Queensland. Very wide host range, potentially affecting all babyleaf crops.



Emerging caterpillars (A Carmichael, QUT) and adult moth (D Hobern)



Mature caterpillar (J Ekman)

Cutworm

Agrotis spp.

DESCRIPTION

Egg: Ribbed, pearly white domes, generally laid in compact clusters on vegetation or moist soil.

Caterpillar: Plump, smooth grey caterpillars with a slightly greasy appearance. Grows up to 50mm long. Young larvae feed on vegetation near the ground, but as they grow they become nocturnal, hiding in the soil during the day and

emerging to feed at night.

Tend to curl into a ball if disturbed.

Pupa: Dark reddish brown, found in the soil.

Adult: Wings held flat over back, patterned with brown, cream and grey. The bogong moth is a type of cutworm.



Active (FT Gort Flickriver) and disturbed (SARDI (inset)) caterpillars



DAMAGE

Caterpillars cut off seedlings at soil level, usually during the night. Plants may be dragged under the soil to feed on during the day.

MOST COMMON

Prefers warm conditions (25 to 30°C) with high humidity. Damage is most likely during spring, especially in areas newly converted to cropping.



Adult moth (NSW DPI) and cutworm damage to chard (C Longacre)



Damsel bug

Nabis spp.



DESCRIPTION

Egg: Whitish, oval eggs laid into plant tissues.

Nymph: Similar to adults except smaller and lacking wings.

Adult: Slender, light tan bug 8 to 12mm long with long, prominent sucking mouthpart for feeding. Long legs, of which the front two are stronger for grasping prey.

BENEFIT

Damsel bug nymphs and adults are extremely aggressive predators on other insects, including aphids, leafhoppers and various caterpillar species.

MOST COMMON

Can occur at any time of year.



Damsel bug adult (J Ekman)

Diamondback moth

Plutella xylostella

DESCRIPTION

Egg: Pale yellow, oval eggs are laid in clumps on leaves and stems.

Caterpillar: Initially colourless, developing to bright yellowish green. Tend to drop from the plant if disturbed. Mature at 10 to 12mm long.

Pupa: Silvery mesh cocoon attached to the leaf or stem.

Adult: Slender, brown wings held in a tent over its body.

Central light brown stripe along the back edges of the wings incorporates three 'diamond' shapes.

DAMAGE

As they grow, caterpillars progress from mining the insides of leaves to making numerous small feeding holes or 'windows' (leaving the upper leaf surface intact). Mature caterpillars leave large holes, especially between leaf veins.



Feeding windows and holes in kale seedling (J Ekman)



MOST COMMON

Major pest of brassica crops such as Asian leafy greens, rocket and kale. Numbers increase from spring in South Australia, summer in Victoria and autumn in Queensland. Can survive over winter in Queensland if temperatures are mild. Eggs don't hatch below 8°C while temperatures over 35°C reduce insect survival.

Frequently resistant to common insecticides.



Caterpillar (R Ottens Uni Georgia, Bugwood.org), *pupa* (W Cranshaw Colorado SU, Bugwood.org) and *adult moth* (D Griffiths)

Fall armyworm

Spodoptera frugiperda



DESCRIPTION

Egg: Large, clustered masses of up to 200 pale yellow to grey eggs, usually laid on leaf undersides and covered with a layer of hairs.

Caterpillar: Initially light green to brown with a dark head capsule, they become darker as they mature, becoming striped in brown and grey. Fall armyworms have a characteristic pale, upside down Y-shaped marking on the head and four dark spots arranged in a square on the second last body segment.

Adult: Nocturnal, speckled brown moth 3 to 4cm across with wings held flat across the body. Cream hindwings.

DAMAGE

Although lettuce and brassicas are not preferred hosts, damage can occur. Caterpillars chew on leaves and stems, leaving ragged holes. Fall armyworm is resistant to many insecticides, including synthetic pyrethroids.

MOST COMMON

Generally prefers tropical to subtropical climates, so can occur year round in northern areas and late summer to autumn in the south.



Mature fall armyworm larva (FAO), circles indicate the four distinctive dark spots on the 2nd last segment and light inverted 'Y' on head. Female (L) and male (R) moths (Plant Health Australia)

Flea beetle

Tribe Alticini



DESCRIPTION

Egg: White to oval, laid in the soil.

Larva: White grubs with brown heads which live in the soil.

Adult: Small, shiny beetle with enlarged hind legs, allowing them to jump like fleas. The small striped flea beetle is black with yellow stripes along its wing covers, whereas other species are metallic blue to black.

DAMAGE

Adults feed on the plant leaves, causing small round pits or holes, while larvae feed on the plant roots.

MOST COMMON

Occasional spring-summer pest, particularly to Asian leafy products, rocket and spinach.



Metallic flea beetle Altica spp. (top) (R Reiner), *flea beetle on rocket* (Ontario MAF) and *small striped flea beetle (right)* (K McCloughan)

Fungus gnats

Bradysia spp.



DESCRIPTION

Egg: Tiny, laid in soil.

Larva: Clear to white maggots with a small black head, 5 to 8mm long. Leaves a trail of slime as it travels across the soil.

Adult: Tiny black flies 2 to 3mm long with a single pair of clear or smoky wings, long antennae and long, slender legs.

DAMAGE

Larvae live near the soil surface where they feed on seedling roots and stems. They can also potentially act as vectors for fungal diseases, especially those affecting seedlings.

MOST COMMON

Prefer damp conditions where there are high levels of organic matter and/or nutrients. More commonly a pest of greenhouses than field crops.



Fungus gnat larva (JK Clark) and adult (A Broadley DAFF)

Green mirid

Creontiades dilutus



DESCRIPTION

Egg: Single eggs are inserted into the leaves, with the tops projecting from the surface.

Nymph: Pale green, pear shaped nymph. Antennae have reddish brown tips.

Adult: Pale green bug approximately 7mm long with clear wings folded flat over its back. Antennae nearly as long as the body. Agile bug, sometimes with red markings.

DAMAGE

During feeding adults and nymphs inject digestive enzymes into plants, which can kill growing points. Mainly a contamination issue in babyleaf products.

MOST COMMON

Summer months.



Nymph (M Khan QDAF) and *adult green mirid* (J Neichler)

Green vegetable bug

Nezara viridula



DESCRIPTION

Egg: Neat rafts of barrel shaped, creamy eggs are laid on leaf undersides, turning golden as they mature.

Nymph: Initially orange-red, then turning green with bright red, black and white patterning. Tend to aggregate together.

Adult: Green, shield shaped bug around 15mm long.

DAMAGE

Young shoots are damaged by sap sucking. Usually a minor pest but adults can be hard to see, making them a potential contamination issue.

MOST COMMON

Spring-summer on a wide range of host plants.



Nymph (L Turton NSW DPI) and *adult bug* (S McDougall NSW DPI)

Ground beetle

Carabidae spp.



DESCRIPTION

Egg: Laid in clusters in moist soil debris.

Larva: Segmented grub with relatively large head and obvious jaws for attacking prey.

Adult: Flattened black beetle 8 to 12mm long with ridged wing covers. They are fast runners and rarely fly.

BENEFIT

Larvae and adult beetles are predatory on insects, caterpillars, slugs, snails and other pests. They usually forage in soil litter, or close to the ground.

MOST COMMON

Year round.



Ground beetle (J Ekman)

Heliothis/Native budworm

Helicoverpa armigera, *H. punctigera*

DESCRIPTION

Egg: Laid singly. Ribbed, white domes 1mm diameter, darkening before hatching.

Caterpillar: Initially light brown they darken and develop distinct stripes as they mature. Colour is highly variable, ranging from dark grey to brown or greenish. Caterpillars grow up to 50mm long.

Pupa: Brown, usually just under the soil surface. Rain stimulates emergence.

Adult: Stout moth with green eyes and lightly patterned brown wings, hind wings pale brown with dark edges.

DAMAGE

Caterpillar feeding creates large, ragged holes. Larvae tend to hide under leaves and in the central part of the plant, where they can damage the apical bud. On lettuce they prefer the leaf midribs, where they cause extensive damage, as well as leaving behind large amounts of gummy brown frass.

MOST COMMON

Warm weather. Commonly found on lettuce, more rarely on brassicas and spinach.



Heliothis eggs (S Grigg) and adult moth (J Ekman)



Heliopsis caterpillar, and feeding damage to lettuce (J Ekman)

Hoverfly

Syrphidae spp.



DESCRIPTION

Egg: Oval white eggs usually laid near aphid colonies.

Larva: Cream coloured maggot with stripe on upper surface and dark mouth hooks, up to 10mm long.

Adult: Resembles a bee or wasp with black and yellow bands across a rather flattened abdomen, but actually harmless. Often hovers near plants, feeding on nectar and pollen.

BENEFIT

Larvae are voracious predators of aphids. Adult hoverflies are also effective pollinators.

MOST COMMON

Warm weather, especially summer.



Hoverfly larva (A Ryland) *and adult* (J Ekman)

Lacewing – brown

Micromus tasmaniae



DESCRIPTION

Egg: Oval cream eggs laid singly on leaves.

Nymph: Slender brown larva up to 10mm long with smallish head but large, sickle shaped jaws and long tail.

Adult: Delicate brown insect up to 8mm long with large, finely veined wings held upright along it's body. Large, round, greenish eyes and long antennae. Smaller than green lacewing.

BENEFIT

Adults and larvae are voracious predators of aphids, small caterpillars, thrips and mites.

However, adults can be a contamination issue on leafy greens, as their large wings can easily stick to wet leaves.

MOST COMMON

Year round.



Brown lacewing larva (S Grigg) and adult (J Ekman)

Lacewing – green

Mallada signatus



DESCRIPTION

Egg: Whitish eggs laid on long, thin stalks, either singly or in rough groups.

Nymph: Thick bodied, up to 8mm long light brown larva which camouflages itself with the remains of its prey.

Adult: Slender, delicate pale green insect 12 to 15mm long with transparent, finely veined wings held upright along the body. Large, round red eyes and long antennae.

BENEFIT

Adults and nymphs are voracious predators of aphids, small caterpillars, thrips and mites.

MOST COMMON

Year round.



Green lacewing larva with thrips at right (J Ekman)



Adult green lacewing (J Ekman)

Ladybird – fungus eating

Illeis gálbula



Neither **pest** nor beneficial

DESCRIPTION

Larva: Grey and yellow with black dots and reptilian appearance, up to 6mm long.

Adult: Bright yellow with black markings, fast moving and active during the day.



DAMAGE

None: Nymphs and adults feed primarily on powdery mildew fungus. Other fungal species and pollen may also be eaten. Can be an early indicator of pathogen infection.

MOST COMMON

Late spring to autumn.



Fungus eating ladybird larva and adult (J Ekman)

Ladybird – predatory

Coccinella transversa, *Hippodamia variegata*, *Diomus notescens*

DESCRIPTION

Egg: Upright yellow eggs, laid in small clusters.

Larva: Black with coloured markings and 'crocodile like' appearance, up to 6mm long.

Adult: Brightly coloured, dome shaped beetles with distinctive spots and stripes on their outer wing covers.

BENEFIT

Both adults and larvae are active predators of aphids, thrips, moth eggs and mites.

MOST COMMON

Late spring to autumn.



Minute two spotted ladybird (L) and Transverse ladybird (R) (J Ekman)



Transverse ladybird larvae attacking an aphid (F Arcaro) (top) and white collared ladybird (J Ekman)

Leafhopper / Jassid

Austroasca viridigrisea



DESCRIPTION

Egg: Tiny and laid under the leaf surface.

Nymph: Similar to the adult but wingless. Habit of moving sideways when disturbed.

Adult: Look like tiny cicadas; torpedo shaped, ranging in colour from yellowish to green and mottled brown. Jump away quickly if disturbed. Tend to feed on the undersides of leaves of a wide range of host plants.

DAMAGE

All lifestages suck plant sap, reducing vigour and leaving whitish patches on the tops of leaves. Do not confuse with thrips damage on the underside of leaves

MOST COMMON

Warmer months, only occasionally a major pest.



Leafhopper (Colorado State Uni) and feeding damage on rocket (S Grigg)

Leaf miner – brassica

Liriomyza brassicae



DESCRIPTION

Egg: Small, round white eggs laid singly into the leaf underside.

Larva: White to creamy yellow maggots up to 3mm long. Mature larvae drop to the soil to pupate.

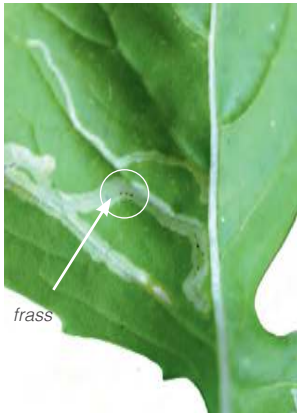
Adult: Small grey or black fly about 3 to 4mm long.

DAMAGE

Females may puncture leaves multiple times before laying an egg, causing leaf spots. Developing larvae make increasingly obvious feeding tunnels inside the leaves, depositing dark particles of frass.

MOST COMMON

A major pest of brassicas including leafy Asian greens and rocket, especially during early spring. Several species of parasitoid wasp attack this leaf miner.



Leaf miner feeding tunnels on rocket (J Ekman) and an adult fly.

Leaf miner – chrysanthemum

Chromatomyia syngenesiae



DESCRIPTION

Egg: Small eggs laid singly into or on leaf tissue.

Larva: Cream to yellow maggots up to 5mm long. Pupates shallowly inside the leaf underside.

Adult: Small grey and black fly about 3 to 4mm long.

DAMAGE

The larvae form a narrow, linear mine tending to either the upper or lower leaf surface, making them unmarketable.

MOST COMMON

Commonly feeds on sowthistle and related garden plants (nasturtium, chrysanthemum etc), only an occasional pest on lettuce. Usually controlled naturally by parasitoid wasps.



Cineraria leaf miner feeding tunnels on sowthistle (A Ibrahim) and (inset) lettuce.

Leaf miner – serpentine

Liriomyza huidobrensis, *Liriomyza trifolii*



DESCRIPTION

Larva: Initially transparent, becoming yellow to orange as they grow. Mature larvae are about 3mm long and usually drop to the soil to pupate.

Adult: Tiny (up to 2.5mm long) black fly with yellow markings on the head and body.

DAMAGE

Irregular leaf mines are created as larvae burrow through the leaf tissue. These reduce plant growth and affect marketability. Adults can cause significant feeding

damage if numbers build too high. In severe cases the plant may die.

MOST COMMON

First identified in 2020, serpentine leafminer (sometimes called potato leafminer) has become a major pest due to its wide host range and resistance to many pesticides. Adult flies are not strong flyers, so spread occurs mainly by moving infected plant materials. Prefers warm to mild, coastal climates, spreading inland with adequate moisture.



Serpentine leafminer damage, note adult fly also on leaf (S Jelinek); close up showing leaf mine and mature larva (T Klejdysz)

Leaf miner – spinach

Liriomyza chenopodii

DESCRIPTION

Egg: Small, white, cylindrical eggs laid into the leaf tissue.

Larva: Cream to yellow maggots up to 3mm long. Mature larvae drop to the soil to pupate.

Adult: Small black and yellow fly about 2mm long.

MOST COMMON

A major pest of spinach and chards. Most common in spring and early autumn in southern Australia. Several species of parasitoid wasp attack this leaf miner.

DAMAGE

Females may puncture leaves multiple times before laying an egg, causing leaf spots. Developing larvae make irregular feeding tunnels inside the leaves, making leaves unmarketable.



Leaf miner egg lay into spinach (S Grigg) and feeding tunnels (D Holland)



Looper

Chrysodeixis spp.



DESCRIPTION

Egg: Ribbed, flattened domes laid singly on leaf undersides.

Caterpillar: Light to dark green, lightly striped and slender caterpillars which move with a distinct looping motion.

Mature larvae are up to 40mm long and feed openly on a wide range of host plants.

Pupa: Dark brown, attached to the plant.

Adult: Stout moth with feathery crest on the thorax and richly patterned wings held in a tent over its body.

DAMAGE

Holes in leaves; leaves can be skeletonised.

MOST COMMON

Summer-autumn.

Australian cabbage looper moth
(J Crosbie)



Green garden looper caterpillar (J Ekman)

Lucerne leafroller

Merophyas divulsana



DESCRIPTION

Egg: Flattened, yellow, laid in small clusters.

Caterpillar: Light grey-green to brown, up to 12mm long. Caterpillar wriggles backwards if ejected from its leaf tunnel.

Adult: Light tan (female) or tan with brown markings (male) moth up to 10mm long.

DAMAGE

Caterpillars roll leaves up with webbing, then feed from inside.

MOST COMMON

Mainly a pest of lettuce in South East Queensland, most common during late summer-autumn.



Leafroller caterpillar (NSW DPI) and adult male moth (L Craggs)

Mite – blue oat

Penthaleus spp.



DESCRIPTION

Egg: Round, laid singly or in clusters of three to six on the soil surface and on roots and stems of food plants.

Nymph: Initially pinkish orange and 0.3mm long, darkens as it matures.

Adult: Bluish black with eight bright red legs and distinctive red mark on the back. Moves quickly if disturbed.

DAMAGE

Active during cooler part of the day when the mites leave the soil to feed on young leaves and shoots. Feeding damages the leaf surface, causing large whitish patches.

MOST COMMON

Widespread from Tasmania to southern Queensland during the cool, wet part of the year. Resting eggs are laid when daily maximums exceed 20°C. These hatch only after high temperatures are followed by cool weather and rain.



Blue oat mites and damage (Vic DPI) *and adult mite* (B Bell)

Mite – clover

Bryobia spp.



DESCRIPTION

Egg: Round, red, laid singly or in small groups.

Nymph: Bright orange to red, initially with only six legs but developing eight in later instars.

Adult: Dark greyish orange or olive green, eight orange-red legs of which the front two are much longer than the others.

DAMAGE

Tends to feed mainly on the upper leaf surfaces, causing distortion and scarring of young leaves.

MOST COMMON

Found on spinach and brassica crops. Most active during warm periods but can be found at any time of year.



Clover mite (*A. Orion*) and mite damage on spinach leaves (S Grigg)

Mite – predatory

Phytoseiulus persimilis and others



DESCRIPTION

There are a number of predatory mite species, of which *Phytoseiulus persimilis* is the most commonly used as a biological control agent.



Predatory mites, with remains of prey mites (D Roberts)

Egg: Oval, orange tinged, double the size of pest mite egg.

Nymph: Pale orange, pear shaped.

Adult: Orange to reddish, pear shaped, fast moving, slightly larger than pest mite species.

BENEFIT

Predatory on other mites, including two spotted mite and bean spider mite.

MOST COMMON

Multiplies rapidly at temperatures over 26°C.



Predatory mite *Phytoseiulus persimilis* (Wikipedia commons)

Mite – redlegged earth mite

Halotydeus destructor



DESCRIPTION

Egg: Orange, minute, laid singly on lower stems or soil debris during winter-spring. During summer a diapausing egg is retained within the female mite's body.

Nymph: Reddish pink with six legs, 0.2mm long, darkens as it matures.

Adult: Completely bluish-black body with bright red legs. Generally feeds in groups of up to 30.

DAMAGE

Lacerates plant leaves to release sap, resulting in large, whitish patches on leaves. Mainly feeds in the morning or in overcast conditions. If disturbed it will drop to the ground and hide.

MOST COMMON

Cool, wet weather, generally autumn to early summer in southern parts of Australia. Spends most of the time in the soil.



Redlegged earth mite (NSW DPI)

Mite – spinach crown

Rhizoglyphus spp.



DESCRIPTION

Egg: Round, semitransparent, barely visible with the naked eye and deposited between folds in new leaves.

Nymph & Adult: Nymphs and adults are similar in appearance and only reach 0.7mm long. All stages are semitransparent with prominent long hairs and light brown legs.

DAMAGE

Mites feed mainly on young, expanding leaves at the

centre of the plant. Emerging tissues are stunted and deformed.

MOST COMMON

Favoured by cool, wet conditions and soils rich in organic matter especially if repeated spinach crops are grown. Mainly a pest of spinach and chard in Tasmania and southern Victoria. Most damage occurs during spring when plant growth is slow, with occasional outbreaks in autumn.



Spinach crown mite (S Tirpak, Rutgers PDL) and damage (S Grigg)

Mite – two spotted

Tetranychus urticae



DESCRIPTION

Egg: Translucent white, laid on leaf undersides.

Nymph: Translucent white, changing to bright orange in overwintering form.

Adult: Whitish to yellow green, around 0.5mm long with a large dark olive spot either side of its body. Overwintering form has a dark red body and white legs.

DAMAGE

Mites form colonies on lower leaf surfaces, especially near the petiole. These areas become covered in fine webbing. Feeding causes silvery speckling on the leaf surface and the leaves to become twisted and distorted.

MOST COMMON

Mainly during hot, dry weather (25 to 30°C).



Two spotted mites overwintering form (L, top), normal form with egg (R) (G San Martin) and damage to rocket (J Ekman)

Parasitoid wasps

Trichogramma spp., *Telenomus* spp., *Diadegma* spp.,
Netelia spp., *Cotesia* spp.

DESCRIPTION

There are many different types of parasitoid wasps, a number of which are sold commercially for control of caterpillars and aphids.

Adult: Range in size from tiny black wasps less than 0.5mm long that lay their eggs inside moth eggs (e.g.

Trichogramma or *Telenomus*) to larger species up to 18mm long that lay their eggs in pest caterpillars or pupa (e.g. *Diadegma*, *Netelia* and *Diadromus*). While many are black or grey, others are orange or a mixture of colours.



Diadegma sp., a parasitoid of diamondback moth (J Ekman); *Cotesia glomerata* larvae have emerged from this cabbage white caterpillar and pupated directly underneath their dead host; newly emerged adult wasp (bottom right) (J Ekman)



Some parasitoids are highly host specific, others will attack a range of species.

butterflies, or directly into aphid adults or nymphs. One or many larvae live inside their host, eventually killing it.

BENEFIT

The adult females lay their eggs inside eggs, caterpillar or pupa of pest moths or

MOST COMMON

Any time of year.



Parasitised aphid 'mummies' (top) (N Dimmock Uni Northampton, Bugwood.org), *Telenomus sp.* and *Trichogramma sp.* wasps laying into *heliiothis* eggs (NSW DPI)

Plague soldier beetle

Chauliognathus lugubris



DESCRIPTION

Larva: Soil dwelling, with distinct rounded segments, larvae are strict carnivores that consume insect pupae, insect eggs, young caterpillars and other organisms. Larvae take up to a year to mature.

Adult: Slender beetle with bright orange abdomen and metallic green wings. Up to 15mm long.

BENEFIT

Predatory on aphids, caterpillar eggs and other pests, which are supplemented with nectar and pollen. However, beetles can present a significant contaminant issue when large populations are present, especially in leafy greens.

MOST COMMON

Summer in south-eastern Australia. Large swarms sometimes gather to mate, the triggers for which are not understood.



Plague soldier beetle adult (J Ekman)

Rove beetle

Paederus spp.



DESCRIPTION

Adult: Resembles an earwig or large ant more than a beetle due to tiny size of its wing covers. Black head and body with orange-red thorax and wide orange red stripe across the lower part of its body. Although the beetle can fly, it prefers to run and is very agile. It has a habit of curling its abdomen when running or disturbed.

BENEFIT

Predatory on various small insects.

MOST COMMON

On soil around moist places. They are attracted to irrigated areas and hunt actively during the day. Note that beetles contain a toxin which is released if they are damaged or crushed. This can cause extreme skin irritation, known as *Paederus dermatitus*.



Rove beetle (J Ekman)

Rutherglen bug

Nysius vinitor

DESCRIPTION

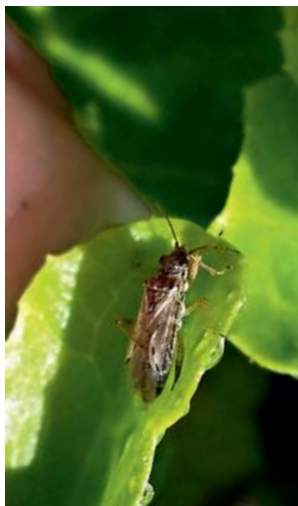
Nymph: Pear shaped, reddish brown and wingless. Nymphs mainly feed on a range of weed species, not vegetable crops.

Adult: Slender, dark grey bugs about 5mm long with transparent wings and black eyes.

DAMAGE

Can cause some feeding damage through sap sucking, although vegetable crops are not preferred hosts.

Main issue is contamination of fresh cut products.



Rutherglen bug (E Tubb, J Ekman)



MOST COMMON

Multiplies during spring in weed species as well as in field crops such as sunflower, sorghum and safflower.

Moves into vegetables during summer when other hosts are unavailable, where it can

reach large numbers. May be controlled during late summer in southern states by a naturally occurring fungal infection.



Rutherglen bug killed by fungal infection

Healthy and parasitised Rutherglen bugs on Victorian lettuce (S Grigg)

Shore flies

Family *Scatella*



DESCRIPTION

Egg: White, oval, about 0.4mm long and laid on the soil surface.

Larva: Pale, brownish maggots grow up to 3mm long.

Adult: Small black flies with grey wings and reddish eyes, up to 2mm long, similar shape to drosophila.

DAMAGE

Adults and larvae do not directly damage plants as they feed on algae, yeast and soil microorganisms. However, they leave black excrement (fly specks) on the plant leaves and are a contamination issue.

MOST COMMON

Like fungus gnats, shore flies are attracted to damp areas with actively growing algae and high levels of organic matter. More commonly found in greenhouses than field crops.



Shore fly adult (M Suvac) and pupa

Springtails

Family Collembola



DESCRIPTION

Egg: Microscopic, laid within the top 50mm of soil in batches of up to 50.

Nymph and Adult:

Semitransparent, ranging in size from 0.5 to 2mm long. Soil inhabiting springtails are effectively blind and semi-aquatic. They lack the springing apparatus of above ground species.

DAMAGE

Springtails feed on plant roots, causing extensive scarring. Roots can become brown or blackened, the plant wilts and may die.

MOST COMMON

Favoured by cool, wet conditions with heavy soils rich in organic materials. They are a particular pest of spinach.



Springtail damage to spinach roots (L Du Toit, WSU)

Thrips – onion, plague, tomato, WFT

Thrips tabaci, *T. imaginis*, *Frankliniella schultzei*,
Frankliniella occidentalis

DESCRIPTION

While there are many species, onion thrips, plague thrips, blossom thrips and western flower thrips (WFT) are the main pest species in vegetables. Identification of thrips species is difficult due to their tiny size.

Nymph: Cream to yellowish, wingless, generally less than 1mm long.

Adult: Light to dark brown with thin bodies approx. One to 2mm long. Narrow, transparent wings are held along their backs.

DAMAGE

Feeding causes silvering of the leaves, severe damage leading to leaf curling. However the major damage potentially caused by thrips is transmission and spread of viruses. This is species specific. For example, tomato spotted wilt virus is efficiently transmitted by WFT, can be transmitted by onion thrips, but is not transmitted by plague thrips.

MOST COMMON

All crops may be affected, especially during warm, dry weather. Onion thrips are common in early summer, WFT and tomato thrips most common in mid-late summer.

Thrips prefer to feed on new shoots as well as hiding in the leaf axis of young seedlings. Many thrips species can breed in flowering weeds such as wild radish and fireweed. Note that WFT is resistant to many insecticides.



Western flower thrips (C Maureira)



Thrips damage on rocket (Uni Mass. Ext.) and lettuce (Y Pinot, INRA Montpellier (top) and M Mirnezhad Leiden Uni, Bugwood.org)

Weevil – vegetable

Listroderes difficilis

DESCRIPTION

Egg: Pale, laid in soil surface litter in autumn.

Larva: Up to 12mm long, creamy yellow or greenish grub with orange brown head. Pupates in the soil in early spring

Adult: Mottled brown about 8mm long with pale V-shaped mark in the middle of the back and a prominent snout.

DAMAGE

Larvae and adults chew distinctive rounded holes in leaves during the evening and at night. Usually a minor pest, damage is generally superficial but affects plant appearance and saleability. Heavy infestations can kill seedlings.



Vegetable weevil larva showing distinctive brown markings (S Learmonth DAFWA), larva on wombok (A Ryland) and adult weevil (V Engel)



MOST COMMON

Larvae are present during autumn and winter, emerging as adults in spring. Adults are inactive in the soil during summer.



Vegetable weevil larvae in pak choy (D Roos NC State Uni) and spinach leaf damage with newly emerged larvae (S Grigg)

Weevil – whitefringed

Naupactus leucoloma



DESCRIPTION

Egg: Pale yellow, laid in sticky, gelatinous clumps in ground litter or lower plant stems.

Larva: Whitish C-shaped grub with brown head and black mandibles, up to 13mm long.

Adult: Grey-brown striped with white side band and a short snout. Up to 12mm long. Adults cannot fly but walk long distances.

DAMAGE

Larvae live 5 to 15cm deep in the soil where they eat plant roots. Adults feed on lower leaves but rarely cause major damage.

MOST COMMON

Mainly a pest of potatoes and legumes. However, larvae remaining in the soil after a preferred crop will attack vegetable plant roots. Larvae are active during autumn to spring, adults emerge in summer. Females can lay eggs without mating.



Whitefringed weevil larvae with feeding damage to lettuce roots (S Grigg) and adult weevil (S Hinkley & K Walker, Museum Vic)

Wireworm - false

Gonocephalum spp., *Pterohelaeus* spp. and others



DESCRIPTION

Larva: Hard, smooth, golden brown larva with round head and darker mouthparts. Up to 30mm long with similar appearance to mealworms, to which they are closely related.

Adult: Dull dark grey to brown, oval shaped beetle commonly known as a 'darkling beetle'. Often found in or on the soil.

MOST COMMON

False wireworm larvae tend to stay in the upper layers of loose, cultivated soil. Larvae develop through autumn and winter, causing most damage just before pupation in early spring. Adult beetles emerge from late spring and can migrate long distances.

DAMAGE

The soil dwelling larvae are attracted to germinating seeds, feeding on developing roots and shoots. Adult darkling beetles are active on the soil surface and will feed on young shoots. They are not normally a major pest but can ring-bark small plants.



False wireworm larva (Virginia Tech Extension) and adult darkling beetle (P Chew Brisbaneinsects.com)

Wireworm - true

Family Elateridae



DESCRIPTION

Larva: Cylindrical or slightly flattened larvae, creamy coloured with a smooth, distinctly segmented body. Brown to reddish head equipped with large mandibles. The tail is also brown to reddish and may be forked with a serrated edge.

Adult: Dark grey, brown or black, torpedo shaped 'click' beetle with finely ridged wing covers.

DAMAGE

Young larvae feed on roots in the top 5cm of soil. Mature larvae may burrow deeper in response to dry conditions or cool temperatures.

MOST COMMON

Most often a problem in weedy fields or those recently planted to grain crops or pasture. Spring and summer transplants are particularly at risk.



*Click beetle (adult true wireworm)
(Skitterbug)*



Wireworm larva (M Bertone)





Diseases

Alternaria leaf spot/ Target spot



Alternaria spp.

SYMPTOMS

Dark grey to black spreading spots with distinct margins and sunken centre, surrounded by a yellow halo. Fine black spores develop in the centres of the lesions. As the lesions age they dry and become papery, eventually falling out to give a 'shot hole' effect.

CROPS AFFECTED

Lettuce and leafy brassicas.

FAVOURABLE BY

Moist conditions, especially if plants are stressed. Infection spreads during storage and transport, particularly at temperatures above 10°C.



Alternaria leaf spot on mizuna (Ontario MAF)

Anthracnose – spinach

Colletotrichum dematium



SYMPTOMS

Small, circular, water soaked lesions which grow in diameter as they develop. Older lesions turn light brown, with tissues becoming thin and papery. Tiny, dark, spines (setae) eventually develop on the outer border of the lesions.

CROPS AFFECTED

Spinach.

FAVOURED BY

Leaves remaining wet for more than a few hours, cool conditions (10 to 20°C).



Anthracnose on spinach (J Damicone (L), A Wyenandt Rutgers Extension)

Anthracnose – lettuce

Microdochium panattonianum



SYMPTOMS

Small, brownish circular to oval lesions, often developing initially on leaf midribs. These grow and join together, the centres becoming light brown and papery.



CROPS AFFECTED

Lettuce

FAVOURLED BY

Damp, cool conditions (15 to 18°C), where leaves remain wet for eight hours or more. Most commonly occurs in late winter and spring.



Anthracnose on butter lettuce (V Galea) and green coral lettuce (S Grigg)

Bacterial leaf spot – brassicas



Pseudomonas spp., *Xanthomonas* spp.

SYMPTOMS

Brownish, angular lesions develop between the leaf veins, often with a dark edge or yellow halo.

FAVoured BY

High temperatures combined with wetness on leaves. Symptoms can increase postharvest, especially if the product stays wet and/or is not kept cold.

CROPS AFFECTED

All brassica crops.



Bacterial leaf spot on rocket (L Tesoriero NSW DPI)

Bacterial leaf spot – lettuce

Xanthomonas axonopodis pv. *vitians*



SYMPTOMS

Dark, angular water-soaked lesions develop, mainly between the leaf veins. Lesions are sharply defined, sometimes with a yellow halo.

CROPS AFFECTED

Lettuce.

FAVOURED BY

Moderately uncommon.



Bacterial spot on lettuce (S Grigg (L) and C Bull)



Bacterial soft rot

Pectobacterium spp.

SYMPTOMS

Wet, slimy rot of stems and leaves, often with an unpleasant smell.

CROPS AFFECTED

All.

FAVOURLED BY

Warm, wet conditions. Infection occurs in the field but symptoms increase

and spread postharvest, especially in fresh cut products.

Postharvest rot is most likely if products have grown in wet conditions, been packed wet or stored at inappropriate temperatures. Packaging that results in low O₂/high CO₂ atmospheres can increase rot development.



Bacterial soft rot during production of pak choy (J Ekman) and coral lettuce (S Grigg)



Postharvest bacterial rot of baby spinach and cos lettuce (T Kristensen)

Black rot / Bacterial leaf spot



Xanthomonas campestris pv. *campestris*

SYMPTOMS

Roughly 'v' shaped bright yellow to brown lesions, usually on the leaf edges initially but progressing inwards. Veins become blackened within the necrotic area.

CROPS AFFECTED

Brassicas.

FAVOURED BY

Warm, humid conditions. Can be seed borne, also spreads through a crop by equipment or water splash.



Black rot on rocket (*P Di Benedetto*) and brassica seedlings (*L Tesoriero*)

Cercospora leaf spot

Cercospora spp.



SYMPTOMS

Small red or brown-black flecks with reddish borders expand to circular spots with ashy grey centres. These may eventually fall out, giving a 'shot hole' appearance.

CROPS AFFECTED

Spinach, chards.

FAVOURLED BY

Warm, humid weather.



Cercospora spot on chard (S Grigg)



Cercospora leaf spot on beetroot (Uni. Massachusettes Extension)

Cladosporium leaf spot

Cladosporium variabile



SYMPTOMS

Small, sunken leaf spot less than 5mm diameter with distinct margins, white to tan in colour. Spots multiply in number as the disease progresses. Dark green spores develop in older spots.

CROPS AFFECTED

Spinach, chards.

FAVOURED BY

Development is favoured by cool conditions (10 to 20°C) with high humidity. Disease can be seed borne as well as spread from crop residues and weed hosts.



Cladosporium leaf spot on spinach (G Higgins Uni Massachusetts Amherst)

Clubroot

Plasmodiophora brassicae



SYMPTOMS

Distortion and thickening of the roots, particularly the tap root. Plants are stunted and tend to wilt, particularly on hot days. Infected roots are unable to take up water and nutrients efficiently. Eventually the plant will die.

CROPS AFFECTED

Asian leafy, rocket, kale.

FAVoured BY

Warm temperatures combined with wet, acidic (pH below 7.0) soil. Crops which are direct seeded into heavy soil are most at risk, especially if clubroot has been observed on the site within the previous five years. Spores can persist in the soil for several years and are easily spread in water, on machinery and within plant trash.

There is no cure for clubroot, so disease management involves using resistant varieties, liming soil to raise pH over 7.0, improving drainage and rotating crop types.



Clubroot on rocket (S Grigg)



Clubroot symptoms in a crop of rocket (S Grigg)

Corky root

Rhizorhapis suberifaciens



SYMPTOMS

Yellowish patches appear on the roots, which gradually enlarge and turn greenish brown. Cracks and rough, swollen areas develop on the root surface and the entire taproot can become brown and non-functioning. Feeder roots are reduced, breaking off easily when examined. Above ground symptoms include stunting, wilting during warm weather and uneven growth.

CROPS AFFECTED

Lettuce.

FAVOURLED BY

High temperatures. Corky root develops fastest when daytime temperatures are close to 31°C and soil temperatures are 17 to 25°C. Plants are most susceptible between the 2nd and 7th true leaf stages. Continual cropping with susceptible lettuce varieties, especially if direct seeded, also favours disease development.



Normal (L) and corky root affected (R) lettuce seedlings (M Titley) and initial symptom development; roots are starting to brown, developing corky growths and longitudinal bursting (ephytia.inra.fr/5875/Salads-Main-symptoms).

Damping off

Pythium spp., *Aphanomyces* spp., *Phytophthora* spp.

SYMPTOMS

Pre-emergence, damping off can cause brown, gelatinous rotting within the seed coat. If seeds do germinate, crop emergence is poor and seedlings are stunted, yellowing and wilted. Water soaked lesions appear on the lower part of the tap root or near the soil junction, sometimes resulting in excess branching of the root system above the infection (esp. *Pythium*). Seedlings tend to fall over or collapse and die.

CROPS AFFECTED

All.

FAVOURED BY

Wet soil conditions. The various fungi responsible for damping off can survive in the soil for extended periods, either as resting spores or in plant trash.



Damping off of spinach due to Pythium (E Tubb)



Collapse and death of lettuce seedlings (N Cattlin)



Brown decay at the root/shoot junction (S Grigg)

Damping off – fusarium wilt

Fusarium oxysporum



SYMPTOMS

General wilting of seedlings, foliage loses colour and eventually dies. Roots and vascular tissues turn black.

CROPS AFFECTED

Spinach.

FAVoured BY

Acidic soils low in organic matter.



Fusarium wilt of spinach (L Tesoriero NSW DPI)



Fusarium wilt effects on roots (L du Toit WSU)

Damping off – wire stem

Rhizoctonia solani



SYMPTOMS

Dry, sunken cankers with a sharply defined margin develop near the soil junction soon after seedlings emerge. Plants wilt and collapse. More advanced seedlings may send out new shoots from below the diseased area. Like other causes of damping off, *Rhizoctonia* is common in soil and can survive long periods on plant debris or as sclerotia (hard resting structures).

CROPS AFFECTED

Asian leafy, rocket, spinach.

FAVOURED BY

Warm wet soils especially if combined with physical damage at soil level, e.g. windy conditions, transplanting or insect damage.



Damping off of spinach due to wire stem (S Grigg)

Downy mildew – brassicas

Hyaloperonospora parasitica



SYMPTOMS

In the early stages, bleached or yellowish areas appear on the leaf upper surfaces. Soft whitish mould develops on the undersides of leaves, turning brown with age. The upper surfaces of cotyledon leaves become puckered and speckled, while sunken, black, angular speckling develops on more mature leaves.

CROPS AFFECTED

Asian leafy, rocket.

FAVOURED BY

Cool, moist conditions. The disease can spread during storage, but growth is slowed at temperatures below 5°C.



Downy mildew on tatsoi and rocket (S Grigg)

Downy mildew – lettuce

Bremia lactucae



SYMPTOMS

Angular yellow patches appear on the upper leaves which are bounded by the leaf veins. Soft, creamy spores develop, mainly on the undersides of leaves but also sometimes on the tops. Infected areas turn brown with age.

Spores in close up (W Chen)

Downy mildew symptoms on the upper and lower sides of lettuce leaves (M McGrath Cornell CALS)

CROPS AFFECTED

Lettuce.

FAVOURABLE BY

Cool (10 to 20°C) conditions, especially if leaves stay wet due to rain or dew. Susceptibility varies greatly between varieties.



Downy mildew – spinach



Peronospora farinosa f. sp. *spinaciae*,
Peronospora farinosa f. sp. *betae*

SYMPTOMS

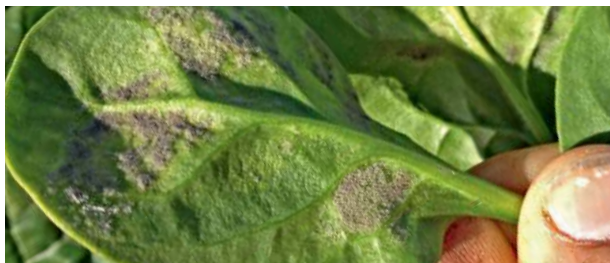
Mottled, yellow areas appear, mainly between the leaf veins. Soft, bluish grey mould develops on the undersides of leaves, turning brown with age.

FAVOURLED BY

Cool (10 to 20°C) conditions, especially if there is free water on the leaves. The disease can spread during storage, but growth is slowed at temperatures below 5°C.

CROPS AFFECTED

Spinach, chard.



Downy mildew on spinach early (J Ekman) and advanced (S Grigg)

Grey mould

Botrytis cinerea



SYMPTOMS

Watersoaked lesions are topped by a layer of white mould, which develops into characteristic fluffy grey moulds as the spores are formed.

CROPS AFFECTED

All.

FAVOURABLE BY

Infection occurs in the field and is most likely in cool, damp growing conditions. Symptoms often appear postharvest, especially if the plant tissue is damaged and/or remains wet. The fungus continues to grow at temperatures close to 0°C, making it difficult to control during storage and transport.



Grey mould on lettuce (D Kindersley (L); J Foulkes (R)) and spinach (T Klejdysz)

Peppery leaf spot

Pseudomonas syringae pv. *maculicola*



SYMPTOMS

Small, black to purple irregularly shaped spots and speckling develop on leaves, sometimes with very thin yellow margins. Can be seed borne and survive on crop residues.

CROPS AFFECTED

Asian leafy, rocket, kale.

FAVOURED BY

Prolonged cold, damp conditions, especially if leaves remain wet.



Peppery spot on wombok (L Tesoriero NSW DPI) and cabbage (S Gironde, inset)

Phoma leaf spot

Phoma lingam (asexual form of *Leptosphaeria maculans*)



SYMPTOMS

Round to oval white-brown spots, up to 2cm in diameter, mainly on the older leaves. Small black specks (spores) are scattered over the leaf spots but more pronounced in its centre. Dry rot can develop on leaf petioles and stem bases, and plants wilt and collapse.

CROPS AFFECTED

Mainly Asian leafy.

FAVOURED BY

High relative humidity and temperatures of 15 to 20°C. Wet leaves are required for infection. Spores can be spread by wind, rain, irrigation water, on crop debris and potentially insects.



Phoma leaf spot (L Tesoriero NSW DPI)

Powdery mildew

Erysiphe cruciferarum



SYMPTOMS

Irregularly shaped patches of white, powdery mould develop on the upper surface of leaves and stems, particularly older leaves. Symptoms also occasionally appear on the lower leaf surface.

CROPS AFFECTED

Asian leafy, rocket, kale, chard.

FAVOURABLE BY

Warm, dry conditions. Uncommon on babyleaf crops.



Powdery mildew on tatsoi (HJ Jee)



Powdery mildew on kale (T Rusinek)

Ring spot

Mycosphaerella brassicicola

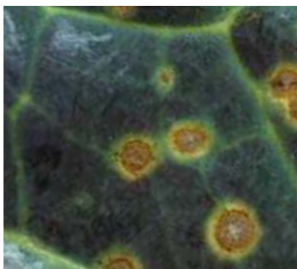


SYMPTOMS

Dark grey, circular 'target' spots develop on the leaves, surrounded by a yellow halo. Small black fruiting bodies form inside the spots in concentric rings.

FAVOURED BY

Cool, damp weather, where leaves stay wet continuously for at least 24 hours. More likely to occur if the new crop is planted into undecomposed crop residues. Symptoms may not develop for up to two weeks after infection. Spots can continue to spread during postharvest storage.



Early and later ring spot symptoms (AfroBrazilian) and on purple tatsoi (S Grigg)

Root rot

Pythium spp., *Aphanomyces* spp., *Phytophthora* spp.,
Fusarium spp.



SYMPTOMS

Root rots are often caused by a complex of different organisms. The resulting symptoms are similar to damping off, but affect mature plants. Wilting and collapse initially affect the older leaves, but eventually spread to the whole plant. Sometimes the rot spreads into the basal area of the stem and becomes visible above ground.

CROPS AFFECTED

All. Spinach is particularly susceptible.

FAVOURED BY

A variety of conditions depending on the species complex present; some are favoured by dry conditions, others by wet.



Root rot on spinach (L Tesoriero NSW DPI)

Root rot – black

Berkeleyomyces basicola



SYMPTOMS

Long red to black lesions develop on the roots, resulting in stunted growth. Cutting across the leaf base reveals blackening in the vascular tissue.

CROPS AFFECTED

Lettuce, Asian leafy.

FAVOURLED BY

Soil temperatures less than 20°C, soil pH greater than 5.6. Reportedly spread by fungus gnats and shore flies within protected cropping environments. Associated with lack of crop rotation.



Black root rot (INRA (top); L Tesoriero NSW DPI)

Root rot – bottom rot

Rhizoctonia solani



SYMPTOMS

Initial symptoms are wilting of the outer leaves. Small, sunken brown lesions appear on the midribs and areas in contact with the soil. These grow rapidly, spreading to internal leaves and stem tissue. Lesions may ooze brownish liquid. Secondary soft rots often develop causing the head to collapse.

CROPS AFFECTED

Lettuces, particularly early season and less upright varieties.

FAVOURABLE BY

Warm (greater than 25°C), moist weather. The fungus can survive extended periods in fallow soil, so bottom rot is likely to reoccur in soils previously affected and/or which are high in organic matter. This fungus also causes damping off in seedlings.



Bottom rot of lettuce (L Tesoriero NSW DPI)

Septoria leaf spot

Septoria lactucae



SYMPTOMS

Angular yellow leaf spots, bounded by the veins, appear on the outer leaves. These spread and turn brown and papery with tiny black dots (pycnidia) scattered on the lesions.

FAVoured BY

Cool, moist conditions. Usually spread in water but can also be seed-borne. Spores can survive in crop debris and in weed species.

CROPS AFFECTED

Lettuce.



Septoria spot on lettuce top and underside (J Ekman)

Stemphylium leaf spot – lettuce



Stemphylium botryosum f.sp. *lactucum*

SYMPTOMS

Usually appears first on the outer leaves. Tiny, water soaked spots (1 to 2mm diameter) enlarge and multiply, becoming sunken and papery with a darker brown halo.

CROPS AFFECTED

Lettuce.

FAVOURABLE BY

Warm conditions (25 to 30°C), wet leaves and close to saturation humidity. The fungus cannot develop at less than 13°C.



Stemphylium leaf spot on lettuce (L Tesoriero NSW DPI)

Stemphylium leaf spot – spinach



Stemphylium botryosum f.sp. *spinacia*

SYMPTOMS

Small, circular to oval grey-green sunken spots. These enlarge, turn light brown in the centre and become papery as the disease progresses.

CROPS AFFECTED

Spinach.

FAVOURABLE BY

Warm (15 to 28°C) weather, combined with high humidity. Seedborne disease.



Stemphylium leaf spot on spinach (L Du Toit WSU, L Tesoriero NSW DPI)

Virus – mosaic

Alfalfa mosaic, Cucumber mosaic (CMV) Tomato spotted wilt virus (TSWV), Lettuce mosaic virus (LMV), Lettuce necrotic yellows (LNYV) etc

SYMPTOMS

General mottling, mosaic or ring spots on leaves. Plants are stunted and young shoots can appear bunched and distorted. Plants may wilt and die, particularly when infected with TSWV and LNYV.

CROPS AFFECTED

Some viruses have specific hosts. Others (such as CMV and TSWV) affect a wide range of crops and weeds.



Lettuce necrotic yellows virus (L Tesoriero NSW DPI)



FAVOURED BY

Often spread by aphids, except TSWV which is spread by thrips. LMV also spreads by infected seed. Populations of insect vectors commonly build up in weeds and move into crops during dry weather.



Tomato spotted wilt virus on lettuce
(L Tesoriero NSW DPI)



Turnip mosaic virus on buk choy (L Tesoriero NSW DPI)

White blister/White rust

Albugo candida



SYMPTOMS

Raised white spots appear, mainly on the undersides of leaves. Initially smooth, lesions become powdery and blister-like, causing leaf distortion.

CROPS AFFECTED

Asian leafy, rocket, spinach.

FAVOURLED BY

Humid weather. Will develop under a wide range of conditions.



White blister on spinach (J Damicone and J Bailey (top))

White leaf spot

Pseudocercospora capsellae



SYMPTOMS

Large numbers of pale, papery spots up to 1cm diameter on leaves. Seedlings may die; heavily infected leaves may yellow and drop off.

CROPS AFFECTED

Asian leafy, rocket, kale.

FAVOURED BY

Cool (10 to 15°C), wet conditions. Can be seed borne or spread by wind.



White leaf spot on buk choy seedling (L Tesoriero NSW DPI)

White mould / Sclerotinia

Sclerotinia sclerotiorum, *Sclerotinia minor*



SYMPTOMS

Initially found in decaying tissue in the lower leaves, the fungus develops into a soft, wet rot covered with white cottony growth. The disease blocks the plants vascular system, causing it to wilt and die. In later stages hard, black resting spores (sclerotia) form.

CROPS AFFECTED

Brassicas and lettuce.

FAVoured BY

Cool, moist conditions. The disease can continue to grow and spread to neighbouring materials after harvest, even at temperatures below 5°C.



White mould growing around the base of a lettuce, and resulting death of the whole plant (J Ekman)





Disorders

Blindness



SYMPTOMS

Usually visible on seedlings on the 3rd to 4th true leaf, which is thickened, stunted and distorted. Subsequent growth is reduced, with lettuce failing to develop hearting leaves or normal shape.

CAUSED BY

Unknown. Generally a more frequent problem in transplant lettuce than direct seeded crops and in summer rather than winter. May be caused by a combination of environmental and agronomic factors.

CROPS AFFECTED

Lettuce.



Blind lettuce seedling (E Tubb)

Brown stain



SYMPTOMS

Large reddish-brown patches appear, mainly on the midribs.

CROPS AFFECTED

Lettuce.

CAUSED BY

Can be triggered by high carbon dioxide (greater

than 5%) or very low oxygen (less than 2%) in the storage atmosphere. This can occur if the gas permeability of the packaging does not approach the respiration rate of the contents. Respiration is increased by high temperatures during storage and transport, disease and ethylene exposure.



High CO₂ induced brown stain (A Kader)

Calcium deficiency – tipburn



SYMPTOMS

Browning of the leaf margins, particularly the inner leaves, which become dry and papery. Affected leaves fail to develop properly and have a cupped appearance. Damaged areas are prone to other diseases and have shortened shelf life.

CROPS AFFECTED

Lettuce.

CAUSED BY

Occasionally related to soil deficiency, but more often caused by the plant growing faster than calcium can move from the roots to the growing tips. Tipburn is most frequent during humid summer weather. Under these conditions plants grow rapidly but evaporation and, therefore, water movement through the plant, is reduced. Particularly affects the inner leaves.



Tipburn in lettuce (S Grigg)

Cold damage



SYMPTOMS

Germination appears patchy, plants lack vigour and leaves may yellow or develop atypical colours. Symptoms may vary across a crop even when all other factors are the same, especially where plantings have been successive.

CAUSED BY

Cold temperatures during crop establishment and early growth. Soil temperatures of 10 to 20°C are optimum for spinach. During germination plants are highly sensitive to temperatures higher or lower than this and may fail to emerge or have reduced vigour.

CROPS AFFECTED

Mainly spinach.



Normal spinach (L) and cold-damaged plant (R) (M Titley)

Copper toxicity



SYMPTOMS

Small, light brown spots appear, mainly along the leaf veins. These increase and darken as symptoms progress.

CROPS AFFECTED

Lettuce.

CAUSED BY

Copper sprays.



Copper toxicity on lettuce (S Grigg)

Ethylene damage - leafy greens



SYMPTOMS

Premature yellowing of leaves, accelerated development of rots during storage and rapid senescence.

CAUSED BY

Exposure to the plant hormone ethylene. Ethylene gas is produced by ripening fruit, combustion engines and rotting vegetation. Concentrations as low as 0.1ppm can affect quality. Effects are reduced by storage below 5°C.



Rocket and choy sum yellowing due to ethylene exposure (J Ekman). Rots are also starting to develop in the rocket.

Ethylene damage - lettuce



SYMPTOMS

Depressed, tan coloured, elongated pits appear on the midribs. Roundish specks may also appear on the leaves themselves. These increase and darken over time.

CAUSED BY

Exposure to the plant hormone ethylene. Ethylene gas is produced by ripening fruit, combustion engines and rotting vegetation. Concentrations over 5ppm are sufficient to induce russetting. Iceberg lettuce is the most susceptible. Symptoms are reduced by storage below 5°C.



Russetting due to ethylene exposure (J Ekman).

Fertiliser burn – lettuce



SYMPTOMS

Dark or blackened necrotic areas appear and expand in the leaf bases. Leaves can wilt, become chlorotic and die.

CROPS AFFECTED

Lettuce.

CAUSED BY

Application of post-transplant fertiliser after more than four leaves have started to develop. Fertiliser granules become trapped in the leaf bases, where they burn the plant tissue.



Fertiliser granules and burn on lettuce (S Grigg)

Fertiliser burn – urea



SYMPTOMS

Bleached, papery areas develop on outer edges and exposed areas of leaves.

CAUSED BY

Application of foliar urea at too high a concentration or with incorrectly calibrated spray equipment.

CROPS AFFECTED

All.



Fertiliser burn caused by urea application to spinach (M Titley)

Frost damage – permanent



SYMPTOMS

Leaves become bubbled and distorted and necrotic areas develop. Large water-soaked areas may appear if injury is severe.

CROPS AFFECTED

All.

CAUSED BY

Frost settling on leaves for an extended period—tolerance varies between species and varieties.



Frost injury on rocket and butter lettuce (S Grigg)

Frost damage – recoverable



SYMPTOMS

Smallish water-soaked spots and diffuse areas appear on leaves. If water-soaked areas affect larger, solid areas then plant may not recover.

CROPS AFFECTED

All.

CAUSED BY

Frost—symptoms generally dissipate within a few hours of damage occurring.



Non-permanent frost damage on lettuce seedlings (S Grigg)

Guttation



SYMPTOMS

Tiny droplets of leaf sap appear over the leaves, especially around the leaf edges and veins. As these dry, tiny salt deposits are left. These minute white specks can resemble insect eggs or fertiliser/pesticide contamination.

CROPS AFFECTED

Mostly spinach.

FAVOURED BY

High soil moisture combined with high relative humidity. Guttation is the result of water pressure building up in the plant roots, usually overnight when stomata are closed. Pressure forces xylem sap out through the leaf pores.



Guttation on spinach (J Ekman)

Hail damage



SYMPTOMS

Physical scarring and spotting of leaves. Light hail damage can resemble a leaf spotting disease, but is non-progressive. Although edibility is unaffected, appearance is less attractive.

CROPS AFFECTED

All.

CAUSED BY

Light hail. Severe hail will result in complete crop loss.



Light hail damage on spinach (S Grigg) and hail damage to lettuce (J Ekman)

Herbicide damage



SYMPTOMS

Variable symptoms. Pre-emergent herbicide applications can cause the cotyledons to become thickened, twisted and distorted. Post-emergent applications can result in inrolling and distortion of the first true leaves. Other symptoms include the appearance of bleached, chlorotic patches on the leaves, especially on the leaf margins and stunted growth.

CROPS AFFECTED

All.

CAUSED BY

Potential causes include contamination of the spray tank due to insufficient cleaning, inappropriate herbicide selection and application of a normally non-damaging herbicide to a crop previously treated with a wetting agent.



Herbicide damage to rocket (S Grigg)

Herbicide damage, cont.



Herbicide damage to spinach and beet cotyledons (S Grigg) and below, stunting of spinach seedling (R) compared to normal plant (L) (M Tittley)



Herbicide damage to pak choy (above) (S Grigg) and lettuce (L) (J Ekman)

Nitrogen deficiency



SYMPTOMS

Plants are pale and chlorotic and growth is reduced. Older leaves yellow and die off prematurely. Red or purplish colours can develop in the paler than normal leaves.

CAUSED BY

Nitrogen is required in relatively large amounts for maximum growth. However, it is easily leached, especially from sandy soils low in organic matter. Waterlogging and surface fertiliser application promote release of nitrogen as gas, removing it from the soil.

Note that incorporating high carbon soil amendments, such as straw, can lock up available nitrogen in the soil.



Nitrogen deficiency on pak choy and tatsoi (S Parks NSW DPI)

Oedema



SYMPTOMS

Blistering on the underside of the leaf develops into small, brown, corky growths. These darken and harden with age, sometimes spreading to petioles and stems.

CROPS AFFECTED

Asian leafy, spinach.

CAUSED BY

Excess water in the root zone combined with high humidity and low air temperatures. Oedema is most likely to occur when there is a sudden drop in air temperature. Pressure builds up inside the internal cells, causing them to blister and burst.



Oedema results in raised blisters (S. Grigg; Agrio)

Old seed



SYMPTOMS

Seeds germinate but cotyledons fail to develop normally, with variable rates of germination and growth through the crop. Seedlings lack vigour and are slow to grow past the cotyledon stage.

CROPS AFFECTED

Spinach, chard.

CAUSED BY

Seeds have been stored too long before use, with the result that their carbohydrate reserves are reduced.



Patchy growth due to old seed being used in tatsoi (M Titley)

Pesticide damage



SYMPTOMS

Older seedling leaves have bleached or yellowed margins. New growth is fully green.

CROPS AFFECTED

All.

CAUSED BY

Seedlings which have been drenched in pre-planting systemic pesticide have remained for an extended period in their seedling trays before planting. New growth recovers and is normal.



Pesticide drench damage due to delayed transplanting (M Titley)

Pink rib



SYMPTOMS

Pinkish discolouration of the leaf midribs.

CROPS AFFECTED

Lettuce (mainly iceberg and cos).

CAUSED BY

Pinking is related to harvest damage, which triggers activity of oxidative enzymes. Symptoms are most likely if the midribs are cut or crushed during harvest, cooling is delayed (more than four hours), or lettuces are stored at 5°C or higher. Delays in cooling increase pink rib development even if leaves are then kept below 2.5°C.



Pink rib symptoms are most common on cos (J Ekman) and iceberg (A Kader) lettuces.

Phosphorus deficiency



SYMPTOMS

Poor growth, older leaves (or cotyledons in seedlings) turn bluish green or purple. Stems thin, liable to breakage.

CAUSED BY

Cold weather, which limits phosphorus uptake by the plant, especially if combined with low pH and low levels of available phosphorus in the soil.

CROPS AFFECTED

Rocket, Asian leafy.



Phosphorus deficiency (S Grigg)

Waterlogging



SYMPTOMS

Roots develop on the tops of beds. Leaves become yellow due to inhibition of nitrogen uptake. Plants can become red or purplish.

FAVoured BY

Heavy soils, prolonged rainfall, poor drainage.

CROPS AFFECTED

All.



Poor development associated with waterlogged soil (J Ekman)

Wind damage – lettuce



SYMPTOMS

Plants are stunted and wilt during the day; eventually they may fall over and die.

CROPS AFFECTED

Mainly transplanted lettuce seedlings, such as cos.

CAUSED BY

Strong winds which whip the plant around, abrading the crown. The plant becomes pinched and collapses near the junction with the soil surface. In some cases it will be completely 'ringbarked' and will die. Abrasion also creates a potential entry point for soil pathogens.



Wind damaged lettuce (S Grigg)

