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## PESTS AND BENEFICIALS

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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.

**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.

---

Larvae of black beetle larvae, also known as ‘curl grubs’ (J Ekman)

Pupae of black beetle larvae (J Ekman)

Adult beetle (PADIL)
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.

---

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.
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 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.

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

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.

**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 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.

**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.

**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.

---

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

*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.
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 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.
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 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.

**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.

---

**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.

---

**Fungus gnat larvae (JK Clark) and adult (A Broadley DAFF)**

**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.  

---  

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.  

---  

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

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 15 mm 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.
**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.

---

**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 it’s 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.
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.

**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.

---

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.

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

**MOST COMMON**
Year round.

---

Adult green lacewing (J Ekman)

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

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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.

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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.
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.

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.
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).

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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.

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

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 (e.g., *Trichogramma* or *Telenomus*) to larger species up to 18 mm long that lay their eggs in pest caterpillars or pupae (e.g., *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.

**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.

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

Parasitised aphid ‘mummies’ (top) (N Dimmock Uni Northampton, Bugwood.org), *Telenomus* sp. and *Trichogramma* sp. wasps laying into heliothis 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.

DAMAGE
Benificial 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 dermatitius.*

**MOST COMMON**

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

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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.
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.
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.
**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.

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**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.

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

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

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

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**Weevil – small lucerne**

*Atrichonotus taeniatulus*

**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.

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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 – 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.

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**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 ¾ 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.
## Wireworm
*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.

**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.

**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.

![Wireworm larvae](image)

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

## Weevil – white fringed
*Naupactus leucoloma*

**DESCRIPTION**

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

**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.

**DAMAGE**

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

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*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).

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 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 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](image1)

**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](image2)
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.

**FAVoured 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.
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.

**FAVOURDED BY**
Cool, moist conditions.

![Symptoms on tatsoi (S Grigg) and closeup of soft mould growth on leaf underside (L Tesoriero NSW DPI)](image)

![Downy mildew symptoms of increasing age on rocket, broccoli and cabbage (L Tesoriero NSW DPI)](image)
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.

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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.
**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.

**FAVOURED BY**  
Warm, dry conditions.

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**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.

**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.
DISEASES

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°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), 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.

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Turnip mosaic virus showing chlorotic (L) and necrotic effects (L Tesoriero NSW DPI)

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.

**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 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 (J Ekman)
White leaf spot
*Pseudocercosporella 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. 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

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
<th>CAUSED BY</th>
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<tbody>
<tr>
<td>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.</td>
<td>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.</td>
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</tbody>
</table>

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

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.

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

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

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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.
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)

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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

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<td>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.</td>
<td>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.</td>
</tr>
</tbody>
</table>

Herbicide damage to rocket (S Grigg)
**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.

**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.
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.

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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.

**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.

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*Whiptail symptoms in cauliflower (R Lancaster DAFWA)*

*Nitrogen deficiency in broccoli seedlings (S Grigg) and tatsoi (S Parks NSW DPI)*
## Corky blisters caused by excess internal moisture

**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.

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## 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.

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Corky blisters caused by excess internal moisture (L Tesoriero NSW DPI)  
Patchy growth due to old seed being used in tatsoi (M Tittley)
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 ot be a combination of environment and varietal factors. High rates of nitrogen fertilisation can increase symptoms.

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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.

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Pepper spot closeup and symptoms on wombok (P Gilreath)

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 reduces uptake of calcium and magnesium, potentially causing tipburn.

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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.
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.

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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.
## Waterlogging

<table>
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<td>Roots develop on the tops of beds. Leaves become yellow due to inhibition of nitrogen uptake. Plants can become red or purplish.</td>
<td>Heavy soils, prolonged rainfall, poor drainage.</td>
</tr>
</tbody>
</table>

Poor development associated with waterlogged soil (J Ekman)