Pests, diseases and disorders of brassica vegetables

A FIELD IDENTIFICATION GUIDE

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Pest icons


Beneficial


Damaging


Exotic


Pre-harvest


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Pests and Beneficials

African black beetle

Heteronychus arator

DESCRIPTION

Egg: Small, round, white, laid into the soil.

Larva: Whitish C-shaped grub up to 30mm long with light brown head and six legs. The rear end sometimes has a dark grey tinge.

Pupa: Golden to reddish brown, strongly indented and shaped, found in the soil.

Adult: Shiny, reddish to black, stout-bodied beetle around 10 to 5mm long. Legs are adapted for digging. A strong flyer - adults undertake mass dispersal flights, sometimes in spring but more commonly late March to April.

Larvae of black beetle, also known as 'curl grubs' (J Ekman)

DAMAGE

Larvae feed on plant roots, reducing growth and potentially killing small plants. Adults can cause major damage by chewing the bases of plants and ringbarking seedlings.

MOST COMMON

Spring and early summer, mainly coastal areas extending from Victoria to South East Queensland and the south western region of Western Australia. Favoured by winter rainfall followed by a warm, dry spring and summer.

Adult beetle (PADIL)

Pupae of black beetle larvae (J Ekman)

Aphid – cabbage

Brevicoryne brassicae

DESCRIPTION

Nymph: Young nymphs are bright green, but soon develop a grey, mealy appearance due to their waxy coating.

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.

DAMAGE

Can form large colonies on the youngest leaves, which become stunted and distorted. Severely infested plants are yellowed, stunted, and covered with sticky honeydew excreted by the aphids. As aphids prefer feeding on youngest leaves and flowers, they will go deep into the heart of sprouts and cabbage, creating a contamination issue.

A potential vector for many viruses including cauliflower and turnip mosaic.

MOST COMMON

Mainly a pest of leafy brassicas, numbers tend to peak in spring and autumn when temperatures are moderate.

Distorted leaves of cauliflower (R Lancaster) *and wombok* (J Ekman) *due to cabbage aphid infestation*

Cabbage aphids on gai lan, showing a mix of nymphs, adults and brown, parasitised 'mummies' (J Ekman)

Winged adult aphid (J Ekman) *and aphids under attack by a hoverfly larva (circled), with parasitised 'mummies' also present* (S Grigg)

Aphid – green peach

Myzus persicae

DESCRIPTION

Nymph: Semitranslucent, varying from yellowish to green with dark red eyes.

Adult: Wingless adults resemble nymphs and are approximately 2mm long. Winged females have black heads with dark red eyes and patterned bodies. Can disperse long distances, especially if wind assisted, so infestations can spread rapidly.

Green peach aphid nymphs and adults (J Ekman)

DAMAGE

Causes leaf distortion through feeding and contaminates the product. Large infestations can kill young plants.

A potential vector for many viruses including cauliflower and turnip mosaic.

MOST COMMON

Can overwinter on *Prunus* trees, re-infesting vegetable crops in spring. Found on a wide range of host plants, including brassicas, throughout the warmer months.

A heavy infestation of green peach aphids (E E Nelson Bugwood.org) *and winged adult* (S Bauer USDA ARS)

Aphid – turnip

Lipaphis erysimi

DESCRIPTION

Nymph: Yellowish to olive green and pear shaped.

Adult: Wingless adults are 2 to 4mm long, yellowish to olive green. They sometimes develop a waxy appearance, especially under humid conditions, so may appear similar to cabbage aphids. Winged females are greenish with dark patches on the thorax and head.

DAMAGE

Aphids feed on flowers and the undersides of leaves (particularly older leaves) causing them to become curled and yellow. Infestation can stunt plant growth and contaminate the harvested product.

A potential vector for many viruses, including cauliflower and turnip mosaic.

MOST COMMON

Numbers peak in spring and autumn. Favoured by dry conditions and moderate temperatures.

Turnip aphids (C Wu and KC Sahoo)

Brown marmorated stink bug

Halyomorpha halys

DESCRIPTION

Eggs: Barrel shaped, light green eggs usually found on leaf undersides.

Nymph: Initially black and orange, progressing to patterned brown with rust-red markings.

Adult: Mottled brown shield shaped bug up to 17mm long and 10mm wide. Distinctive alternating cream bands on antennae, legs and side margins of the abdomen.

DAMAGE

Sap sucking by all life stages causes white blotches on leaves, damage can be severe so produce is unmarketable.

MOST COMMON

Not yet in Australia but has frequently been detected. Adults seek shelter (e.g. inside shipping containers) when overwintering, emerging from hibernation in spring. Native to eastern Asia, brown marmorated stink bugs have now spread through Europe and the US, where they are a major horticultural pest.

Hatching nymphs (F Biguzzi)*; semi-mature nymph* (zoology123) *and an adult bug* (D Boevski)

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.

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

DAMAGE

Caterpillars feed on new growth, producing protective webbing as well as frass. Leaves can be webbed together. As the caterpillar attacks the central bud it can prevent head formation, or cause it to be greatly disfigured.

MOST COMMON

Usually a minor pest of brassicas during summer through to autumn in Queensland and New South Wales. Occasionally present in high numbers in southern states during spring.

Cabbage centre moth (G Cox iNaturalist Aust) *and caterpillar* (Barmac Aust.)

Damage caused by the cabbage centre grub; the central shoot has been destroyed, resulting in formation of clusters of side buds
(G Jackson Pestnet).

Cabbage cluster caterpillar

Crocidolomia pavonana

DESCRIPTION

Egg: Up to 300 cream to green eggs laid in a large overlapping pile on the underside of leaves.

Caterpillar: Semi translucent, with dark heads when small. Becomes greenish with yellow and cream stripes as they grow. Up to 25mm long when mature. Unlike cluster caterpillars *(Spodoptera litura*) they feed in groups throughout their development.

Pupa: Golden brown, found in the soil.

Adult: Patterned, buff coloured moth with relatively large wings held in a tent over the body. Female has subtle, light brown markings while the male has more distinct dark brown and cream wing patterning. Both sexes have two white spots with dark border on each wing.

DAMAGE

Completely skeletonise leaves, depositing large amounts of webbing and frass as they grow.

MOST COMMON

Summer and early autumn in northern New South Wales and Queensland.

Mature caterpillar (S Thomson)

Newly emerged caterpillars (M Furlong DAFWA)

Female (Top, H deLange) *and male* (L Finn, Hunter Region School of Photography) *moths*

Feeding damage to a young cabbage plant (H Tsatsia and G Jackson)

Cabbage white butterfly

Pieris rapae

DESCRIPTION

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

Caterpillar: Velvety green, either slightly hairy or smooth, with a thin yellow stripe on their sides and top. Mature caterpillars are around 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. A minor pest which can attack all brassicas, including Asian leafy greens and rocket.

Cabbage white egg, and young caterpillar (J Ekman)

Mature cabbage white caterpillar feeding, and a moribund, parasitised caterpillar; note the dark internal patches developing inside the caterpillar due to feeding by wasp larvae (J Ekman)

Cabbage white pupa and adult butterfly (J Ekman)

Cluster caterpillar / Tropical armyworm

Spodoptera litura

DESCRIPTION

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

Caterpillar: Initially grey-green 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.

Emerging larvae (A Carmichael, QUT*) and mature caterpillar* (J Ekman)

DAMAGE

Cluster caterpillars are related to armyworms and can cause major damage, chewing large, ragged holes in leaves.

MOST COMMON

Spring to autumn in warm subtropical to tropical areas. Very wide host range.

Close up of caterpillar (R Martinez) and pupa (T Klompmaker)

Cluster caterpillar moth (V Fazio)

Cutworm

Agrotis spp.

DESCRIPTION

Egg: Ribbed cream to yellow domes similar to Heliothis eggs but laid in compact cluster.

Caterpillar: Initially grey-green and feed as a group but separate as they mature. Caterpillars darken as they age, becoming dark green-grey to black with red, yellow and cream markings. Adults reach up to 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. The bogong moth is a type of cutworm.

DAMAGE

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

Active (FT Gort Flickriver) *and disturbed cutworm caterpillar* (S Learmonth DAFWA)

MOST COMMON

Damage is most likely during spring, especially in damper areas newly converted to cropping.

Adult moth (NSW DPI) *and cutworm feeding on young plant* (Clemson Uni Bugwood.org)

Damsel bug

Nabis spp.

DESCRIPTION

Egg: Whitish oval laid into plant tissues.

Nymph: Similar to adults except smaller and lacking wings.

Adult: Slender, light tan bug 8 to 12mm long with long, prominant 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 laid in clumps on leaves and stems.

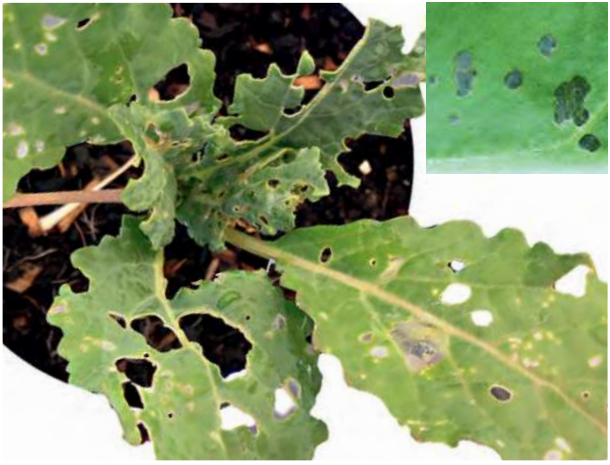
Caterpillar: Initially colourless, developing to bright yellowish green. Tend to drop from the plant if disturbed. Mature at 10 to 12mm long.

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 and buk choy leaf (J Ekman)

MOST COMMON

Major pest of brassica crops. Numbers increase from spring in South Australia, summer in Victoria and autumn in Queensland. Can survive over winter in Queensland if temperatures are mild. Frequently resistant to common insecticides. Eggs do not hatch below 8°C while temperatures over 35°C reduce insect survival.

Clockwise from top: Diamondback moth caterpillar showing chewing damage (P Malinen)*; Diamondback moth adult (giorege1959) and pupa* (W Cranshaw Colorado SU, Bugwood.org)

Fall Armyworm

Spodoptera frugiperda

DESCRIPTION

Egg: Large, clustered masses of up to 200 pale 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 darken and become more strongly striped as they mature. Caterpillars 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.

Male moth (Plant Health Australia)

DAMAGE

Although brassicas are not a preferred host, damage has been reported on crops. 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. Can occur year round in northern areas and late summer to autumn in the south. Adults are strong flyers and can travel hundreds of kilometres.

Mature fall armyworm egg mass (Queensland DAF) *and caterpillar* (FAO). *Circles indicate the four distinctive dark spots on the 2nd last segment and light inverted 'Y' on head. Female moth at right* (Plant Health Australia)

Flea beetle

Phyllotreta spp., *Altica* spp.

DESCRIPTION

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

Adult: Small, shiny beetle, often black with yellowish stripes along its wing covers. The hind legs are enlarged, allowing them to jump like fleas.

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 leafy Asian greens and rocket.

Metallic flea beetle (R Richter)

Small striped flea beetle (R Westerduijn) *and flea beetle damage to Chinese cabbage* (G Jackson PestNet)

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 dark 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. Adults are mainly a contamination issue.

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 larvae (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, wingless and up to 2mm long. Antennae have reddish brown tips.

Adult: Pale green bug approximately 7 to 9mm long, sometimes with brownish markings, and clear wings folded flat. Dark red or brown eyes. Antennae are nearly as long as the body.

DAMAGE

Adults and nymphs inject digestive enzymes into plants during feeding, which can kill growing points. Also a contamination issue.

MOST COMMON

In Queensland and Northern New South Wales, especially during spring and summer. Highly mobile and can disperse long distances.

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

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. Adults are hard to see, but usually a minor pest.

MOST COMMON

Spring and summer on a wide range of host plants.

Egg raft, nymph (L Turton NSW DPI) *and adult bug* (S McDougall NSW DPI)

Ground beetle

Carabidae spp.

DESCRIPTION

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

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

BENEFIT

Both larvae and adult beetles are predatory on insects including caterpillars, slugs, snails and other pests. Larvae often shelter in burrows waiting for prey, while adults 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: Ribbed, white domes 1mm diameter, darkening to brown before hatching.

Caterpillar: Initially 1.5mm long, light brown with dark heads. They remain this colour until they reach around 15mm long, when they darken and develop distinctive stripes along their length. Colour varies from brown to greenish or reddish. Caterpillars grow up to 50mm long.

Adult: Stout moth with lightly patterned brown wings spanning up to 25mm held flat across the body, hind wings pale brown with dark edges.

DAMAGE

Larvae feed on the apical bud and young leaves, stripping foliage, inhibiting new growth and leaving large amounts of frass. Brassicas are not a preferred host of heliothis but can be attacked when other hosts are not available.

MOST COMMON

Warm weather. Larvae prefer leaf undersides or the central part of the plant, where they hide in the apical shoots.

Heliothis eggs (S Grigg)

Young heliothis caterpillar and feeding damage to a pak choy (J Ekman)

Hoverfly

Syrphidae spp.

DESCRIPTION

Larva: Variably coloured, semitranslucent, slug-like maggot that may be cream, green or pink to brown, often with a dorsal stripe. Up to 10mm long with dark mouth hooks.

Adult: Resembles a wasp with black and yellow bands across its 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

Warmer weather, especially during summer.

Hoverfly larva and adult (J Ekman)

Lacewing – brown

Micromus tasmaniae

DESCRIPTION

Egg: Cream, oval eggs laid singly on leaves.

Larva: Slender brown larvae 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 its 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

Present year round, with the highest populations in spring and summer.

Brown lacewing larva (Grahame) *and adult* (J Ekman)

Lacewing – green

Mallada signatus

DESCRIPTION

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

Larva: Thick bodied, light brown and up to 8mm long, the larva camouflages itself using 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 larvae 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 galbula

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/BENEFIT

Larvae 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.

Fungus eating ladybird larva (KL Harris)

MOST COMMON

Late spring to autumn.

Fungus eating ladybird adult (J Ekman)

Ladybird – predatory

Coccinella transversalis, 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.

DAMAGE

All lifestages suck plant sap, reducing vigour and leaving whitish patches on the leaves.

MOST COMMON

Warmer months, only occasionally a major pest.

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

Leaf miner – cabbage

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.

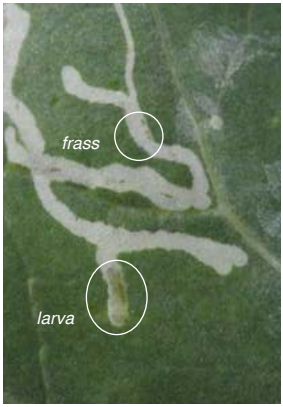
Adult: Small grey or black fly about 3 to 4mm long.

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 – serpentine

Liriomyza huidobrensis

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. In severe cases the plant may die.

Adults can cause significant feeding damage if numbers build too high.

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)

Looper

Chrysodeixis eriosoma, Chrysodeixes 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 through to autumn.

Adult green looper moth (S Mae)

Green looper caterpillar (J Ekman)

Mite – blue oat mite

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: Pinkish orange and 0.3mm long immediately after hatching, darkening as they mature.

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. When daily maximums exceed 20°C resting eggs are laid. These hatch only after exposure to high temperatures followed by cool weather and rain.

Blue oat mites and damage (P Umina, Cesar) *and adult mite* (M Rennert)

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

Halotydeus destructor

DESCRIPTION

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

Nymph: Reddish pink with six legs, 0.2mm long, darkens as they mature.

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

DAMAGE

Tears plant leaves to release sap, resulting in large, whitish patches on leaves. Mainly feeds in the morning or during 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 on broccoli, showing leaf damage (R Lancaster DAFWA)

Redlegged earth mite (S Mae)

Mite – two-spotted mite

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)

Onion maggot

Delia platura

DESCRIPTION

Egg: Tiny, white eggs are laid in the soil or on decaying organic matter.

Larva: Creamy to yellowish maggot with black feeding hook, up to 5mm long. Can be found both in the soil and on plants. Pupates within the top 5cm of soil.

Adult: Grey fly up to 5mm long, similar to a tiny housefly but with a thin abdomen and reddish eyes.

DAMAGE

Larvae burrow into seeds and seedlings, destroying the seeds and stunting young plants. Cauliflower curds can be attacked, producing brown feeding trails. These are an entry point for disease, increasing development of soft rots.

MOST COMMON

Often found in spring, but can tolerate a wide range of climatic conditions. Can be hard to detect in brassicas because of similar, non-pest flies also present.

Onion maggot (left) and pupae (right) on cauliflower curd
(S Learmonth, DAFWA)

Onion maggot fly (D Makhnovsky)

Parasitoid wasps

Trichogramma spp., *Telenomus* spp., *Diadegma* 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 directly into pest caterpillars or pupae (e.g. *Cotesia*, *Diadegma*, *Netelia* and *Diadromus*). Many are black or grey but a few are more brightly coloured.

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

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 shown below* (J Ekman)

BENEFIT

The adult females lay their eggs inside eggs, caterpillars or pupae of pest insects, or directly into aphids. The wasp larvae develop inside their host, consuming it from the inside. The host fails to develop, frequently ceasing to feed, and is eventually killed.

MOST COMMON

Any time of year.

Trichogramma wasp parasitising heliothis eggs (P Sinkyrik)

Parasitised aphid 'mummies' (N Dimmock Uni Northampton, Bugwood.org)

Plague soldier beetle

Chauliognathus lugubris

DESCRIPTION

Larva: Soil dwelling, with distinct rounded segments. Larvae are strict carnivores that eat insect pupae, insect eggs, young caterpillars and other organisms. They 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 periodically form to mate, the causes of which are not understood.

Plague soldier beetle adult (J Ekman)

Redback spider

Latrodectus hasselti

DESCRIPTION

Egg: Round, white egg sacs constructed within untidy 'tangle' webs. Each sac can contain up to 150 eggs.

Adult: Initially light coloured, females soon darken to jet black, with a clearly identifiable bright red longitudinal stripe on the abdomen. Males remain light brown with white markings. Females can grow to 10mm with a pea sized abdomen, whereas slender males are only 3 to 4mm long.

DAMAGE/BENEFIT

Spiders are nocturnal, feeding on small ground dwelling insects such as beetles, millipedes and slaters. Although uncommon, redback spiders are a significant contamination issue if found in broccoli heads.

MOST COMMON

Populations peak in summer, especially if conditions are hot and dry and non-pest populations of insects are high. They can also enter harvested broccoli from webs on bins and equipment.

Webbing with egg sacs, an immature female found on broccoli at retail (consumer image) and adult female spider.

Root knot nematode

Meloidogyne spp.

DESCRIPTION

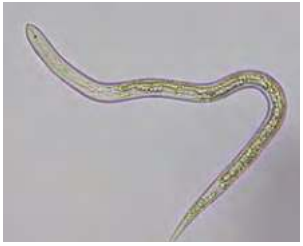
Nematodes are microscopic, wormlike organisms less than 1mm long and rarely visible to the naked eye. They live in the soil, where they parasitise plant roots.

DAMAGE

Swellings, knots and galls develop on infested roots. Upper parts of the plants wilt easily and yield may be reduced.

MOST COMMON

Symptoms are increased in warm environments (over 25°C) especially on mature plants. Nematodes spread in irrigation water, on machinery and through infested seedlings, making farm hygiene and crop rotation important control methods.



Meloidogyne incognita (S Nelson)

Root knot nematode symptoms on turnip (G Holmes, Bugwood.org)

Rove beetle

Paederus spp.

DESCRIPTION

Adult: Resembles an earwig or large ant more than a beetle due to the 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 brassica crops are not preferred hosts. The main issue is contamination of fresh cut products.

MOST COMMON

Multiplies during spring in weed species as well as in field crops such as sunflower, sorghum and safflower. Moves into vegetables when other hosts are unavailable.

Rutherglen bug (J Tweed)

Shore flies

Family Scatella

DESCRIPTION

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

Larva: Pale, brownish maggots which grow up to 3mm long. Pupae form on or in the soil surface.

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

DAMAGE

Adults and larvae feed on algae, yeast and soil microorganisms. Although they do not directly damage plants they leave black excrement (fly specks) on 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.

Adult shore fly (Tony D) *and pupa, showing the sidewise pointing 'horns' (spiracles) typical of shore flies*

Springtails

Family Collembola

DESCRIPTION

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

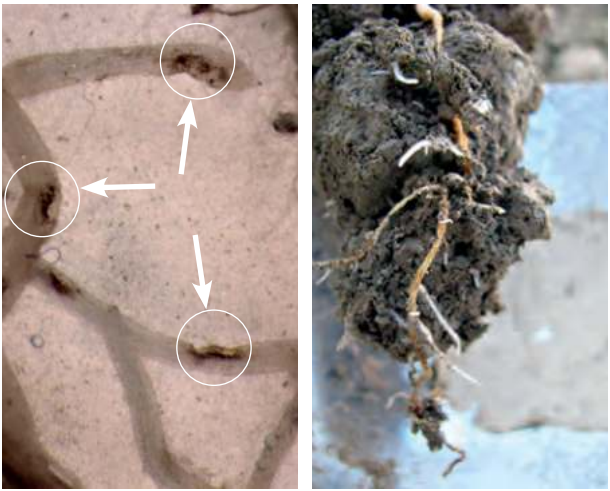
Nymph and Adult: Semitransparent, ranging in size from 0.5 to 2mm long. Soil inhabiting springtails are effectively blind and semi-aquatic. They lack the springing apparatus of above ground species.

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.



Springtail damage to young plant roots (L Du Toit, WSU)

Staphylinid beetle

Family Staphylinidae

DESCRIPTION

Larvae: Small, creamy white to transparent grub with six legs and distinct segmentation. Thought to feed mainly on decaying organic matter.

Adult: Tiny (1 to 2mm long), slender black beetle. Short wing covers, but is able to fly. Similar appearance to the related predatory 'rove beetle', but much smaller.

DAMAGE

Adults fly into crops, resulting in rapid and difficult to detect infestation. The beetles feed on cauliflower curds, making them brown and unmarketable.

MOST COMMON

Little is known about this insect, which is a relatively new pest of cauliflower in south-west Western Australia.

Browning of cauliflower curd due to feeding by Staphylinid beetle and (top) adult beetle in close-up and on a cauliflower leaf (S Learmonth DAFWA)

Thrips – onion, western flower

Thrips tabaci, Frankliniella occidentalis

DESCRIPTION

While there are many species of thrips, onion thrips and western flower thrips (WFT) are the main pest species affecting brassica crops. Identification of thrips species is difficult due to their tiny size. Significant magnification is required.

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

Adult: Light to dark brown with thin bodies about 1 to 2mm long. Narrow, transparent wings are held along their backs.

DAMAGE

Feeding causes silvering of the leaves, in severe cases leading to leaf curling. The major damage potentially caused by certain thrips species is their transmission and spread of viruses (e.g. tomato spotted wilt virus) into the crop.

MOST COMMON

All brassica crops can be affected, especially during warm, dry weather. Onion thrips are common in early summer, WFT more common in mid to late summer. Thrips prefer new shoots as well as hiding in the leaf axes of young seedlings. Control is difficult, as WFT is particularly known for insecticide resistance.

Western flower thrips (C Maureira)

Thrips damage on rocket
(Uni Massachusetts Extension)

Onion thrips on a broccoli leaf
(W Cranshaw CSU Bugwood.org)

Thrips damage to cabbage (P Bachi Uni Kentucky, Bugwood.org)

Weevil – apple

Otiorhynchus cribricollis

DESCRIPTION

Egg: Whitish, less than 1mm long and laid in the soil during autumn.

Larva: Creamy white C-shaped grub with no legs and brown head, growing up to 10mm long.

NB. Similar appearance to garden weevil larvae, which is not known to be a pest of brassicas.

Adult: Glossy, dark reddish brown to black weevil, about 8mm long. All are female and cannot fly.

DAMAGE

Larvae kill seedlings and young transplants by chewing through stems just below the soil surface. Adult weevils are nocturnal, spending the day burrowed shallowly into the soil. They emerge at night to feed on leaves, particularly the growing tips, and can ringbark young stems.

MOST COMMON

Found in southern Australia, apple weevils are mainly a pest of grapevines and orchards. However, brassica crops are also occasionally damaged, especially in WA.

Larvae of the apple weevil (L) and almost identical garden weevil (R) (S Learmonth DAFWA) *and adult weevil* (JS Hansen)

Weevil – small lucerne

Atrichonotus taeniatulus

DESCRIPTION

Egg: Cream, less than 1mm long, laid in the soil during autumn.

Larva: Creamy white C-shaped grub with brown head growing up to 7mm long.

Adult: Light grey weevil with darker mottled stripe along its back and sides. Similar to the whitefringed weevil but smaller (5 to 8mm long) and with lighter, colouring.

DAMAGE

Larvae kill seedlings and young transplants by chewing through stems just below the soil surface. Adult weevils feed on leaves and can ringbark young stems.

MOST COMMON

Most likely to be a problem during early crop establishment, especially on paddocks previously used to grow broadacre crops such as clover or lucerne.

Small lucerne weevil (R Briggs)

Weevil – spotted vegetable

Desiantha diversipes

DESCRIPTION

Egg: Whitish, less than 1mm long and laid in the soil during autumn.

Larva: Creamy white C-shaped legless grub with orange-brown head growing up to 7mm long.

Adult: Speckled grey and black weevil with distinct 'snout'. Adults are smaller than most other weevil species at only 5mm long.

DAMAGE

Larvae kill seedlings and young transplants by chewing through stems just below the soil surface. Adult weevils feed on emerging leaves and can ringbark young stems.

MOST COMMON

Most damage occurs in early spring through to summer, as larvae mature and adults emerge. Although common in southern Australia, this weevil is not usually a serious pest of brassica crops.

Larva (DAFWA) *and adult weevil* (N Odgers)

Weevil – vegetable

Listroderes difficilis

DESCRIPTION

Larva: Creamy yellow or greenish C-shaped legless grub with brown to black head and black jaws, up to 15mm long. They can be identified by the presence of a brown plate, just behind the head. Pupates in the soil in early spring.

Adult: Mottled brown to grey weevil up to 10mm long. They have a distinctive pale V-shaped mark three quarters of the way along their back and a broad snout.

DAMAGE

Nocturnal larvae and adults chew distinctive rounded holes in leaves. Damage is generally superficial but affects plant appearance and saleability. Heavy infestations can kill seedlings.

MOST COMMON

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

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

Weevil – whitefringed

Naupactus leucoloma

DESCRIPTION

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

Larva: Whitish C-shaped legless grub with creamy head and black jaws, up to 15mm 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 ground where they eat plant roots. They can kill seedlings and young transplants by chewing through stems just below the soil surface. Adults feed on lower leaves but rarely cause major damage.

MOST COMMON

Mainly a pest of potatoes and legumes such as lucerne. However, larvae remaining in the soil following a susceptible 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 (Westonmarshall)

Whitefringed weevil larva (JC French Bugwood.org) *and damage to cauliflowers* (S Learmont DAFWA)

Whitefly - brassica

Aleyrodes proletella

DESCRIPTION

Egg: Laid in circles in the dimples on leaf undersides and surrounded by a white, waxy protective 'halo'.

Larva: Wingless, flattened and approximately half the size of the adult.

Adult: Approximately 2mm long with bright white, waxy wings and characteristic grey patches. Wings do not overlap, but are held flat across the back.

Adults fly up from underneath leaves if disturbed.

DAMAGE

Prefers brassicas with crinkly leaves, such as kale, savoy cabbage and wombok. Feeding reduces plant vigor. High populations cause yellow patches along the edges of older leaves and are a contamination issue.

MOST COMMON

Brassica whiteflies can breed year round in warm climates. While the adults are not strong flyers, they can spread long distances on the wind.

Egg laying on the underside of cabbage leaves, showing characteristic waxy discs surrounding eggs laid in a rough circle (A Ryland)

Brassica whitefly adult with eggs (JT Taracido) *and adults and larvae on cabbage* (A Ryland)

Brassica whitefly damage to savoy cabbage

Whitefly - silverleaf

Bemisia tabaci

DESCRIPTION

Egg: Eggs are laid in groups on leaf undersides.

Larva: First instar larvae are flat, greenish, mobile and around 0.3mm long. As they develop they become opaque white and stationary on the leaf. Mature larvae darken to orange-yellow, their bodies thicken and eyes become dark red. These eventually turn into pupae.

Adult: Approximately 1.5mm long, with light yellow body and head and reddish eyes. Pure white, waxy wings overlap, and are held in a tent along the body.

DAMAGE

Larvae and adults suck sap from plants, stunting growth and reducing yield. Leaves develop silvery patches and may drop, while broccoli stalks can be bleached.

Whiteflies excrete sticky honeydew, which encourages sooty mould growth. Silverleaf whiteflies can also transmit some viruses.

MOST COMMON

Whiteflies can tolerate a wide temperature range, continuing to develop between 10 and 35°C.

A mild winter followed by temperatures 25 to 28°C allows rapid development.

White stem symptoms on broccoli (P De Barro)

Silverleaf whitefly and mature nymphs (left, P De Barro; right, V Andras)

Silverleaf whitefly adult (D Gutierrez)

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 larvae (dnnya17 cabi) *and adult beetles with damage to young cauliflower* (S. Learmonth DAFWA)

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.

Wireworm larva (M Bertone)

Click beetle (adult true wireworm) (Skitterbug)

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 centre of the lesions. As the lesions age they dry and become papery, eventually falling out to give a 'shot hole' effect.

FAVOURED BY

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

Alternaria leaf spot on broccoli (G Higgins) *and turnip* (H George)

Alternaria leaf spot on cabbage (L Tesoriero)

Alternaria on broccolini (B Winter) *and cauliflower curd* (Cornell CALS)

Anthracnose

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.

FAVOURED BY

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

Anthracnose on a turnip leaf (S Smith Uni Arkansas)

Anthracnose on a turnip root, with visible mycelia (L Tesoriero NSW DPI)

Anthracnose produces characteristic whisker-like hairs (setae) along with masses of long, sickle-shaped spores (I Matershev)

Bacterial leaf spot

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 with wetness on leaves. Moderately uncommon.

Bacterial leaf spot on rocket and broccoli leaf (L Tesoriero NSW DPI)

Bacterial soft rots

Pectobacterium spp., *Dickeya* spp. *and Pseudomonas* spp.

SYMPTOMS

Wet, slimy rot of stems, leaves and heads, often with an unpleasant smell. Wombok and buk choy are particularly susceptible.

FAVOURED BY

Infection can occur from the soil or through injuries, with development increased by warm, wet weather. Although infection mainly occurs in the field, symptoms may develop and spread postharvest.

Failing to cool products quickly after harvest, poor cool chain management and wet conditions (e.g. due to melted ice inside packaging) increase rot development.

Bacterial head rots on cabbage, showing symptoms in the field (Ontario MAF) *and postharvest* (G Holmes Bugwood.com)

Bacterial head rot of cauliflower (R Lancaster DAFWA)

Bacterial rots of broccoli. Although initial infection occurred at wounds created by leaf trimming and damage during handling, development has been accelerated by the heads remaining wet in melted ice (J Ekman)

Postharvest development of bacterial soft rot in buk choy (J Ekman)

Black root rot

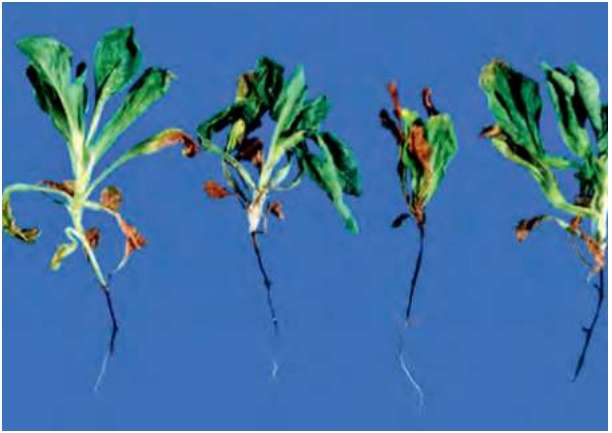
Berkeleyomyces basicola

SYMPTOMS

Long red to black lesions develop on the roots, stunting growth. Cutting across the base of the plant reveals blackening in the vascular tissue.

FAVOURED BY

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



Black root rot on roots (INRA) and effects on young seedlings
(L Tesoriero NSW DPI)

Blackleg disease

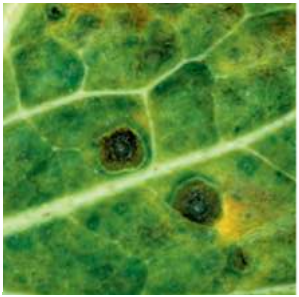
Leptosphaeria maculans

SYMPTOMS

Brown to grey circular lesions form on the leaves, with irregularly distributed pinhead dots (pycnidia). As the disease spreads through the plant, the stems develop sunken dry cankers, especially around the plant base and roots.

Wet, windy weather, especially at temperatures from 5 to 20°C. The fungus generates two types of spores; windborne ascospores and pycnidia, which spread in rain splash and irrigation water. The disease can also spread in seeds.

Blackleg disease on leaves (E Brock)



Blackleg effects on broccoli stem (M Hill) *and leaves* (L Tesoriero)

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. Becomes thin and papery. Veins become blackened within the necrotic area.

FAVOURED BY

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

Black rot on brassica seedling and cabbage (L Tesoriero NSW DPI)

Black rot on cauliflower (R Lancaster DAFWA) *and savoy cabbage* (K Brandt)

Clubroot

Plasmodiophora brassicae

SYMPTOMS

Distortion and thickening of the roots, particularly the tap root. Plants tend to wilt, particularly on hot days, lack vigour and have stunted growth. Infected roots are unable to effectively take up water and nutrients, and eventually the plant will die.

FAVOURED BY

Warm temperatures combined with wet, acidic (pH less than 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, so preventative disease management involves using resistant varieties, liming soil to raise pH over 7.0, in-furrow fungicide application at transplanting, improving drainage and rotating crop types.

Clubroot on broccoli (S Grigg)


Rocket (S Grigg) *and turnips* (G Holmes Bugwood.org) *affected by club root*

Wilting and yellowing of club root infected broccoli (S Grigg)

Damping off

Pythium spp., *Phytophthora* spp., *Rhizoctonia solani*

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.

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. Seedling trays which have not been properly sterilised before use can transmit the disease to new crops.

NB. Seedlings which survive damping off can develop disease symptoms as they grow. See 'Wire stem' entry for more information."

Damping off in broccoli seedling roots (top) (R Lancaster DAFWA)

Early (top) and advanced damping off of broccoli seedlings, and affected seedling showing brown rot at the soil junction (B Winter)

Downy mildew

Hyaloperonospora parasitica

SYMPTOMS

In the early stages, bleached or yellowish areas start to 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, dark brown angular speckling develops on more mature leaves.

FAVOURED BY

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

Symptoms on tatsoi (S Grigg) *and soft mould growth on leaf underside* (L Tesoriero NSW DPI)

Symptoms of downy mildew on the upper and lower leaf surfaces of broccoli seedlings (J Scrace)

Downy mildew symptoms on cabbage (G Holmes Bugwood.org)

Fusarium wilt / Cabbage yellows

Fusarium oxysporum sp. *conglutinans*

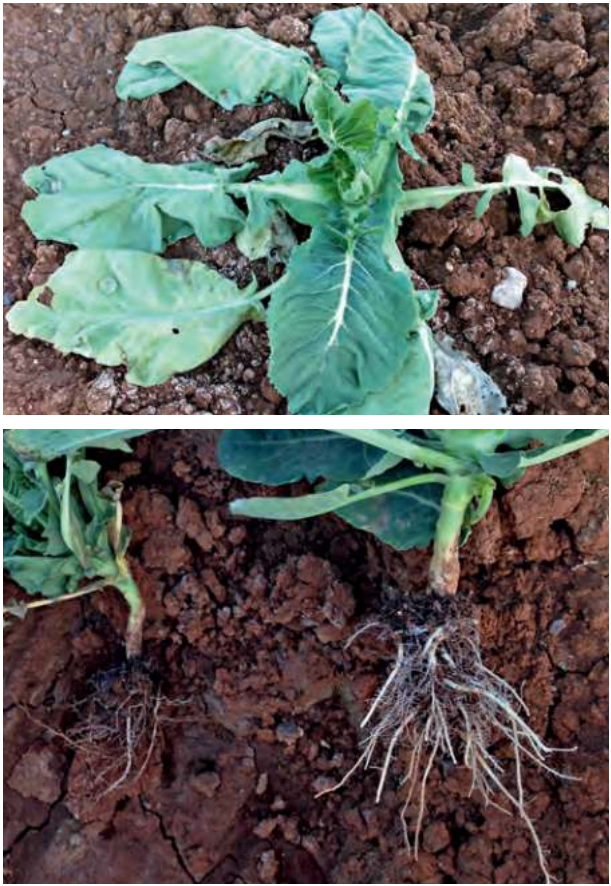
SYMPTOMS

Usually develops 2 to 4 weeks after transplanting. Plants lose vigour and the lower leaves yellow, often more on one side of the plant than the other. Leaves and petioles on that side become curled and warped. Vascular tissues turn yellow, then brown, and eventually the affected areas become dry and brittle.

FAVOURED BY

Warm weather, with the disease progressing most quickly at 25 to 30°C. Symptoms are exacerbated by potassium deficiency. The fungus can survive in the soil for extended periods. Varieties are available which are resistant to this disease.

Typical yellowing due to fusarium wilt on cabbage (KV Subbarao Uni California) *and effects in the field* (S Grigg)



Cauliflower with fusarium wilt and infected plant showing stunted root system on left, compared to normal, healthy plant on right (B Winter)

Grey mould

Botrytis cinerea

SYMPTOMS

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

FAVOURED BY

Cool, damp growing conditions. Although grey mould infection often occurs in the field, symptoms mainly appear postharvest. The disease is most likely to develop if the plant tissue is damaged and/or remains wet during storage. The fungus continues to grow at temperatures close to 0°C, making it difficult to control during storage and transport.

Grey mould on a plant stem (C Franco) *and a broccoli head* (T Kristensen)

Peppery leaf spot

Pseudomonas syringae pv. maculicola

SYMPTOMS

Small, black to purple irregularly shaped spots and speckling develop on leaves, sometimes with thin yellow margins. Can be seed borne and survive on crop residues. Symptoms are usually greatest on the leaf under-surfaces.

FAVOURED BY

Prolonged cold, damp conditions. Symptoms progress postharvest, especially if the leaves remain wet and/or the cold chain is not maintained.

Peppery leaf spot on brussels sprouts (QDAFF) *and cabbage* (M McGrath Cornell CALS)

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.

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, crop debris, irrigation water and, potentially, insects.

Phoma leaf spot (L Tesoriero NSW DPI)

Powdery mildew

Erysiphe cruciferarum

SYMPTOMS

Irregularly shaped patches of white, powdery mould grow over the upper surfaces of leaves and stems, particularly older leaves. Occasionally also develops on the lower leaf surface.

FAVOURED BY

Warm, dry conditions.

Powdery mildew on tatsoi (HJ Jee) *and wombok* (N Gunasingh)

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, wet weather, where leaves stay wet continuously for at least 24 hours. Symptoms may not develop for up to two weeks after infection. More likely to occur if the new crop is planted into undecomposed crop residues.

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

Virus – mosaic

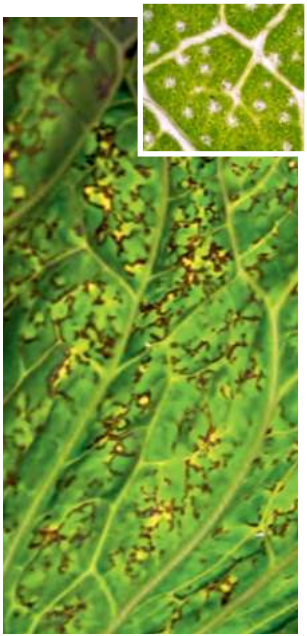
Alfalfa mosaic (AMV), Cauliflower mosaic (CaMV), Cucumber mosaic (CMV) Tomato spotted wilt (TSWV), Turnip yellows (TuYV), Cauliflower mosaic, Turnip mosaic

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.

FAVOURED BY

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



Turnip mosaic virus showing chlorotic (L) and necrotic effects (L Tesoriero NSW DPI)*, and inset showing detail of plant cells*

Cauliflower mosaic virus on seedlings (INRA)

Turnip mosaic virus on buk choy (M McGrath, Cornell CALS)

White blister / White rust

Albugo candida

SYMPTOMS

Raised white spots appear, mainly on the undersides of leaves, with corresponding light green or yellow spots on the upper leaf surfaces. Initially smooth, these lesions become powdery and blister like and can distort leaves.

On broccoli heads, white blister causes flower buds to enlarge, sometimes with white petals becoming visible, making heads unmarketable.

Infection can also progress through the plant's internal tissues, resulting in abnormal growth, lumps and cankers.

FAVOURED BY

Humid weather, where leaves remain damp from irrigation, dew or fog, combined with temperatures from 6 to 24°C. The disease can be transmitted by air borne spores, in irrigation water and on crop residues.

Broccoli and leafy Asian vegetables can be highly susceptible, while the large number of races means even nominally 'resistant' varieties can become diseased.

White blister on broccoli leaf underside (S Grigg)

White blister on the top surface of broccoli leaves (R Lancaster DAFWA), *symptoms on choy sum* (L Tesoriero NSW DPI) *and a broccoli head* (S Grigg)

White leaf spot

Pseudocercosporella capsellae

SYMPTOMS

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

FAVOURED BY

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

White leaf spot on a turnip leaf (N Cattlin)

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

White mould/Sclerotinia

Sclerotinia sclerotiorum

SYMPTOMS

Initially found in decaying tissue in lower leaves, the fungus develops into a soft, wet rot covered with white, cottony fungal growth. All parts of the plant may be affected. In later stages hard black resting bodies (sclerotia) form. These can be up to 10mm across and irregularly shaped.

FAVOURED BY

Cool, moist conditions.

White mould rotting a cauliflower head (R Lancaster DAFWA) *with postharvest symptoms* (inset J Ekman)

Sclerotinia fungus and sclerotia on broccoli (Uni Arizona), *brussels sprouts and cabbage* (L Tesoriero NSW DPI)

Wire stem

Rhizoctonia solani

SYMPTOMS

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

FAVOURED BY

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

Wire stem, causing collapse of young broccoli plants
(R Lancaster DAFWA, L Tesoriero NSW DPI)

Effects in the field of damping off (top) (R Lancaster DAFWA) *and Rhizoctonia infection of cabbage* (G Holmes Valent USA Corp Bugwood.org)

Disorders

Boron deficiency / Hollow stem

SYMPTOMS

Stems and petioles become brittle, cracking and splitting easily. Brownish, water soaked lesions appear on cauliflower curds and broccoli florets, which also develop a strongly bitter taste. As plants grow they develop hollow stems, with brown, corky lesions both inside and outside.

CAUSED BY

Brassicas have a high requirement for boron, so deficiencies are relatively common. Boron deficiency is most likely in light sandy soils, soils that have had heavy applications of lime or dolomite, and strongly acid soils. Symptoms can often develop as the soil dries after an extended wet spell.

Boron deficiency symptoms on broccoli head (JK Clark UC IPM)

Early (top) and advanced (bottom) symptoms in cauliflower and broccoli (R Weir, NSW DPI) *and hollow stem symptoms on cauliflower* (S Grigg)

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.

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, when development is rapid but evaporation and, therefore, water movement through the plant is reduced. Particularly affects the inner leaves.

Tipburn in savoy cabbage (S Grigg) *and cauliflower* (ST Koike UC Davis)

Chocolate spot (cauliflower)

SYMPTOMS

Brown, soft rotten floret in what otherwise appears to be a healthy head.

CAUSED BY

Physical damage to the curd, causing internal breakage and floret death.

Chocolate spot of cauliflower (S Grigg) *and (inset) cut section showing broken floret* (G Holmes Valent USA Bugwood.org)

Cold damage/Purpling (broccoli)

SYMPTOMS

Broccoli head develops a purplish tone, particularly on the most exposed parts.

CAUSED BY

Weather that is too cold for the variety being grown.

Purpling of broccoli heads (J Ekman)

Curd discolouration

SYMPTOMS

Cauliflower head may be yellowed, greenish or even pink toned, especially on the outer curds.

CAUSED BY

Sun exposure, especially if combined with high temperatures. Varieties that lack good leaf cover over the head are most susceptible to this disorder. Can also be caused by genetic variation in the seed line.

Pink and greenish discolouration of cauliflower heads compared to normal white head (R Lancaster DAFWA)

Curd blackening

SYMPTOMS

Light brown spots appear on the cauliflower curds, primarily at the apices of the florets. These darken over time, becoming brown to black.

CAUSED BY

The causes of curd blackening are unclear. The condition could be due to microbial infection, physical damage, physiological stress, or a combination of causes. It is possible ethylene may also play a role. Curd blackening generally occurs during extended storage.

Curd blackening (J Ekman)

Ethylene damage

SYMPTOMS

Premature yellowing of leaves, bud opening and yellowing of broccoli heads and discolouration of cauliflower curd. Leaves tend to detach from the main stem and storage life is reduced.

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.

Broccoli three weeks after harvest; the head at the left was exposed to ethylene whereas the head at right was protected from it (J Ekman)

Buk choy yellowing due to ethylene exposure (J Ekman)

Fertiliser burn

SYMPTOMS

Blackened necrotic areas or bleached patches appear and expand on the leaves and in the leaf axils. Leaves can wilt, become chlorotic and die.

CAUSED BY

Application of dry fertiliser which has stayed on the leaves.

Fertiliser granules and burn on broccoli (S Grigg)

Freezing damage

SYMPTOMS

Dark, water-soaked areas on leaves or florets. The plant tissue disintegrates and is likely to rot.

CAUSED BY

Can occur in products that have been top iced, such as broccoli, broccolini and brussels sprouts. Ice is usually -10°C or lower, so can freeze the plant tissue at contact points. Young florets in the centre of broccoli heads are most susceptible. Freezing damage can also occur if leafy greens (e.g. buk choy) are placed directly under the delivery air in coldrooms set at close to 0°C.

Freezing damage caused by top icing of brussels sprouts, and head rot in broccoli where the florets have been damaged by contact with ice (J Ekman)

Frost damage

SYMPTOMS

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

CAUSED BY

Frost settling on leaves for an extended period; tolerance varies between varieties.

Frost injury on rocket and broccoli (D Schellenberg)

Heat stress

SYMPTOMS

Buds develop unevenly on broccoli heads, potentially resulting in both overmature, yellowing buds and immature buds on the same head. These form indents where water can pool following rain or irrigation, increasing the risk of bacterial soft rots.

CAUSED BY

High temperatures during the shift from vegetative growth to development of the inflorescence. The critical period occurs over the 10 day period just before the crown becomes visible. Severe heat can also kill individual flower buds, resulting in head rots.

Heat stress of broccoli heads, resulting in uneven bud formation and individual floret rots (M McGrath, Cornell CALS)

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 leaf inrolling and distortion and the appearance of bleached, chlorotic patches. Damage is often most severe on the leaf margins, and results in stunted growth.

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 to pak choy, broccoli seedlings (S Grigg) *and buk choy* (L Tesoriero NSW DPI)

Hollow stem

SYMPTOMS

Small, elliptical cracks in the inner stem widen as the plant grows, eventually forming a cavity. This provides an entry point for pathogens and results in brown, corky lesions. In broccoli and cauliflower the cavity can extend into the head, affecting the florets.

CAUSED BY

Acidic, light textured soils. While hollow stem is often associated with boron deficiency it is often caused by a combination of factors. High soil nitrogen and potassium, together with wide plant spacing of large, fast-growing cultivars, are associated with the disorder.

Hollow stem symptoms on cauliflower (S Grigg) *and broccoli* (C Rohwer)

Magnesium deficiency

SYMPTOMS

Often produces characteristic bright yellow chlorosis on the older leaves. Chlorosis spreads from the tips and margins towards the main vein. Eventually only a small triangular area near the leaf base may remain green. In cauliflower and cabbage, pale to brown necrotic areas can appear between leaf veins without prior yellowing.

CAUSED BY

Acidic, light textured soils are most likely to become deficient, especially if heavily fertilised. Dolomite can be used to correct this deficiency.

Symptoms on broccoli and cauliflower (R Weir, NSW DPI)

Manganese toxicity

SYMPTOMS

Yellowing and then death of the margins on the older leaves. As the inner area continues to grow, the leaves develop a cupped appearance. Leaves become spotted and scorched, particularly around the margins.

FAVOURED BY

Usually an issue on acid soils. Symptoms are worse if periodic waterlogging is followed by warm dry spells.

Manganese toxicity on broccoli (C Rosen Uni of Minnesota)

Molybdenum deficiency

SYMPTOMS

Without molybdenum plants are unable to use the nitrates absorbed from the soil, so initial symptoms can resemble nitrogen deficiency. However, accumulation of nitrates in the leaf edges causes them to become distorted and develop a whitish, scorched appearance.

Cauliflowers develop 'whiptail', in which the leaf margins progressively die back causing the leaves to become narrow and distorted. Eventually, new leaves may be little more than midribs with small, irregular sections of leaf blade attached.

CAUSED BY

Associated with acid soils. Cauliflower is particularly susceptible.

Whiptail symptoms in cauliflower (R Lancaster DAFWA)

Nitrogen deficiency

SYMPTOMS

Plants are pale and chloritic and growth is reduced. Older leaves in particular may yellow and die 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. Incorporation of high carbon soil amendments, such as straw, can lock up available nitrogen in the soil.

Nitrogen deficiency in broccoli seedlings (S Grigg) *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.

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 internal cells, causing them to blister and burst.

Oedema results in raised blisters (Saillog) *which develop into corky growths* (Utah State University)

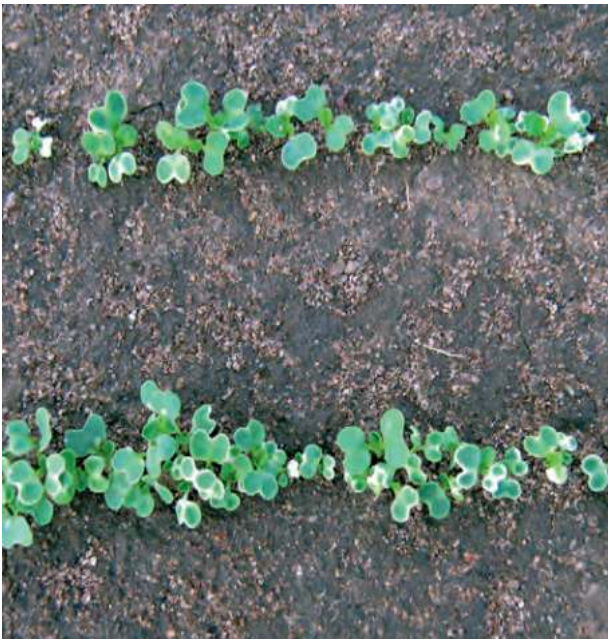
Old seed

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.

FAVOURED 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)

Pepper spot / Gomasho

SYMPTOMS

Although pepper spot or 'gomasho' can occur on European cabbages, it is most common on wombok.

Small, dark, oval spots develop, about the size of sesame seeds. Initially these appear on the white midribs of the outer leaves but spread gradually into the centre of the head. Spots develop on both the outer and inner leaf surfaces and worsen during postharvest storage, especially at temperatures above 2°C.

CAUSED BY

The cause of this disorder is unknown, but is likely to be a combination of environment and varietal factors. High rates of nitrogen fertilisation may increase symptoms.

Pepper spot on wombok (J Ekman)

Phenolic browning

SYMPTOMS

Cut or damaged surfaces turn brown

CAUSED BY

Damage to the plant cells allows phenolic compounds to mix with oxidative enzymes. This results in formation of the brown compound melanin.

The reaction does not occur instantly, but increases over time, especially at warm storage temperatures. Phenolic browning can be minimised by trimming using a sharp knife and storing at close to 0°C.

Phenolic browning of the cut surfaces of Brussels sprouts and leaf bases of broccoli (J Ekman)

Phosphorus deficiency

SYMPTOMS

Poor growth, older leaves (or cotyledons in seedlings) turn bluish green or purple. Stems are thin and break easily.

CAUSED BY

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

Purpling of rocket and cauliflower due to Phosphorus deficiency
(R Lancaster DAFWA)

Potassium deficiency

SYMPTOMS

Yellowing and burned areas initially develop around the leaf margins and between the veins. Necrotic areas may be light brown to almost black. Symptoms are worst on the older leaves. The plant internodes can be reduced, resulting in a short growth habit.

CAUSED BY

Application of fertilisers which are unbalanced, being higher in nitrogen than potassium, often associated with intensive cropping.

Note that excess potassium reduces uptake of calcium and magnesium, potentially causing tipburn.

Potassium deficiency in cauliflower (R Weir NSW DPI) *and tatsoi* (S Parks NSW DPI)

Riciness (cauliflower)

SYMPTOMS

Curds are small and uneven. Individual parts of the florets elongate and separate, making them appear somewhat like grains of rice.

CAUSED BY

While there is no clearly defined cause, riciness is associated with high temperatures, especially if combined with rapid growth. Can be due to mismatch between the variety and the environment, or unusual growing conditions. Excess nitrogen may also contribute to the condition.

Riciness of cauliflower (Int produce training)

Salt burn

SYMPTOMS

Most common symptom is a general reduction in growth. In more severe cases leaves develop bleached, burned areas, typically at the leaf tip and around the edges. Older leaves develop problems first and can tend to fall off.

CAUSED BY

High levels of salt in soil or irrigation water. The problem is most common in inland irrigation districts, but can also occur in coastal areas where irrigation water is brackish. Irrigation management and drainage are important control measures.

Vegetable crops vary widely in their salt tolerance. For example, spinach is relatively tolerant but some brassicas can be quite sensitive.

Bleached leaf tip due to salt burn on tatsoi (S Parks, NSW DPI)

Warm weather syndrome

SYMPTOMS

Open, loose head on either broccoli or cauliflower

CAUSED BY

The variety is unsuited to the warmth of the climate in which it is being grown.

Open heads of cauliflower and broccoli

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.

Poor development associated with waterlogged soil (J Ekman)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