



# Pests, Diseases and Disorders of Brassica Vegetables

A FIELD IDENTIFICATION GUIDE

Jenny Ekman, Len Tesoriero and Stuart Grigg





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# Pests and Beneficials

# African black beetle

*Heteronychus arator*

## DESCRIPTION

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

**Larvae:** Whitish C-shaped grub up to 30mm long with light brown head and 6 legs. The rear end sometimes has a dark grey tinge.

**Pupae:** Golden to reddish brown, strongly indented and

shaped, found in the soil.

Adult: Shiny, reddish to black, stout-bodied beetle around 10-15mm long. Legs are adapted for digging. A strong flier - adults undertake mass dispersal flights, sometimes in spring but more commonly late March to April.



Larvae of black beetle larvae, 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 Qld and south western region of WA. 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 2.5 mm long. Winged adults are greyish with black head and thorax.

## DAMAGE

Can form large colonies on the youngest leaves which become stunted and distorted. Can spread cauliflower mosaic virus to brassicas. Also a potential contamination issue.

## MOST COMMON

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



Distorted leaves of cauliflower due to cabbage aphid infestation (R Lancaster DAFWA)



Adults, nymphs, parasitised 'mummies' (top, S Grigg) and cabbage aphid wingless adults (S Williams)

# Aphid – green peach

*Myzus persicae*

## DESCRIPTION

**Nymph:** Varies from yellowish to green.

**Adult:** Wingless adults are pale yellow to green and around 2 mm long. Winged females have black heads with dark red eyes and patterned bodies.

## DAMAGE

Causes leaf distortion through feeding, contaminates the product and potentially acts as a vector for many viruses. Large infestations can kill young plants.

## MOST COMMON

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



Green peach aphid nymphs (A Ryland)



Green peach aphids  
(EE Nelson Bugwood.org)  
and winged adult  
(S Bauer USDA ARS)

## Aphid – turnip

*Lipaphis erysimi*

### DESCRIPTION

**Nymph:** Yellowish to olive green. All stages appear similar with only size changing.

**Adult:** Wingless adults are 2–4mm long, yellowish to olive green and sometimes with a waxy appearance—especially under humid conditions.

Winged females are greenish with a dark patches on the thorax and head.

### DAMAGE

Aphids infest flowers and the undersides of leaves

(particularly older leaves) causing them to become curled and yellow. Plant growth may be stunted. Turnip aphids can potentially spread many viruses and are a potential contamination issue.

### MOST COMMON

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



Turnip aphids (L Turton, NSW DPI)

## Cabbage centre grub

*Hellula hydralis*

### DESCRIPTION

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

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

**Pupae:** Brown, often formed within webbing on the plant.

**Adult:** Mottled brown moth, wings held in a flattened tent over body, around 12 mm 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 QLD and NSW, high numbers occasionally in southern states during spring.



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

# Cabbage cluster caterpillar

*Crocidolomia pavonana*

## DESCRIPTION

**Egg:** Laid in a large cluster on the underside of leaves. Dark cream to brown.

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

**Pupae:** Golden brown, found in the soil.

**Adult:** Patterned, buff coloured moth with relatively large wings held in a tent over the body. Female has



Newly emerged caterpillars (top) (M Furlong DAFWA) and mature caterpillar (L Finn, Hunter Region School of Photography)

subtle markings while the male has distinct dark brown and cream wing patterning. Both have 2 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 NSW and Queensland.



Female moth (top) and male moth (L Finn, Hunter Region School of Photography)

# 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 around 30 mm long.

**Pupae:** 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 lines and rocket.



Cabbage white egg (J Ekman)



Cabbage white caterpillar 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. cream markings, reaching 50 mm length. Tend to curl into a ball if disturbed.

**Caterpillar:** Initially grey-green and feed as a group but separate as they mature. Caterpillars become dark grey to black with red, yellow and

**Pupae:** Reddish brown, found in the soil.

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

## DAMAGE

Caterpillars skeletonise leaves.

## MOST COMMON

Spring-autumn in Queensland. Very wide host range.



Emerging (A Carmichael, QUT) and young caterpillars (NSW DPI)



Mature caterpillar (NSW DPI) and adult moth (D Hobern)

# 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 50 mm length. Tend to curl into a ball if disturbed.

**Pupae:** 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.



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

## 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.

## 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 8–12 mm long with long, prominent sucking mouthpart for feeding. Long legs, of which the front two are stronger for grasping prey.

### DAMAGE

**Beneficial insect:** 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 10–12 mm long.

**Pupae:** 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 3 'diamond' shapes.

## DAMAGE

As they grow, caterpillars progress from mining the insides of leaves to making numerous small feeding



Feeding windows and holes in kale seedling and buk choy leaf (J Ekman)



holes or 'windows' (leaving the upper leaf surface intact). Mature caterpillars leave large holes, especially between leaf veins.

## MOST COMMON

Major pest of brassica crops. Numbers increase from spring in South Australia, summer in Victoria and autumn in Queensland. Eggs don't hatch below 8°C while temperatures over 35°C reduce insect survival.



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

## False wireworm / Vegetable beetle

*Gonocephalum* spp.

### DESCRIPTION

**Egg:** Laid on or just below the soil surface.

**Larvae:** Dark cream to golden larvae with round head and darker mouthparts. Hard, smooth body with obvious segments, up to 30 mm long. Similar to the common mealworm, to which they are closely related.

**Adult:** Dull dark grey, brown or black oval shaped beetle commonly known as a 'darkling beetle'. Thorax has flanged edges (like a pie dish).

### DAMAGE

Larvae live in the soil where they feed on newly germinated seeds and plant roots. Adults chew stems



False wireworm larvae (Virginia Tech Extension) and adult beetles with damage to young cauliflower (S. Learmonth DAFWA)



at ground level, and may ring-bark small plants.

### MOST COMMON

Larvae develop through autumn and winter but cause most damage during spring. Unlike true wireworms, false wireworms tend not to move around but live in the upper layers of loose, cultivated soil, or just under surface organic matter.

## Flea beetle

*Phyllotreta* spp.

### DESCRIPTION

**Egg:** White to oval, laid in the soil.

**Larvae:** 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.



Red headed flea beetle (top) (C Mares, QDAFF), flea beetle on rocket (Ontario MAF) and turnip flea beetle (right) (M Deml Encyclopedia of Life)

### 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 and rocket.



## Fungus gnats

*Bradysia* spp.

### DESCRIPTION

**Egg:** Tiny, laid in soil.

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

**Adult:** Tiny black flies 2–3 mm 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. Antennae have reddish brown tips.

**Adult:** Pale green bug approximately 7 mm long with clear wings folded flat over its back. Antennae nearly as

long as the body. Agile bug, sometimes with red markings.

### DAMAGE

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

### MOST COMMON

Summer months.



Nymph and adult green mirids (M Khan QDAFF)

## 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 15 mm long.

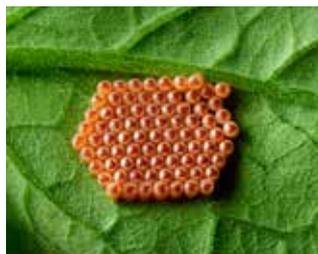
### DAMAGE

Young shoots are damaged by sap sucking. Adults can

be hard to see, so a potential contamination issue.

### MOST COMMON

Spring-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

**Egg:** Laid in clusters in moist soil debris.

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

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

### DAMAGE

**Beneficial insect:** 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 or in small groups. Ribbed, white domes 1 mm diameter, darkening to yellow, orange and finally brown before hatching.

**Caterpillar:** Initially 1.5 mm 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 50 mm long.

**Pupae:** Golden colour, generally found just under

the soil surface. Rain stimulates emergence.

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

## DAMAGE

Large, ragged holes in leaves, frass is a contamination issue.

## MOST COMMON

Warm weather. Larvae prefer leaf undersides or the central part of the plant.



Heliothis eggs (S Grigg)

Heliothis caterpillar (J Ekman) and adult moth (K Power)

## Hoverfly

*Syrphidae* spp.

### DESCRIPTION

**Egg:** Oval white eggs usually laid near aphid colonies.

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

**Adult:** Resembles a bee or wasp with black and yellow bands across its rather flattened abdomen, but actually harmless. Often

hovers near plants feeding on nectar and pollen.

### DAMAGE

**Beneficial insect:** maggots eat large numbers of aphids. However, larvae can present a contamination issue.

### MOST COMMON

Warm weather, especially summer.



Hoverfly adult (J Ekman) and larvae (A Ryland)

## Lacewing – brown

*Micromus tasmaniae*

### DESCRIPTION

**Egg:** Cream, oval eggs laid singly on leaves.

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

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

### DAMAGE

**Beneficial insect:** adults and nymphs are voracious predators of aphids, small caterpillars, thrips and mites. However, can be a contamination issue, especially as the adults' large wings may stick to wet leaves.

### MOST COMMON

Year round.



Brown lacewing larvae (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 8 mm long light brown larva which camouflages itself with the remains of its prey.

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



Adult green lacewing (J Ekman)

### DAMAGE

**Beneficial insect:** Adults and nymphs are voracious predators of aphids, small caterpillars, thrips and mites.

### MOST COMMON

Year round.

## Ladybird – fungus eating

*Illeis galbula*

### DESCRIPTION

**Larvae:** White with black dots and reptilian appearance, up to 6 mm long.

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



Fungus eating ladybird larvae (R Richter) and adult (J Ekman)

### 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.

# Ladybird – predatory

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

## DESCRIPTION

**Egg:** Upright yellow eggs, laid in small clusters.

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

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

## DAMAGE

**Beneficial insect:** Both adults and larvae are active predators of aphids, thrips, moth eggs and mites. However, ladybird larvae can represent a contamination risk.

## MOST COMMON

Late spring to autumn.



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



Transverse ladybird larvae (top) and white collared ladybird (J Ekman)

## Leafhopper / Jassid

Family Cicadellidae

### 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.



Spotted leafhopper (NSW DPI) & feeding damage on rocket (S Grigg)

## Leafminer

*Liriomyza brassicae*

### DESCRIPTION

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

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

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

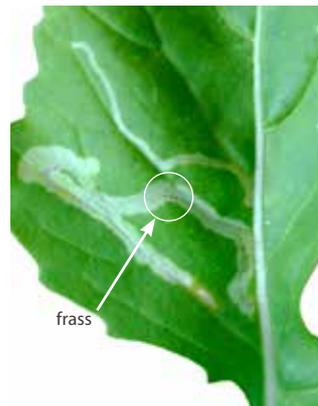
### DAMAGE

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.

## Looper

*Chrysodeixis* spp.

### DESCRIPTION

**Egg:** Laid singly, usually on leaf undersides. Ribbed, flattened domes cream to yellow in colour.

**Caterpillar:** Light green to dark green slender caterpillars with distinct looping motion (unlike heliothis, they have no central prolegs). Mature larvae are 35–40 mm long and feed openly on a wide range of host plants.

**Pupae:** Dark brown, attached to the plant.

**Adult:** Stout moth with richly patterned wings held in a tent over its body.

### DAMAGE

Holes in leaves, leaves can be skeletonised.

### MOST COMMON

Summer-autumn.



Adult moth (P Hampson, Bugwood.org) and caterpillar (J Ekman)

## Mite – blue oat

*Penthaleus* spp.

### DESCRIPTION

**Egg:** Round, laid singly or in clusters of 3–6 on the soil surface and on roots and stems of food plants.

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

**Adult:** Bluish black with 8 bright red legs and distinctive red mark on the back. Moves quickly if disturbed.

### DAMAGE

Active during cooler part of the day when it leaves 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 (Vic DPI) and adult mite (L Schimming)

## Mite – predatory

*Phytoseiulus persimilis*

### DESCRIPTION

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



**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.

### DAMAGE

**Beneficial mite:** Predatory on two spotted mite and bean spider mite.

### MOST COMMON

Multiplies rapidly at temperatures over 26°C.



Predatory mite *Phytoseiulus persimilis* (Bugwood.org (top) and M Talbot)

## 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 mites' body.

**Nymph:** Reddish pink with 6 legs, 0.2 mm 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 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 on broccoli (R Lancaster DAFWA) and mite (L Turton NSW DPI)

## 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 0.5 mm 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 (25–30°C).



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

## Onion maggot / Seedcorn maggot

*Delia platura*

### DESCRIPTION

**Egg:** Tiny, white, elongated eggs are laid in the soil or on decaying organic matter close to plants or seeds.

**Larvae:** Creamy to yellowish legless maggot up to 5 mm long. Can be found both in the soil and on plants. Pupates within the top 5 cm of soil.

**Adult:** Grey fly up to 5 mm long, appears similar to a tiny, slim housefly.

### 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) and (top) adult fly (PADIL)

## 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 0.5 mm long that lay their eggs inside moth eggs (eg *Trichogramma* or *Telenomus*) to larger species

up to 18 mm long that lay their eggs in pest caterpillars or pupae (eg *Diadegma*, *Netelia* and *Diadromus*). While many are black or grey, others are orange or a mixture of colours.

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



*Diadegma* sp., a parasitoid of diamondback moth (J Ekman) and pupae with newly emerged adult *Cotesia glomerata*, parasitoid of cabbage white caterpillars (S Grigg)

### DAMAGE

**Beneficial insect:** The adult females lay their eggs inside eggs, caterpillar or pupae of pest moths or butterflies, or directly into aphid adults or nymphs. One or many

larvae live inside their host, eventually killing it.

### 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

**Larvae:** 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 15 mm long.



Plague soldier beetle adult (J Ekman)

### DAMAGE

**Beneficial insect:** Predatory on aphids, caterpillar eggs and other pests, which are supplemented with nectar and pollen. However, can be a significant contaminant issue.

### MOST COMMON

Summer in southeastern Australia. Large swarms periodically form to mate, the causes of which are not understood.

## Root knot nematode

*Meloidogyne* spp.

### DESCRIPTION

Nematodes are microscopic, wormlike organisms <1 mm long 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 may appear stunted, yellow and wilt easily.

### MOST COMMON

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



Early (above) and late stages (right) of root knot nematode infestation (NSW DPI). A juvenile root knot nematode penetrating a plant root (top right).

## 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.

### DAMAGE

**Beneficial insect:** Predatory on various small insects. However, beetles contain a toxin which is released if they are damaged or crushed. This can cause extreme skin irritation, known as *Paederus dermatitis*.

### MOST COMMON

On soil around moist places. They are attracted to irrigated areas and hunt actively during the day.



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 5 mm 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.

### MOST COMMON

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



Rutherglen bug (J Ekman)



## Shore flies

Family Scatella

### DESCRIPTION

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

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

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

### DAMAGE

Both 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

# Silverleaf whitefly

*Bemisia tabaci*

## DESCRIPTION

**Nymph:** First instar nymphs are flat, greenish, mobile and around 0.3 mm long. Later instar nymphs are also flat but opaque white and stationary on the leaf, appearing similar to soft scale insects with slightly pointed tails.

**Pupae:** Mature nymphs turn yellow, their bodies thicken and eyes become dark red. These eventually turn into pupae.

**Adult:** Snow white, around 1 mm long with wings held in a peak 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, and can transmit some viruses.

## MOST COMMON

Whiteflies can tolerate a wide temperature range, continuing to develop between 10–35°C. A mild winter followed by temperatures 25–28°C allows rapid development.



Silverleaf whitefly nymph and white stem symptoms on broccoli (P De Barro)

Silverleaf whitefly adults and nymphs on cabbage (A Ryland)

# Springtails

Family Collembola

## DESCRIPTION

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

### **Nymph and Adult:**

Semitransparent, ranging in size from 0.5–2 mm 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 Staphilinidae

## DESCRIPTION

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

**Adult:** Tiny (1–2 mm 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 WA.



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

## Thrips – onion, western flower

*Thrips tabaci*, *Frankliniella schultzei*

### 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 <1 mm long.

**Adult:** Light to dark brown with thin bodies approx. 1–2 mm 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 (eg 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 axis' of young seedlings. Control is difficult, as WFT is particularly known for insecticide resistance.



Western flower thrips (PMJ Ramakers APR, Bugwood.org)

Thrips damage on rocket (Uni Massachusetts Extension) and cabbage (P Bachi Uni Kentucky Bugwood.org) and onion thrips on a broccoli leaf (W Cranshaw CSU Bugwood.org)

## Weevil – apple

*Otiorhynchus cribricollis*

### DESCRIPTION

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

**Larvae:** Creamy white C-shaped grub with no legs and brown head, growing up to 10 mm 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 8 mm 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

Although mainly a pest of grapevines and orchards, brassica crops have also been damaged, especially in WA.



Adult weevil (S Hinkley K Walker Museum Vic) and larvae of the apple weevil (L) and almost identical garden weevil (R) (S Learmonth DAFWA)

## Weevil – small lucerne

*Atrichonotus taeniatus*

### DESCRIPTION

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

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

**Adult:** Mottled light brown to grey weevil. Resembles the whitefringed weevil but slightly smaller (up to 8 mm long) and with a lighter, subtly striped 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 ground previously used to grow broadacre crops such as clover or lucerne.



Small lucerne weevils (S Learmonth DAFWA)

## Weevil – spotted vegetable

*Desiantha diversipes*

### DESCRIPTION

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

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

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

Although common in southern Australia, this weevil is not usually a serious pest of brassica crops. It is most likely to be a problem during early crop establishment, especially in WA.



Adult weevil (S Learmonth, DAFWA)

## Weevil – vegetable

*Listroderes difficilis*

### DESCRIPTION

**Larvae:** Creamy yellow or greenish C-shaped legless grub with brown to black head and black jaws, up to 15 mm 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 up to 10 mm long. They have a distinctive pale V-shaped mark  $\frac{3}{4}$  of the way along their back and a prominent snout.

### DAMAGE

Larvae and adults chew distinctive rounded holes in leaves during the evening and at night. Usually minor pest, 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 larvae (S Learmonth DAFWA), larvae on wombok (A Ryland) and (right) adult (DAFWA)

## Weevil – white fringed

*Naupactus leucoloma*

### DESCRIPTION

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

**Larvae:** Whitish C-shaped legless grub with creamy head and black jaws, up to 15 mm long.

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

### DAMAGE

Larvae live 5–15 cm 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.



Whitefringed weevil larvae (S Learmonth DAFWA), adult weevil (A Bradley) and damage to cauliflower seedling by whitefringed weevil larvae (S Learmonth DAFWA)

### 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.



## Wireworm

Family Elateridae

### DESCRIPTION

**Egg:** Laid in batches on the soil surface or in small crevices.

**Larvae:** 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 beetle with finely ridged wing covers. Commonly known as 'click beetle' due to its ability to right itself with a clicking noise if placed upside down.

### DAMAGE

Larvae live in the soil where they feed on plant roots.

### MOST COMMON

Most often a problem in fields recently planted to mulches or weedy. Larvae mainly cause damage during summer and autumn, when they feed on roots in the top 5 cm of soil. Transplants are particularly at risk. They burrow deeper into the soil under dry conditions but may re-appear after irrigation or in cooler temperatures.



Wireworm larvae (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.

## FAVOURED BY

Moist conditions, especially if plants are stressed. Can be seed borne and survive in plant debris, but generally uncommon.



Alternaria leaf spot on mizuna (Ontario MAF) and (inset) on cabbage (G Holmes Valent USA Corp Bugwood.org)



Alternaria spot on cabbage (L Tesoriero NSW DPI), broccolini (B Winter) and cauliflower curd (L Tesoriero NSW DPI)

## 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 – 20°C).



Anthracnose on a turnip leaf (S Smith Uni Arkansas) and turnip root (L Tesoriero NSW DPI)

## 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

Moderately uncommon.



Bacterial leaf spot on rocket (L Tesoriero NSW DPI)

## Bacterial rot – head

*Erwinia* spp., *Pseudomonas* spp.

### SYMPTOMS

A slimy, soft rot accompanied by a foul smell.

### FAVOURED BY

Infection occurs through injuries, with fungal growth further encouraged by warm, wet weather. While symptoms may be observed in the field, they are commonly expressed after harvest.



Bacterial head rots on broccoli (ST Koike UCANR) and cabbage (Ontario MAF)



Bacterial head rot of cauliflower, early and late symptoms (R Lancaster DAFWA)

## Bacterial rot – soft

*Pectobacterium carotovorum*

### SYMPTOMS

Wet, slimy rot of stems, leaves and heads of broccoli and cauliflower, often with an unpleasant smell. Wombok is particularly susceptible, both before and after harvest.

### FAVOURED BY

Warm, wet conditions. Common as a secondary infection following other physical damage.



Bacterial soft rot in wombok and cauliflower (L Tesoriero NSW DPI)

## Black leg

*Leptosphaeria maculans*

### SYMPTOMS

Plants wilt and the leaves become reddish around the margins. Stems and stalks develop sunken dry brown to purple lesions with irregularly distributed pinhead dots. These lesions eventually turn black, and split.

Grey circular spots form on the leaves, also containing large numbers of tiny black dots.

### FAVOURED BY

Wet, windy weather. Can be seed borne, or spread in irrigation water.



Black leg effects on broccoli stem and leaves (M Hill, L Tesoriero NSW DPI)

# 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.

## 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 diseased cabbages (L Tesoriero, NSW DPI)

# 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.

## FAVOURLED BY

Warm temperatures combined with wet, acidic (pH<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 5 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 disease management involves using resistant varieties, liming soil to raise pH over 7.0, improving drainage and rotating crop types.



Clubroot on broccoli (S Grigg)



Rocket affected by club root (S Grigg), clubroot on a single wombok (L Tesoriero NSW DPI) and wilting of affected 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

*Peronospora* spp.

## 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, black, angular speckling develops on more mature leaves.

## FAVoured BY

Cool, moist conditions.



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



Downy mildew symptoms of increasing age on rocket, broccoli and cabbage (*L Tesoriero NSW DPI*)

# Fusarium wilt / Cabbage yellows

*Fusarium oxysporum* sp. *conglutinans*

## SYMPTOMS

Usually develops 2–4 weeks after transplanting. Plants initially lose vigour and the lower leaves yellow, often on one side of the plant more 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 25–30°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)



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

## 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.

### FAVOURED BY

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



Peppery spot on wombok (L Tesoriero NSW DPI)

## Phoma leaf spot

*Phoma lingam* (asexual form of *Leptosphaeria maculans*)

### SYMPTOMS

Round to oval white-brown spots, up to 2 cm 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 15–20°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 on the upper surface of leaves and stems, particularly older leaves. Occasionally also on the lower leaf surface.

### FAVOURSED BY

Warm, dry conditions.



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

## Ring spot

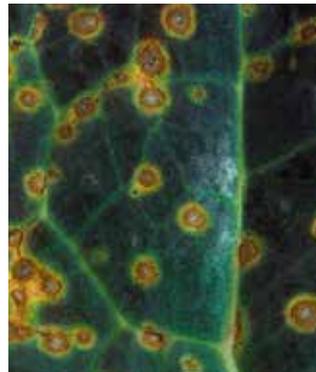
*Mycosphaerella brassicola*

### 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.

### FAVOURSED 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.



Ring spot on cabbage (L Tesoriero NSW DPI) and purple tatsoi (S Grigg)



## Root rot – black

*Thielaviopsis basicola* (syn. *Chalara elegans*)

### 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.

### FAVOURED BY

Soil temperatures  $<20^{\circ}\text{C}$ , soil pH  $>5.6$ . 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)

# Virus – Mosaic

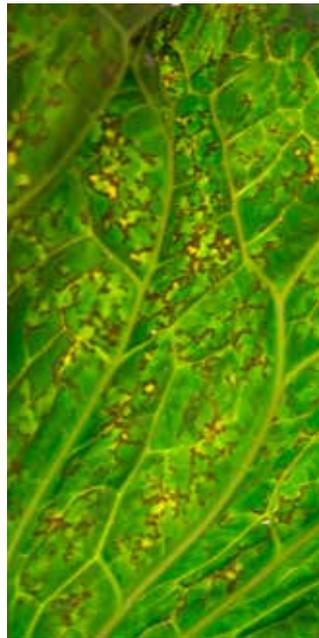
*Alfalfa mosaic, Cucumber mosaic (CMV) Tomato spotted wilt virus (TSWV),*

## 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)

*Cauliflower mosaic, Turnip mosaic*



Cauliflower mosaic virus on seedlings (INRA), turnip mosaic virus on turnip leaves (DB Langston Uni Georgia Bugwood.org) and buk choy (L Tesoriero NSW DPI)

# 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 plants internal tissues, resulting in abnormal growth, lumps and cankers.



White blister on broccoli leaf underside (S Grigg)

## FAVOURED BY

Humid weather, where leaves remain damp from irrigation, dew or fog, combined with temperatures from 6–24°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 the top surface of broccoli leaves (R Lancaster DAFWA), symptoms on choy sum (L Tesoriero NSW DPI) and a broccoli head (J Ekman)

## White leaf spot

*Pseudocercospora capsellae*

### SYMPTOMS

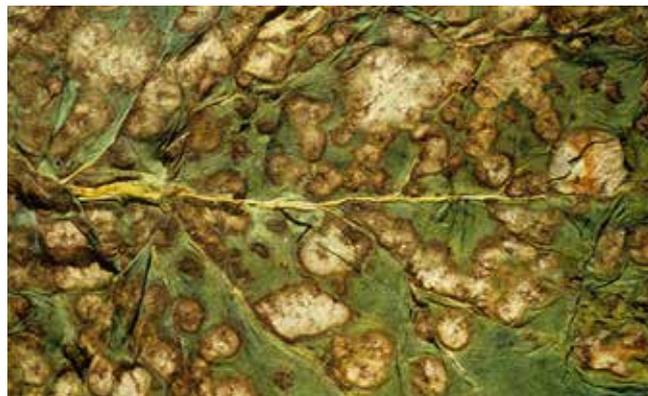
Large numbers of pale, papery spots up to 1 cm diameter on leaves. Seedlings may die; heavily infected leaves can yellow and drop off.

### FAVOURED BY

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



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



White leaf spot on cauliflower leaf (L Tesoriero NSW DPI)

# White mould / sclerotinia

*Sclerotinia* spp.

## 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 10 mm across and irregularly shaped.

## FAVOURED BY

Cool, moist conditions.



White mould rotting a cauliflower head (R Lancaster DAFWA)



*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. Plants wilt and collapse.

Plants wilt and collapse. Seedlings die, 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 specially if combined with physical damage at soil level eg windy conditions, transplanting 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

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.

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

### 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.



## 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)

## 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)

# 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 seedling (S Grigg) and buk choy (L Tesoriero NSW DPI)



## 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)

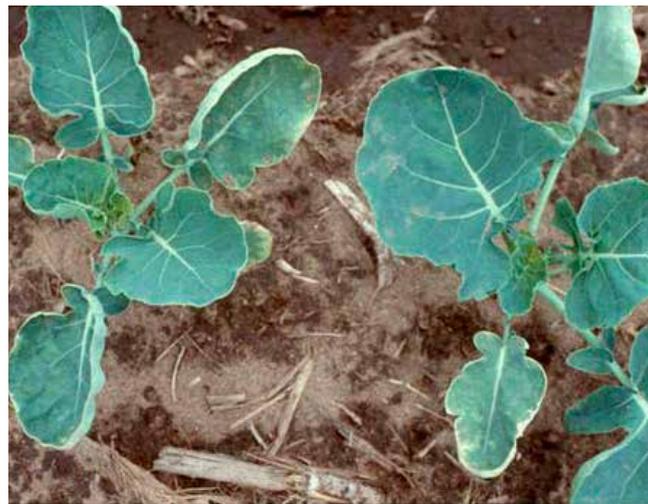
## Manganese toxicity

### 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. Made worse by periodic waterlogging 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 chlorotic 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.

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.

### CAUSED BY

Nitrogen is required in relatively large amounts for maximum growth. However,



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. Pressure builds up inside the internal cells, eventually causing them to blister and burst.



Corky blisters caused by excess internal moisture (L Tesoriero NSW DPI)

## 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 / black speck

### SYMPTOMS

Most common on wombok, pepper spot or “gomasho” can also occur on European cabbages. 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 0°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 can increase symptoms.



Pepper spot closeup and symptoms on wombok (P Gilreath)

## 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.



Purpling of cauliflower leaf 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 and occur most on the older leaves. The plant internodes can be reduced, resulting in a short growth habit.

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



## CAUSED BY

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



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.

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.

## CAUSED BY

While there is no clearly defined cause, riciness



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, with spinach relatively tolerant but lettuce and some brassicas moderately 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)

