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Pests, diseases and disorders of cucurbits

A FIELD IDENTIFICATION GUIDE

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Always seek advice from a professional to confirm the identification of pests, diseases and disorders and to devise the most effective management strategy.

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Pest icons


Beneficial


Damaging


Exotic
Not present
in Australia


Pre-harvest


Postharvest

Important notice

Symptoms caused by different pests and pathogens can sometimes be very similar, making an immediate diagnosis in the field difficult. Always seek advice from a professional to confirm the identification of pests, diseases and disorders and to devise the most effective management strategy.

This guide contains both endemic and exotic pests, the latter answering to the definition of not being known to occur in Australia. As Australian horticulture is continuously exposed to biosecurity threats, it is important that every industry stakeholder is aware of current exotic threats and always on alert.

For more information about biosecurity and surveillance please download the guide developed by Plant Health Australia Ltd (2021) Exotic pest identification and surveillance guide for tropical horticulture (Version 1.0 February, 2021). Plant Health Australia, Canberra, ACT, at www.bit.ly/phaID

Any unusual plant pest or disease should be reported immediately to the relevant state or territory agriculture agency through the Exotic Plant Pest Hotline (1800 084 881).

Visit www.planthealthaustralia.com.au/response-arrangements/ for more information.

Contact the Biosecurity Officer, Melons Australia at: biosecurity@melonsaustralia.org.au.

Visit www.outbreak.gov.au to learn about current outbreaks of exotic species.

Useful links

Plant Health Australia:

www.planthealthaustralia.com.au

Melons Australia - Biosecurity and Pest and Disease Management:

www.melonsaustralia.org.au/grower/biosecurity-and-pest--disease-mgt

Queensland Government – Horticultural Diseases and Disorders:

www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/biosecurity/plants/diseases/horticultural

National Fruit Fly Council:

www.preventfruitfly.com.au

AUSVEG – Crop Protection of Cucurbit:

www.ausveg.com.au/biosecurity-agrichemical/crop-protection/cucurbits/

For more images of beneficials, pests, diseases and disorders visit:

www.invasive.org and www.iNaturalist.org

Further reading

Virus Diseases of Cucurbits in Australia - Factsheet:

www.bit.ly/4aFgJ3a

Bacterial Diseases Affecting Australian Vegetable Crops - Guide:
www.bit.ly/3KhmNDU

Exotic Pest Identification and Surveillance Guide for Tropical Horticulture:

www.bit.ly/phaID

The Australian Handbook for the Identification of Fruit Flies:
www.it.ly/3KeltSu

Soil-borne Diseases in Vegetable Crops – A Practical Guide to Identification and Control:

www.bit.ly/3Kg6RBQ

Contents

Pests and Beneficials

Diseases

Contents

Disorders

Pests and Beneficials

African black beetle

Heteronychus arator

DESCRIPTION

Egg: Round, cream to white, oval and about 1.8 mm long, laid into the soil.

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

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

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

Larvae of black beetle, also known as 'curl grubs' or 'cockchafers' (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 Southeast Queensland and the Southwestern region of Western Australia. Favoured by winter rainfall followed by warm, dry spring and summer.

Adult beetle (PADIL)

Pupae of black beetle larvae (J Ekman)

Aphid – melon

Aphis gossypii (cotton aphid)

DESCRIPTION

Egg: Initially yellow, eggs soon turn glossy black. Overwintering eggs are laid only during cold conditions.

Nymph: Tan to grey or green with dark head.

Adult: Wingless adults are 1 to 2 mm long, light to dark green. Winged forms are slightly smaller and green to black.

Under warm conditions females can mature in only four days and produce 85 nymphs, enabling rapid expansions of the population.

DAMAGE

Feeding activity on leaf undersides and growing tips causes severe distortion, reducing photosynthesis. Foliage becomes chloritic and may die. Aphids secrete honeydew, leading to the growth of sooty mould and affecting fruit quality and can transmit viruses.

MOST COMMON

Year round on a wide host range, including all cucurbit crops.

Melon aphid infestation (BT Wrenhill)

Aphid infestation on cucumber (Zhy)

Aphid infestation on closed pumpkin flower (left, M Schouten) and on opening pumpkin flower (DPIRD)

Aphid – other

Myzus persicae (green peach aphid), *Macrosiphum euphorbiae* (potato aphid), *Aphis craccivora* (cowpea aphid)

DESCRIPTION

Nymph: Green peach and potato aphid nymphs are yellowish to light green. Cowpea aphid nymphs are waxy and dull grey.

Adult: Wingless adults of most species resemble nymphs.

In contrast, while wingless green peach aphid adults are green, the winged adults have black heads, dark red eyes and dark, patterned bodies.

Both wingless and winged potato aphids are green with red eyes. The winged form has brownish legs and antennae.

Both wingless and winged adult cowpea aphids have glossy black bodies with black and white banded legs.

Winged adults can disperse long distances, especially if wind assisted, so infestations can spread rapidly.

Potato aphid nymphs and adults; top image shows an adult giving birth to a fully formed nymph (J Rorabaugh)

DAMAGE

Feeding by aphids causes leaf distortion and wilting. Excreted honeydew encourages sooty mould growth, reducing photosynthesis and contaminating fruit.

Aphids can transmit some plant viruses, including cucumber and squash mosaic viruses. Cowpea aphids inject toxins into the plant while feeding, increasing damage.

MOST COMMON

Aphids are generally most common during warmer months. Cowpea aphid is particularly heat-tolerant.

Cowpea aphids, including winged adults (Charles)

Green peach aphids (J Ekman)

Aphid parasitoid

Aphelinus spp., *Aphidius* spp.

DESCRIPTION

Small dark wasps with pointed abdomens, generally less than 5 mm long.

BENEFIT

All immature stages are completed inside the aphid's body. The females lay one egg inside each aphid. The larva feeds on the aphid, killing it. It then pupates, emerging as an adult and leaving the typical 'aphid mummy' behind. Adult parasitoids feed on pollen or nectar.

Development from egg to adult can take up to three weeks, with several generations per year.

MOST COMMON

Common during warm weather, especially late summer to autumn.

Some aphid parasitoids are commercially available to provide biological control of aphids.

Aphidius ervi ovipositing eggs in aphid (left, M Schreiner, Colorado State Uni., Bugwood.org) and parasitised aphid 'mummies' (Biobee)

Assassin bug

Family Reduviidae

DESCRIPTION

Nymph: Similar to adult but wingless.

Adult: Large family of colourful shield-shaped bugs 10 to 30 mm long with large eyes and powerful, curved, sucking mouthpart. Colour varies from orange to red and brown, sometimes with distinct patterning. Strong front legs for grasping prey.

BENEFIT

Adults and nymphs are aggressive predators on other insects, particularly soft bodied caterpillars. A single nymph may consume 150 to 200 *Heliothis* caterpillars.

MOST COMMON

Any time of year.

Common assassin bug nymph (top) and adult (P Chew)

Big-eyed bug

Geocoris spp.

DESCRIPTION

Nymph: Patterned brown, pear-shaped with prominent eyes. Wing buds appearing in later instars.

Adult: Black bug around 5 mm long with prominent dark eyes. Fast moving, with clear wings folded flat over its back.

BENEFIT

Adults and nymphs prey on aphids, mites, *Heliothis* eggs and small caterpillars. Some species attack brown marmorated stink bug eggs and nymphs.

MOST COMMON

Any time of year.

Adult big-eyed bug (S Vassella)

Brown marmorated stink bug

Halyomorpha halys

DESCRIPTION

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

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

Adult: Mottled brown shield shaped bug 12 to 17 mm long and 7 to 10 mm wide. Distinctive alternating cream bands on antennae, legs, and side margins of the abdomen.

DAMAGE

Sap sucking by all life stages causes white blotches on leaves.

MOST COMMON

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

Brown marmorated stink bug nymphs hatching (F Biguzzi)

Semi-mature brown marmorated stink bug nymph (zoology123)

Brown marmorated stink bug adult (D Boevski)

Cricket – black field

Teleogryllus spp.

DESCRIPTION

Nymph: Similar to adult, but with less developed wings.

Adult: Stout, black cricket with large head, short wings and powerful rear legs. Females have long ovipositor. Males make distinctive chirruping call at dusk.

DAMAGE

Not usually a major problem but can cause damage by feeding on roots, leaves and stems. Can also damage irrigation by chewing on drip tape.

MOST COMMON

Active during warmer months. Crickets usually hide in cracks or crevices during the day and come out at night to feed.

Black field cricket (J Ekman)

Cricket – mole

Family Gryllotalpidae

DESCRIPTION

Nymph: Similar to adult, but with less developed wings.

Adult: Brown, roughly cylindrical cricket 3 to 4 cm long with muscular appearance. Forelegs are adapted for digging and the head and thorax are reinforced with thickened covers. Hind legs are small compared with other crickets. Females are capable flyers.

DAMAGE

Eats plant roots, both above and below ground, which it accesses using a network of burrows.

MOST COMMON

Urban areas and well-watered grasslands. Most active during warmer months, when males dig special resonating burrows and produce a distinctive loud, vibrating call at dusk.

Mole cricket (Wikicommons)

Cucumber beetle

Acalymma vittatum (striped), *Diabrotica undecimpunctata* (spotted)

DESCRIPTION

Egg: Clusters of oval, orange-yellow eggs are laid in spring on leaf undersides or in soil crevices close to host plants.

Larva: Creamy white grubs with dark heads and legs, reaching up to 12 mm long. Mature larvae pupate in the soil.

Adult: Bright yellow with distinct black stripes or spots, adults are 8 to 9 mm long with beaded black antennae and black or banded legs.

DAMAGE

Larvae feed on plant roots and tunnel through lower stems. Adults feed on foliage, pollen, flowers and melon rind. Beetles can transmit bacterial wilt and cucumber mosaic virus.

MOST COMMON

Not present in Australia.

Cucumber beetles are common in North America. They are a major biosecurity threat as they can act as a vector of bacterial wilt of curcurbits.

Spotted cucumber beetle (T Brooks)

Striped cucumber beetle damage to a flower (left) and a leaf (Uni. of Utah)

Striped cucumber beetles feeding on zucchini (R Vanderkam)

Striped cucumber beetle adult (R Thibault)

Cucumber moth

Diaphania indica

DESCRIPTION

Egg: Whitish ovals, 1 mm long, laid in small groups under the leaves.

Caterpillar: Light green to 20 mm long, with two characteristic white stripes on the back.

Pupa: Dark brown, 12 mm long and 3 mm wide, pointed at both ends. Forms silky cocoons by folding the leaves of the host plant.

Adult: 20 mm long with 25 mm wingspan, characteristic white wings with wide brown edges and a tuft of reddish brown hair on the tip of the abdomen.

DAMAGE

Larvae feed on leaves between the veins, then roll the leaves with their silk, feeding from the inside. Flowers and fruits may also be attacked.

MOST COMMON

Tropical and sub-tropical areas. Adults are active at night.

Cucumber moth adult (left, P Radhakrishna) and larvae (U Calvo)

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. Tend to curl into a ball if disturbed. Can grow from 20 to 50 mm.

Pupa: Reddish brown, found in the soil.

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

DAMAGE

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

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

MOST COMMON

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

Adult moth (NSW DPI)

Cutworm feeding on young plant (Clemson Uni., Bugwood.org)

Damsel bug

Nabis spp.

DESCRIPTION

Egg: Laid into plant tissue. Small, oval-shaped, green to yellow or brown.

Nymph: Similar to adults except smaller and lacking wings.

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

BENEFIT

Nymphs and adults are aggressive predators on many other insects including aphids, leafhoppers, moth eggs and small caterpillars.

MOST COMMON

Any time of year.

Damsel bug adult (J Ekman)

Earwig – common brown

Labidura truncata

DESCRIPTION

Nymph: Similar to adult but smaller and lighter coloured.

Adult: Light brown, flattened and segmented body up to 35 mm long with dark brown patches and dark eyes. Large pincers on the tail, which are curved in males and straighter in females.

BENEFIT

Attacks caterpillars and moth pupae, such as *Heliothis*.

MOST COMMON

Any time of year.

Brown male earwig (top) (A Henderson, Minibeast Wildlife) and female brown earwig attacking a pupa (J Wessels, QDAF)

Earwig – European

Forficula auricularia

DESCRIPTION

Egg: Oval, pearly white, 1 mm long, deposited in soil. Adult females care for their offspring during the early growth stages.

Nymph: Resemble adults but very pale. They turn brown as they age and develop wings.

Adult: 12 to 15 mm long, brown with small pale wings and pale legs. Clearly segmented antennae and abdomen. Pincers are curved inwards in males and straight in females. Could be confused with the common brown earwig, a beneficial native earwig.

DAMAGE

Omnivorous, they feed on leaves, stems and fruits, with severe infestations leaving plants completely defoliated. They can also represent a contaminant in postharvest.

MOST COMMON

Temperate areas of Southern Australia, associated with human-influenced environments and source of infection favoured by no-till practices and crop residues left in the field. Adults nest in autumn, with nymphs emerging towards spring.

Male European earwig (A Kouprianov)

Entomopathogen – fungi

Beauveria bassiana, Metharhizium spp.

DESCRIPTION AND BENEFIT

Several fungal species can infect healthy insects including caterpillars, beetles, fruit flies and locusts. Infection is mainly through consumption, but some fungi can infect insect directly. The fungus kills and eventually consumes the insect.

MOST COMMON

May be applied as biological control agents or occur naturally. Some species are relatively host-specific, whereas *Beauveria* and green muscardine fungus (*Metarhizium* spp.) have a wider host range.

Metarhizium on killed beetle host (J Sullivan)

Weevils killed by *Beauveria* and green muscardine fungus (AN Proasov)

Entomopathogen – nematode

Steinernema spp., *Heterorhabditis* spp.

DESCRIPTION AND BENEFIT

Entomopathogenic nematodes are tiny (1 to 2 mm) and whitish to small translucent. Different species have two different feeding strategies: passively waiting for a prey to get close then ambushing, or actively searching for targets in the soil or water layers.

Nematodes penetrate the host and multiply inside, eventually killing it.

MOST COMMON

May be applied as biological control agents or occur naturally.

Entomopathogenic nematodes can attack a wide range of insects, particularly those present in the soil and/or wet environments.

Nematodes released from dead larva (P Greb, USDA, Bugwood.org)

Entomopathogen – virus

DESCRIPTION AND BENEFIT

Nucleopolyhedrovirus (NPV) is a viral disease of caterpillars. Infection occurs when caterpillars eat viral particles. The virus spreads rapidly through the entire body, killing the host within 4 to 7 days depending on dose and temperature.

NPV on caterpillars (QDAF)

MOST COMMON

Though naturally occurring in Australia there are highly effective commercial blends of NPV strains. Targeted caterpillars unlikely to become resistant.

Beet armyworm killed by NPV (D Nance)

Fall armyworm

Spodoptera frugiperda

DESCRIPTION

Egg: Large, clustered masses of up to 200 pale eggs, usually laid on leaf undersides.

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

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

Fall armyworm egg mass (QDAF)

Female moth (left) and male moth (Plant Health Australia)

DAMAGE

Caterpillars chew on leaves and stems, leaving ragged holes. Fall armyworm is resistant to many insecticides, including synthetic pyrethroids.

MOST COMMON

Generally prefers tropical to subtropical climates, so can occur year round in northern areas and late summer to autumn in the south. Adults are strong flyers, potentially able to travel hundreds of kilometres, while larvae can feed on at least 350 plant species. Cucurbits can be attacked if favoured hosts are not available.

Circles indicate the four distinctive dark spots on the 2nd last segment and light inverted 'Y' on head (P Horne)

Fruit fly – cucumber

Zeugodacus cucumis (syn. *Bactrocera cucumis*)

DESCRIPTION

Egg: White, banana-shaped, 1 mm long, laid in clusters under the fruit skin.

Larva: Cream-coloured maggot reaching 7 mm long at maturity. Mature larvae can 'spring' by bending and straightening their body, allowing them to leave the fruit to pupate in the soil.

Pupa: Brown, 5 mm long barrel-shaped pupa formed in the soil.

Adult: Slender reddish-brown and yellow fly with distinctive yellow 'keel' in the centre of the thorax in addition to yellow markings on the shoulders and back.

DAMAGE

Larvae feed inside fruit, dissolving it into a liquid they can digest by introducing symbiotic bacteria. Infested fruit collapse and rot.

MOST COMMON

Known to occur in Southeast Queensland and Northern NSW, with populations peaking in late summer.

Cucumber fruit fly adult (M Tattersall)

Cucumber fruit fly damage on cucumber (J Ekman)

Fruit fly – Mediterranean

Ceratitis capitata

DESCRIPTION

Egg: White, banana-shaped, 1 mm long, laid in clusters under the fruit skin.

Larva: Cream coloured maggot with dark feeding hook, reaching 7 mm long at maturity.

Pupa: Dark reddish brown, 4 mm long, barrel shaped.

Adult: Characteristic pattern of black and white blotches on thorax, brown and white striped abdomen and reddish eyes. Wings with black, brown, and yellow markings.

DAMAGE

Larvae feed inside fruit, causing disintegration and rotting. A major quarantine issue for exported host product, including that transported to domestic markets other parts of Australia.

MOST COMMON

Only present in Western Australia. Populations peak in mid to late summer, with flies overwintering as adults. Cucurbits are not a favourite host, but can still be attacked.

Female Mediterranean fruit fly (G Ohm)

Fruit fly – melon

Zeugodacus cucurbitae (syn. *Bactrocera cucurbitae)*

DESCRIPTION

Egg: White, banana-shaped, 1 mm long, laid in clusters under the fruit skin.

Larva: Cream coloured maggot with dark feeding hook, up to 10 mm when mature.

Pupa: Brown, 5 mm long barrel-shaped pupa formed in the soil.

Adult: Slender reddish-brown and yellow fly 6 to 8 mm long with slim yellow 'keel' on the thorax in addition to yellow markings on the shoulders and back. A black 'T' on the abdomen (sometimes incomplete) and two big dark brown spots towards the tip of the wings are characteristic of the species.

DAMAGE

Larvae feed inside fruit, causing disintegration and rotting. Major pest of cucurbits including watermelon, rockmelon, cucumber and pumpkin.

MOST COMMON

Not present in Australia. Native to India and is now found in more than 40 countries across southern Asia, island nations of Oceania and parts of Africa. Serious biosecurity threat.

Melon fly maggots infesting bitter melon (left, G Walker) and adult female (R.S Copeland)

Fruit fly – Queensland

Bactrocera tryoni

DESCRIPTION

Egg: White, banana-shaped, 1 mm long, laid in clusters under the fruit skin.

Larva: Creamy white maggots, up to 8 mm long, yellowish with dark feeding hook when mature.

Pupa: Brown, 5 mm long barrel-shaped pupa formed in the soil.

Adult: Reddish brown fly, 6 to 8 mm long with yellow 'shoulder pads'.

DAMAGE

Larvae feed inside the fruit, liquefying the flesh. A major quarantine issue for exported host product, including some domestic markets.

MOST COMMON

Populations peak in late summer, especially in humid weather. Found throughout Eastern Australia on a large host range. Infestation can occur whenever day temperatures exceed around 16°C.

Queensland fruit fly larvae (top left), pupae (bottom left) and adult female (J Ekman)

Green mirid

Creontiades dilutus

DESCRIPTION

Egg: Laid into leaf stalks and new plant growth.

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

Adult: Pale green bug approximately 7 to 9 mm long with clear wings folded flat over its back. Dark red eyes, and antennae nearly as long as the body. Agile bug, sometimes with reddish markings.

DAMAGE

Adults and nymphs inject digestive enzymes into plants during feeding, which can kill growing points. Not destructive but can delay the growth of young crops.

MOST COMMON

In Queensland and Northern New South Wales, especially during spring and summer.

Nymph (left, M Khan, QDAF) and adult green mirid (J Wessels, QDAF)

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.

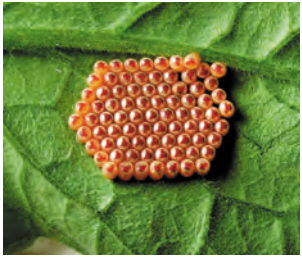
DAMAGE

Young shoots are damaged by sap sucking. Adults are hard to see, but usually a minor pest.

MOST COMMON

Spring and summer on a wide range of host plants.

Nymph (L Turton, NSW DPI)



Egg raft (L Turton, NSW DPI)

Adult (S McDougall, NSW DPI)

Ground beetle

Family Carabidae

DESCRIPTION

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

Adult: Various sizes and colours, with ridged elytra (wing covers). Usually fast runners and often flightless.

BENEFIT

Both larvae and adult beetles are predatory on insects including caterpillars, slugs, snails, and other pests. Larvae often shelter in burrows waiting for prey, while adults forage in soil litter or close to the ground.

MOST COMMON

Year round.

Adult ground beetle (R Richter)

Heliothis / Native budworm

Helicoverpa armigera, H. punctigera

DESCRIPTION

Egg: Laid singly or in small groups. Ribbed, white domes 1 mm diameter that darken before hatching.

Caterpillar: Initially light brown with dark heads, but darken and develop distinctive stripes along their length. Colour highly variable, from brown to greenish and grey. Up to 50 mm long when mature.

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

DAMAGE

Larvae feed on leaves, flowers and fruits, while frass can be a contamination issue.

MOST COMMON

Warm weather. Larvae prefer leaf undersides or central parts of plants, where they can hide in the shoots.

Heliothis eggs (S Grigg)

Adult moth (J Ekman)

Heliothis caterpillars, showing their variability in colouration (J Ekman)

Hoverfly

Family Syrphidae

DESCRIPTION

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

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

BENEFIT

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

MOST COMMON

Warmer weather, especially during summer.

Hoverfly larva (J Ekman)

Hoverfly adult feeding on pollen (J Ekman)

Lacewing – brown

Micromus tasmaniae

DESCRIPTION

Egg: Cream, oval eggs laid singly on leaves.

Larva: 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.

BENEFIT

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

MOST COMMON

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

Brown lacewing adult (J Ekman)

Brown lacewing larva (Grahame)

Lacewing – green

Mallada signatus

DESCRIPTION

Egg: Laid on long, thin stalks, either singly or in rough groups. Pale green when fresh, turning grey just before hatching and then white once hatched.

Larva: Thick bodied, light brown and up to 8 mm long, the larva camouflages itself using the remains of its prey.

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

BENEFIT

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

MOST COMMON

Year round.

Green lacewing larva, with thrips at right (J Ekman)

Adult green lacewing (P Horne)

Ladybird – cucurbit (28-spotted)

Epilachna vigintioctopunctata (syn. *Henosepilachna cucurbitae*)

DESCRIPTION

Egg: Upright, oval, yellow eggs laid in batches of 10 to 20 under leaves.

Larva: Pale yellow with dark branched spines on their backs, growing up to 6 mm.

Pupa: Pale cocoon with branched spines attached under the leaf.

Adult: Orange, black-dotted ladybird with short downy hair on the wings (distinguishing characteristic for plant-feeding ladybirds). Variable number of spots. Slow moving, they escape by acting dead and dropping on the ground.

DAMAGE

Larvae feed on leaf underside, while adults feed on both sides of leaves. Feeding activity affects plant growth and yield. Seedlings may be killed by the attack.

MOST COMMON

Population increases with higher minimum temperatures and relative humidity.

Cucurbit ladybird eggs (top left, Beatsheet), larva (top right, U Calvo), pupa (bottom left, DAFWA) and adult (U Calvo)

Ladybird – fungus eating

Neither pest nor beneficial

Illeis galbula

DESCRIPTION

Larva: Grey and yellow with black dots covered with short spines, up to 6 mm long.

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

DAMAGE AND BENEFIT

Larvae and adults feed primarily on powdery mildew fungus. Other fungal species and pollen may also be eaten. Can be an early indicator of pathogen infection.

MOST COMMON

Late spring to autumn.

Fungus eating ladybird larva (KL Harris)

Fungus eating ladybird adult (J Ekman)

Ladybird – predatory

Coccinella transversalis, Hippodamia variegata, Diomus notescens

DESCRIPTION

Egg: Upright yellow eggs, laid in small clusters.

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

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

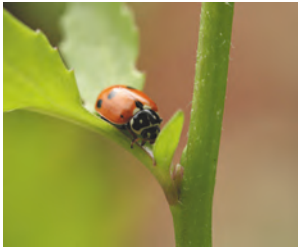
BENEFIT

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

MOST COMMON

Late spring to autumn.

Minute two spotted ladybird (left) and transverse ladybird (J Ekman)



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

Leafhoppers / Jassids

Family Cicadellidae

DESCRIPTION

Egg: Less than 1 mm long, laid under the leaf surface.

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

Adult: Look like cicadas; torpedo shaped, ranging in colour from yellowish to green and mottled brown. Jump away quickly if disturbed. 2 to 6 mm, depending on the species. Tend to feed on the undersides of leaves.

DAMAGE

All life-stages suck plant sap, reducing vigour and leaving whitish patches on the leaves.

MOST COMMON

Warmer months, usually a minor pest.

Vegetable leafhopper nymph, showing sucking damage to leaf (T Klejdysz)

Leafhopper adult (Colorado State Uni.)

Leafminer – American serpentine

Liriomyza trifolii

DESCRIPTION

Egg: Oval, 1 mm long eggs laid singly into the leaf underside.

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

Adult: Small black and yellow fly about 2 mm long, yellow underside and legs. Matte greyish back helps identification.

DAMAGE

Developing larvae make feeding tunnels inside the leaves, reducing plant vigour. Short life-cycle and wide host range means populations increase rapidly.

MOST COMMON

Currently present in Northern Queensland and North Western Australia, where it is a major pest during early spring. Adults are not strong flyers so can usually be found on host plants.

Larva (P Scanlon, DPIRD)

Pupa (LJ Buss, Uni. of Florida)

Adult (I Marsman)

Leafminer damage on watermelon leaves (C Lucid)

Leafminer – serpentine

Liriomyza huidobrensis

DESCRIPTION

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

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

DAMAGE

Irregular leaf mines are created as larvae burrow through the leaf tissue, reducing plant growth and vigour. In severe cases the plant may die.

MOST COMMON

First detected in Australia in 2020, serpentine leaf miner has become a major pest due to its wide host range and resistance to many pesticides. Adults are not strong flyers, so spread occurs mainly by moving infected plant materials. Prefers warm to mild coastal climates, spreading inland with adequate moisture.

Serpentine leafminer adult (CSL, Harpenden)

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

Leafminer – tomato

Liriomyza bryoniae

DESCRIPTION

Egg: White, elliptical, 0.2 mm long, inserted into leaf tissue just underneath the surface.

Larva: Initially colourless, become greenish to yellowish as they grow. Mature larvae are about 2 mm long and usually drop to the soil to pupate.

Adult: Emerge early in the mornings, less than 2 mm long, black with yellow markings on the head and body. Shiny black back is similar to vegetable leafminer.

Tomato leafminer damage (T Klozer)

DAMAGE

Irregular leaf mines are created as larvae burrow through the leaf tissue reduce plant growth and vigour. In severe cases the plant may die. Adult females feed on plant sap and other exudates.

MOST COMMON

Not present in Australia.

It is widespread in Europe, the mediterranean and far East Asia and is a high biosecurity risk.

Tomato leafminer adult (W Billen, Bugwood.org)

Leafminer – vegetable

Liriomyza sativae

DESCRIPTION

Egg: White, 0.2 mm long, inserted into leaf tissue just underneath the surface.

Larva: Initially colourless, become greenish to yellowish as they grow. Mature larvae are about 2 mm long and usually drop to the soil to pupate.

Adult: Black and yellow fly less than 2 mm long. Similar to American serpentine leafminer, but its back is shiny black instead of dark grey. Moves quickly if disturbed.

DAMAGE

Irregular leaf mines are created as larvae burrow through the leaf tissue, reducing plant growth and vigour. In severe cases the plant may die. Adult females feed on plant exudates.

MOST COMMON

Isolated populations detected in Far North Queensland. It is a biosecurity risk to other parts of Australia.

Vegetable leafminer adult (Ag Victoria)

Leafminer feeding damage (A. Kranz)

Mite – predatory

Phytoseiulus persimilis

DESCRIPTION

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

Nymph: Pale orange, pear shaped.

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

BENEFIT

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

MOST COMMON

Multiplies rapidly at temperatures over 26°C. It is the most commonly used mite for biological control.

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

Predatory mite *Phytoseiulus persimilis* (Wikipedia commons)

Mite – redlegged earth

Halotydeus destructor

DESCRIPTION

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

Nymph: Reddish pink with six legs, 0.2 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 during overcast conditions. If disturbed it will drop to the ground and hide.

MOST COMMON

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

Redlegged earth mite (S Mae)

Mite – two-spotted

Tetranychus urticae

DESCRIPTION

Egg: Translucent white, laid on leaf undersides.

Nymph: Translucent white to greenish, orange in overwintering form.

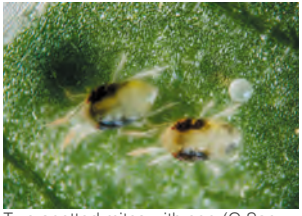
Adult: Whitish to yellow green, around 0.5 mm long with a large dark olive spot either side of its body. Overwintering form is dark red with white legs.

DAMAGE

Mites form colonies on lower leaf surfaces, especially near the petiole. These become covered in fine webbing. Feeding causes stippling and yellowing of the leaves, which can coalesce into larger dead and yellow patches. Leaves may wilt and die.

MOST COMMON

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



Two-spotted mites with egg (G San Martin)

Two-spotted mite damage to watermelon (Purdue Uni.)

Onion maggot

Delia platura

DESCRIPTION

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

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

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

DAMAGE

Larvae burrow into seeds and seedlings, destroying the seeds and stunting young plants.

MOST COMMON

Often found in spring, but can tolerate a wide range of climatic conditions.

Onion maggot adult (D Makhnovsky)

Onion maggot eggs, larva and pupa inside squash seed (H Doughty, Bugwood.org)

Parasitoids

Trichogramma spp., *Telenomus* spp., *Trissolcus basalis, Microplitis* spp., *Netelia* spp., Tachinid flies

DESCRIPTION

There are many naturally occurring parasitoid wasps and flies. Some are also sold commercially for biocontrol.

Wasps: Range in size from less than 0.5 mm long to larger species up to 18 mm long. Some lay their eggs inside other eggs (e.g. *Trichogramma* spp.) whereas others lay their eggs directly into pest caterpillars or pupae (e.g. *Microplitis* spp.). Some species stick their eggs directly onto the host (e.g. *Netelia* spp.).

Many parasitoid wasps are black or grey, but a few are more brightly coloured. Some are highly host-specific whereas others will attack a range of species.

Flies: Tachinid flies, also known as bristle flies, lay creamy oval eggs which are usually stuck directly onto the skin of a host caterpillar.

Adults are grey or brown, similar to a housefly but more stout and bristled.

BENEFIT

Most parasitoid wasp and fly larvae develop within the host, consuming it from the inside. Egg parasitoids prevent crop damage by killing the larvae before it hatches. Larval parasitoids such as *Microplitis* spp. reduce feeding, the caterpillar eventually dying.

Once mature, parasitoid larvae pupate inside or outside the host.

Tachinid fly (P Chew) and a tachinid fly egg on a *Heliothis* caterpillar (Ophis)

In the case of *Netelia* spp., the larva develops and pupates externally.

Both *Netelia* spp. and most tachinid larvae do not complete development until the host pupates. They therefore don't prevent crop damage, but do reduce subsequent populations.

Netelia spp. eggs, laid close to the head of a host caterpillar (R Piper)

MOST COMMON

Any time of year.

Microplitis ocellate (JK Lindsey)

Netelia spp. adult (Tom)

Trichogramma spp. wasp parasitising *Heliothis* eggs (P Sinkyrik)

Plague soldier beetle

Chauliognathus lugubris

DESCRIPTION

Larva: Soil dwelling, aboveground or in foliage, 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.

BENEFIT

Predatory on aphids, caterpillar eggs and other pests, which are supplemented with nectar and pollen.

MOST COMMON

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

Plague soldier beetle adult (J Ekman)

Pumpkin beetle

Aulacophora abdominalis (plain), *Aulacophora hilaris* (banded)

DESCRIPTION

Egg: Laid in small clusters on dead leaves or moist soil under plants.

Larva: Creamy white grub up to 12 mm long.

Pupa: Pupate in chambers in the soil.

Adult: Small (7 mm long) orange beetle usually in large groups. Banded pumpkin beetle has a large black spot on each corner of its wing covers.

DAMAGE

Larvae live in the soil, where they feed on roots and fruit undersides, while adults attack leaves, flowers, and small fruits. Feeding activity is usually in groups and generates a window pattern, as they feed between the veins.

Attacks can skeletonise plants, killing young plants. Older plants can withstand higher pressure but yield and fruit quality will be affected.

Beetles can potentially transmit Cucumber green mottle mosaic virus (CGMMV) during feeding.

MOST COMMON

Occurs across Australia during warmer months. Banded pumpkin beetle is mainly present in Eastern Australia while plain pumpkin beetle is most common in temperate areas.

Note that other pumpkin beetle species (*A. indica)* is not present in Australia and poses a biosecurity threat.

Plain pumpkin beetle (DE Walter)

Banded pumpkin beetle (DC Simon)

Red and blue beetle

Dicranolaius bellulus

DESCRIPTION

Larva: Creamy, soil-dwelling grub.

Adult: Glossy beetle around 5 mm long with blue head and orange thorax. The metallic blue wing covers have a distinctive broad orange band across the centre and an orange tip at the end.

BENEFIT

Adults feed on *Heliothis* eggs, small caterpillars and small insects such as aphids.

MOST COMMON

In summer. Active mainly in the early morning and at sunset.

Female red and blue beetle (Cinclosoma)

Root-knot nematodes and Guava root-knot nematode

Meloidogyne spp., *Meloidogyne enterolobii*

DESCRIPTION

Root knot nematodes are minute (<1.5 mm), soil-dwelling and wormlike. They spend most of their lifecycle in galls formed on the roots of a host plant, with only a short free-living stage in the soil.

DAMAGE

Juveniles invade root tips, where they stimulate overgrowth of root cells. Feeding induces formation of galls (root-knots), in which the developing adults are embedded. This reduces root activity (water and nutrient uptake) and exposes the plants to secondary infections, stunting growth and affecting yield and quality.

Guava root-knot nematode (GRKN) has a broad range of hosts, being able to develop and reproduce on crops resistant to other *Meloidogyne* species, with higher infection rates and more severe root galling.

MOST COMMON

In sandy soils and warm weather. Guava root-knot nematode has been detected in Queensland and Northern Territory and poses a serious biosecurity threat.

Root knot on young cucumber plants (left, C Averre, North Carolina State Uni., Bugwood.org) and Guava root knot on infected roots (NT government)

Rove beetle

Family Staphylinidae

DESCRIPTION

Adult: Very large family, with high variability of shapes, sizes and colours. Some contain a highly irritant chemical they release when wounded.

Although the beetle can fly, they are fast runners and prefer hunting on the ground rather than flying.

BENEFIT

Predatory on various small insects.

MOST COMMON

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

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

Adults and nymphs feed on sap from stems, leaves and flowers.

MOST COMMON

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

Rutherglen bug (J Tweed)

Snake gourd semilooper

Anadevidia peponis

DESCRIPTION

Egg: Ribbed domes, greenish white, laid singly.

Caterpillar: Initially green with white stripes, black forelegs and distinct raised black spots and spikes over its full body. Matures to 40 mm long, green and white with a hump at the last abdominal segment.

Pupa: Thin cocoon formed in the leaf fold.

Adult: Brown moth with lightly patterned forewings. Wingspan around 40 mm.

DAMAGE

Caterpillars cut edges of leaf lamina, fold it over and feed within the leaf fold. Damage can be serious if young plants are attacked, causing complete defoliation.

MOST COMMON

Can attack a wide range of cucurbits. Widespread in Southeast Asia, now found in New South Wales.

Late instar caterpillar (Baluperoth)

Adult snake gourd semilooper (B Brathwaite)

Squash bug

Anasa tristis

DESCRIPTION

Egg: Bronze and elliptical, 1.5 mm long, laid in clusters of about 20, usually under the leaves or on petioles.

Nymph: Hatchlings are 2.5 mm long and light green, turning grey and darkening as they mature.

Adult: Around 15 mm long, speckled dark grey-brown with alternating gold and brown spots around the edge of the abdomen.

DAMAGE

Feeding causes severe damage to leaves, causing them to wilt, blacken and die, a process sometimes called Anasa wilt. Attacks all cucurbits but prefers pumpkin and squash.

MOST COMMON

Not present in Australia.

Found throughout north America. A biosecurity threat.

Egg clusters on squash (left) and nymphs (Pollinator, English Wikipedia)

Adult squash bugs (C Cullinan)

Squash leaf-footed bug

Leptoglossus gonagra

DESCRIPTION

Egg: Cylindrical, bronze, laid in chains on leaf undersides.

Nymph: Spindly, bright orange and black bugs with black legs.

Adult: Up to 20 mm long, black or dark brown, with a thin curved orange line behind the head, and orange-red spot on the under surface and sides. Long and powerful back legs with prominent, leaf shaped, outgrowths.

Eggs (Dvoribird, Bugguide.net)

Nymphs at various ages (A Dalia)

DAMAGE

Nymphs and adults suck sap from stems, fruits and seeds. Stems can become yellow and chloritic, while feeding on fruit causes them to shrivel, rot and occasionally drop. High infestations can kill young plants.

MOST COMMON

During spring and summer. Oubreaks are most likely after mild winters, which allow survival of overwintering adults. A major pest of citrus and passionfruit.

Adult (J Vazquez)

Squash vine borer

Eichlinia cucurbitae (syn. *Melittia cucurbitae*)

DESCRIPTION

Egg: 1 mm long, brownish, laid singly on the lower part of the main stem or leaf stalks.

Caterpillar: White with darkened head capsule, 2 mm long when newly emerged. Mature into fleshy 25 mm long grubs that pupate in the soil.

Adult: 16 mm long, metallic green-black front wings, almost transparent hind wings. Olive back and bright orange abdomen with orange-red hairs and line of black dots.

DAMAGE

Newly emerged larvae burrow into vines, where they feed on the host plant tissue. This blocks water flow to the rest of the plant, initially causing wilting but eventually to collapse and plant death.

MOST COMMON

Not present in Australia.

Common in the eastern states of the USA. Adult moths are wasp mimics, active during the day.

Larvae damaging squash stem (left, N Campbell) and adult (KRJ430)

Thrips

Thrips tabaci (onion), *Frankliniella occidentalis* (western flower), *Thrips palmi* (melon)

DESCRIPTION

While there are many species of thrips, onion thrips, western flower thrips (WFT) and melon thrips are the main pest species affecting cucurbits. 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: Golden brown with darker stripes running down their slender backs. 1 to 2 mm long. Narrow, transparent wings are held along their backs.

DAMAGE

Feeding activity causes chlorosis and silvering of leaves and scarring of fruit. Worst potential damage is vectoring viruses.

MOST COMMON

All cucurbits can be affected, especially during warm, dry weather. Onion thrips are common in early summer whereas WFT are more common in mid to late summer. Thrips prefer new shoots and young seedlings.

Control is difficult. WFT is particularly known for insecticide resistance.

Western flower thrips on a cucumber flower

Melon thrips (S. Diffie, Uni. of Georgia, Bugwood.org)

Melon thrips damage to watermelon leaves (G Holmes, Cal Poly, Bugwood.org)

Thrips – predatory

Family Phlaeothripidae, Family Aeolothripidae

DESCRIPTION AND BENEFIT

Predatory thrips are active hunters. Nymphs and adults feed on other thrips, mites, and small eggs, sucking out their contents. Adults are around 2 mm long, slightly bigger than plant feeding thrips. They are usually found among their prey, especially thrips, and are easily recognisable due to their distinctive colours or patterns (e.g., *Scolothrips sexmaculatus* has six spots on its back).

MOST COMMON

They favour tropical and sub-tropical environments.

Nymph (top) and adult Scolothrips feeding on their prey (Uni. of California, Riverside)

Weevil – Fuller's rose

Pantomorus cervinus

DESCRIPTION

Egg: Yellowish, cylindrical, 1 mm long, laid in a mass and covered with a white sticky material. Laid on soil surface, between leaves or in soil trash.

Larva: Legless white grubs, with yellowish head capsule and black mandibles. Up to 12 mm at maturity. Pupates in the soil.

Adult: Speckled brown weevil 6 to 8 mm long with bulging black eyes. Wing covers are fused, and adult weevils are unable to fly. All Fuller's rose weevils are female, reproducing asexually.

DAMAGE

Larvae feed on roots and underground stems, causing stunting. This opens a path for secondary infection, and eventually the death of the plant. Adults chew on leaves, sometimes leaving only the midrib.

Fullers rose weevil is a major pest of citrus and a biosecurity issue for some export markets.

MOST COMMON

Adults emerge in summer to autumn and tend to be nocturnal, feeding at night and seeking shelter during the day.

Adult (R Van Epps)

Weevil – whitefringed

Naupactus leucoloma

DESCRIPTION

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

Larva: Whitish, legless grub with yellow-brown head retracted into the body with only the jaws visible.

Adult: Grey-brown striped weevil up to 12 mm long with white side stripe and a short snout. Wing covers are fused, and adult weevils are unable to fly. All whitefringed weevils are female, reproducing asexually.

DAMAGE

Larvae live 5 to 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.

MOST COMMON

Damage is most likely in warm, moist conditions during autumn to spring.

Whitefringed weevil larva (left, E Barnard) and adult (Clemson Uni.)

Whitefly – greenhouse

Trialeurodes vaporariorum

DESCRIPTION

Egg: Oval, 0.2 mm long, laid in groups on leaf undersides.

Nymph: Oval, flat and semitransparent, resembling scales. First instar nymphs are mobile, while later stages are not.

Pupa: Milky-yellow, flattened ovals with a few long hairs and fringe of short hairs. Red eyes become visible as it develops.

Adult: Approximately 1 mm long, with light yellow body and head and reddish eyes.

Pure white, waxy wings are held flat, parallel to the leaf surface.

DAMAGE

Nymphs and adults suck sap from plants, stunting growth and reducing yield. Leaves develop silvery patches and may drop. Whiteflies excrete sticky honeydew, which encourages sooty mould growth and are a critical transmitter of some viruses. Major pest of greenhouse crops and commonly insecticide resistant.

MOST COMMON

Most active at temperatures from 23 to 25°C. Both juveniles and adults tend to stay on leaf undersides.

Greenhouse whitefly adult (D Cappaert, Bugwood.org)

Whitefly – silverleaf

Bemisia tabaci (Biotype B – *Bemisia argentifolii)*

DESCRIPTION

Egg: Oval, 0.2 mm long, laid in groups on leaf undersides.

Nymph: First instar nymphs are flat, greenish, mobile and around 0.3 mm long. As nymphs develop, they become opaque white and stationary on the leaf.

Pupa: Mature nymphs darken to orange-yellow, their bodies thicken and eyes become dark red. These eventually turn into pupae.

Adult: Approximately 1 mm long, with light yellow body and head and reddish eyes.

Pure white, waxy wings are held in a tent along the body, which differentiates them from greenhouse whiteflies.

DAMAGE

Nymphs and adults suck sap from plants, stunting growth and reducing yield. Whiteflies excrete sticky honeydew, which encourages sooty mould growth and are a critical transmitter of some viruses.

MOST COMMON

Temperatures of 25 to 28°C allow rapid development, but can develop at 10 to 35°C. Mild winters lead to rapid population growth in spring.

Silverleaf whitefly mature nymphs (top) (V Andras) and adult (D Gutierrez)

Whitefly – parasitoids

Encarsia formosa, Eretmocerus hayati

DESCRIPTION AND BENEFIT

Whitefly parasitoids lay single eggs inside whitefly nymphs. Larvae feed on the host and pupate with it, with only the wasp emerging from the pupal case.

Encarsia females are black with a yellow abdomen. Males are rare, larger, and black.

Eretmocerus females are bright yellow. Males are a darker yellow and have slightly longer antennae. Developing larvae are difficult to see with the naked eye.

Recently emerged female Encarsia (L Canas, Ohio State Uni, Bugwood.org)

Parasitised and unparasitised whitefly nymphs (D Cappaert, Bugwood.org)

MOST COMMON

Warm conditions. They are commercially available as biological control agents.

Eretmocerus adult (Bioplanet)

Wireworm – false

Family Tenebrionidae

DESCRIPTION

Larva: Smooth, golden to brown larva with round head and darker mouthparts. Hard, smooth body with obvious segments, up to 30 mm long. Similar to mealworms, to which they are closely related.

Adult: Dull dark grey, brown, or black oval shaped beetles commonly known as 'darkling beetles'. Beetles are often found in or on the soil.

DAMAGE

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

MOST COMMON

Unlike true wireworms, false wireworm larvae tend not to move around but live in the upper layers of loose, cultivated soil, or just under organic material.

The larvae develop through autumn and winter, causing most damage just before pupation in early spring.

Adult beetles emerge from late spring to mid-summer and will migrate if the habitat is unsuitable.

False wireworm larva (left, Z Clark) and adult darkling beetle (J Martin)

Wireworm – true

Family Elateridae

DESCRIPTION

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

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

DAMAGE

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

MOST COMMON

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

True wireworm larva (left, J Neumann) and adult click beetle (Skitterbug)

Diseases

Alternaria leaf spot

Alternaria cucumerina, Alternaria alternata

CROPS AFFECTED

Rockmelon, cucumber, watermelon and squash.

SOURCE OF INFECTION

Crop debris, seeds, weeds and other cucurbit hosts. Spread by rain, wind, irrigation, cultivation, equipment and workers.

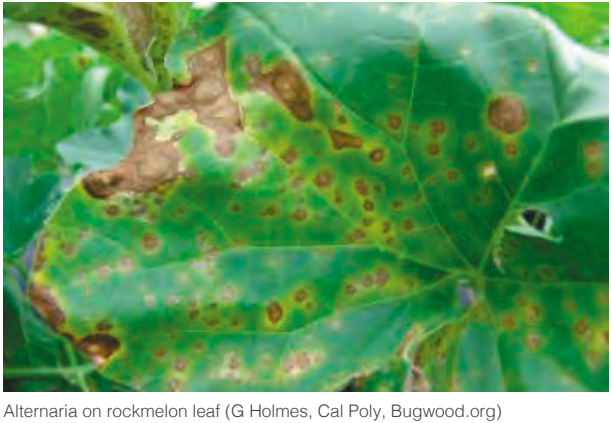
SYMPTOMS

Small circular tan spots surrounded by a yellow halo and with white centres appear on the upper leaf surface. The spots enlarge, sometimes fusing with adjacent lesions, darken and form a depression, sometimes with concentric rings. Severe infections cause defoliation, leaving fruit exposed.

The fungus can also attack the fruit, causing sunken lesions. Disease can continue to develop on infected fruit postharvest.

FAVOURED BY

Warm and moist conditions causing leaf wetness.



Alternaria on rockmelon leaf (G Holmes, Cal Poly, Bugwood.org)

Angular leaf spot

Pseudomonas syringae pv. *lachrymans*

CROPS AFFECTED

Most cucurbits but especially cucumber.

SOURCE OF INFECTION

Infected seed and crop residue.

SYMPTOMS

Small water-soaked areas appear on the underside of the leaves. These lesions are confined by the veins, giving them an angular appearance similar to downy mildew.

The spots darken on the upper side of the leaf, developing a yellow halo. Spots on the leaf undersides may appear shiny due to bacterial exudates that turn white when drying. The centres of the spots may disintegrate. Similar, slimy circular lesions may appear on fruits.

FAVOURED BY

Humid conditions and presence of infested crop residues. Moisture on the leaves increases spread.

Angular leaf spot on cucumber leaf (G Holmes, Cal Poly, Bugwood.org)

Anthracnose

Colletotrichum orbiculare

CROPS AFFECTED

Cucumber, melon and watermelon.

SOURCE OF INFECTION

Infected seed and crop debris.

SYMPTOMS

Small, circular, water-soaked lesions on the leaves, becoming yellow in melon and cucumber and dark brown to black in watermelon. Lesions eventually turn brown, becoming thin and papery.

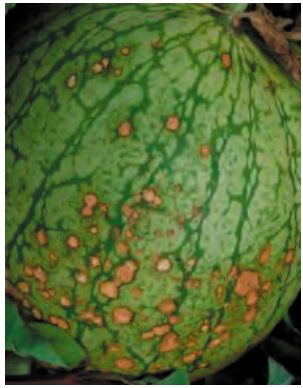
The spots expand, unrestricted by veins, often cracking in the centre.

Elongated dark spots may develop on stems and circular, sunken lesions can appear on fruits. Salmon-coloured spores appear in these lesions, characteristic of the disease.

Fruit infected in the field may only develop symptoms postharvest.

FAVOURED BY

Warm and humid weather.



Anthracnose on cucumber leaf (left, L Tesoriero) and Anthracnose on watermleon fruit (OMAFRA)

Bacterial fruit blotch

Acidovorax avenae subsp. *citrullis*

CROPS AFFECTED

All melons and watermelons.

SOURCE OF INFECTION

Infected seed.

SYMPTOMS

Dark water-soaked areas appear on the underside of cotyledons and first true leaves of infected transplants. Lesions on the stem of young seedlings can cause early collapse and death.

Light to reddish-brown necrotic lesions appear on foliage, often spreading along the midrib. These act as reservoirs of disease, but do not usually cause defoliation.

Susceptible fruit develop water-soaked areas with irregular margins. Within a few days the whole fruit may be covered in dark green, greasy looking patches. Older lesions dry out and crack, exposing the rind to secondary infections. Initial stages of infections on honeydews can resemble measles.

FAVOURED BY

Warm wet weather. Infected transplants are the main source of outbreaks.

Bacterial fruit blotch lesion along the leaf ribs on watermelon leaf (J Brock, Uni. of Georgia, Bugwood.org)

Internal (middle) and external symptoms on watermelon (L Tesoriero)

Bacterial leaf spot or crown rot

Pseudomonas syringae

CROPS AFFECTED

All cucurbits.

SOURCE OF INFECTION

Infected seed, introduced on infected transplants or carried on crop debris. Easily spread by water.

SYMPTOMS

Initially greasy-looking, water-soaked lesions appear on both margins and centres of leaves. These turn brownish, often with a dark edge or yellow halo. Transplants may be killed.

The bacteria can also cause crown or fruit rot, depending on which part of the plant is infected.

FAVOURED BY

Cool, wet weather, especially during spring.

Bacterial lesions on cucumber (left) and watermelon leaves (IFAS)

Bacterial leaf spot or bacterial rot on fruit

Xanthomonas cucurbitae

CROPS AFFECTED

All cucurbits.

SOURCE OF INFECTION

Infected seed and crop debris.

SYMPTOMS

Water-soaked, mostly angular lesions on the underside of leaves. May resemble angular leaf spot, but lesions are not always defined by the veins.

Yellowish spots form on the upper surface, turning brown or translucent, retaining the yellow halo. On fruit, lesions are initially small, rounded, slightly depressed, tan with a dark halo. They may become sunken and slimy and ultimately crack the rind, causing the fruit to rot.

FAVOURED BY

Warm, damp weather and wet leaves.

Lesion on pumpkin (left, J French, New Mexico State Uni., Bugwood.org) and spots on underside of watermelon leaf (IFAS)

Bacterial rots

Pectobacterium spp., *Pseudomonas* spp., *Dickeya* spp., *Pantoea ananatis*

CROPS AFFECTED

Any cucurbit fruit.

SOURCE OF INFECTION

Bacteria are common in irrigation water and the environment.

SYMPTOMS

Water-soaked areas on fruits which expand rapidly. Flesh collapses and liquefies.

FAVOURED BY

Hot and wet or humid conditions. Often involved in secondary infections of previously damaged fruit.

Bacterial soft rot on a Japanese netted melon (K Kido)

Bacterial soft rot on melon (M Wibisono)

Bacterial wilt

Erwinia tracheiphila

CROPS AFFECTED

Not present in Australia.

Can infect most cucurbits, especially cucumbers and melon, but not watermelon.

SOURCE OF INFECTION

Striped and spotted cucumber beetles vector this diseases (but are not present in Australia). The bacterium is short-lived on debris, but survives on weeds and volunteer cucurbits.

SYMPTOMS

Wilting can happen at any stage, but especially during periods of rapid growth.

Affected leaves develop marginal chlorosis and necrosis. The whole plant eventually collapses.

Bacterial wilt can be diagnosed in the field by making a cut in a symptomatic stem, rejoining and slowly pulling the pieces apart again; Bacteria from the vascular tissue will be visible as filamentous strands between the two pieces.

FAVOURED BY

Water stress. Environmental conditions affect symptom expression but have less effect on spread and disease incidence.

Filamentous strands of bacteria in a rockmelon stem (left, G Holmes, Cal Poly, Bugwood.org) and bacterial wilt on field pumpkin (H.F Schwartz, Colorado State Uni., Bugwood.org)

Beet pseudo-yellows virus

CROPS AFFECTED

Greenhouse cucumbers and melons.

SOURCE OF INFECTION

Greenhouse whitefly.

SYMPTOMS

Beet pseudo-yellows yirus (BPYV) causes yellow spots on older leaves first. These develop into blotchy raised areas between veins, while the veins remain green. Affected spots can fuse, forming large, thickened areas which become brittle and disintegrate.

As the disease progresses symptoms appear on the younger leaves. Fruit set is reduced and severely affected plants are stunted. BPYV can easily be mistaken for nutritional deficiencies, insect feeding or poor growing conditions.

FAVOURED BY

High light intensity, high populations of whitefly.

Cucumber plant affected by BPYV (NSW DPI)

Begomoviruses

Large group of different viruses including cucurbit leaf crumple, squash leaf curl and others

CROPS AFFECTED

Not present in Australia.

Around 24 virus strains known worldwide that can infect various cucurbits.

FAVOURED BY

High whitefly populations. Widespread in India, the Americas and parts of Asia. Significant biosecurity threat.

SOURCE OF INFECTION

Silverleaf whitefly.

SYMPTOMS

Diverse symptoms include mosaic yellowing, mottling, vein clearing and leaf distortion and curling. Plants are stunted and fruit are malformed, making them unmarketable.

Vein clearing in zucchini (CABI)

Severe begomovirus symptoms (Plant Pathology)

Black root rot

Phomopsis sclerotioides (syn. *Diaporthe sclerotioides*)

CROPS AFFECTED

Cucumbers and melons.

SOURCE OF INFECTION

Soil-borne.

SYMPTOMS

Initially small, isolated, sunken necrotic spots on finer roots. These are followed by greyish black or brown areas forming on older roots, sometimes coalescing. Black lines (pseudostromata) and resting bodies (pseudosclerotia) appear.

Roots may be girdled and killed due to death of the outer layer.

Infection climbs up the plant, the stems developing long brown or black lesions with amber, gummy exudates.

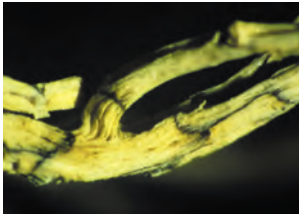
Plants are stunted, with few branches and small leaves. Fruit fail to mature. Wilting sets in quickly, without leaf yellowing, and is proportional to root symptoms, usually late in the season.

FAVOURED BY

Poorly drained, acidic soil, especially if plants have been weakened by heat stress and lack of water. Associated with lack of crop rotation.

The pathogen causing black rot of cucurbits (*P. cucurbitae)* is not present in Australia and represents a serious biosecurity threat.

Black root rot (Koppert, Netherlands)



Pseudostromata in cucumber roots (L Tesoriero)

Cercospora leaf spot

Cercospora citrullina, C. cucumerina

CROPS AFFECTED

All cucurbits. Most common on watermelon, rockmelon, and cucumber.

SOURCE OF INFECTION

Infected drop debris, volunteers, and weeds.

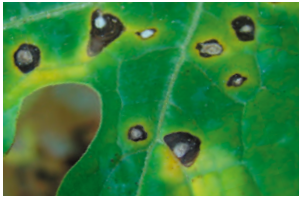
SYMPTOMS

Spots are usually only found only on foliage. Small, circular yellow spots, initially on older leaves, which turn necrotic and spread as the disease progresses.

The centres of the lesions dry out, becoming light grey.

FAVOURED BY

Free moisture and temperature between 26 to 32°C. The fungus survives on crop debris, volunteers, and weeds.



Closeup of lesions (IFAS)

Symptoms on watermelon leaf (J Damicone, Oklahoma State Uni.)

Charcoal rot

Macrophomina phaseolina

CROPS AFFECTED

Wide range of cucurbits.

SOURCE OF INFECTION

Soil-borne and seed-borne.

SYMPTOMS

Initial sign of infection is usually the plants wilt easily. Water-soaked lesions develop at soil level, followed by the appearance of brownish ooze. This resembles gummy stem blight, but no fruiting bodies are present. The affected tissue dries and cracks.

Fruit may appear intact but develop a black internal rot and collapse postharvest. In rockmelons affected flesh is surrounded by a characteristic reddish halo.

Microsclerotia form on the dead tissue.

FAVOURED BY

Warm to hot conditions. Often occurs close to maturity if plants are stressed due to water stress or salinity.

External (left) and internal charcoal rot symptoms on rockmelon fruit (T Keinath, Clemson Extension)

Choanephora blossom blight / Cucurbit wet rot

Choanephora cucurbitarum

CROPS AFFECTED

Wide range of hosts.

SOURCE OF INFECTION

Typically soil-borne.

SYMPTOMS

Water-soaked lesions on flowers, and initially, at the blossom end of fruit. These progress rapidly under favourable conditions, developing into characteristic fluffy, light grey fur topped with fine black spores.

FAVOURED BY

Warm, damp weather. Infection commonly occurs at flowering, but can also be through damaged tissues.

Choanephora on a flower (G Holmes, Cal Poly, Bugwood.org)

Choanephora on squash (G Holmes, Cal Poly, Bugwood.org)

Cottony leak / Watery rot

Pythium spp., *Phytophthora* spp., *Rhizoctonia* spp., *Fusarium* spp.

CROPS AFFECTED

All cucurbits, but particularly cucumber and squash.

FAVOURED BY

Warm temperatures and wet soil.

SOURCE OF INFECTION

Soil-borne.

SYMPTOMS

Brown, water-soaked lesions developing into soft, rotted areas on fruit parts in direct contact with soil.

Under humid conditions white, cottony fungal growth may appear on the fruit surface and spreads postharvest.

Cottony leak on zucchini (G Holmes, Cal Poly, Bugwood.org)

Symptoms on watermelon (R.A Melanson, Mississippi State Uni., Bugwood.org)

Cucumber green mottle mosaic virus

CROPS AFFECTED

All cucurbits.

SOURCE OF INFECTION

Cucumber green mottle mosaic virus (CGMMV) can be introduced in infected seed or by contact with infected structures, soil, or debris.

SYMPTOMS

Vein clearing. Leaves appeared mottled, yellowish, and crumpled.

Fruits, if they develop at all, may be symptomless externally, or spotted, streaked, and distorted. Internally they are discoloured or necrotic, especially in watermelon.

Note that this group includes Kyuri green mottle mosaic virus and Zucchini green mottle mosaic virus, which are not present in Australia.

FAVOURED BY

Leaf symptoms are more pronounced under cool, low-light conditions, while fruit damage is more evident at high temperatures.

CGMMV on cucumber leaves (left, L Tesoriero) and heavy symptoms on watermelon fruit (NT DPIRD)

Cucumber and squash vein yellowing viruses

CROPS AFFECTED

Not present in Australia.

Cucumber vein yellowing virus (CVYV) and squash vein yellowing virus (SqVYV) can infect melon, squash, watermelon, cucumber.

SOURCE OF INFECTION

Silverleaf whitefly.

SYMPTOMS

Leaf vein yellowing and clearing, chlorosis, necrosis, and stunting. Affected fruit can appear deformed, present mosaic pattern or cracks. Symptom severity can vary greatly depending on host.

FAVOURED BY

Ideal warm conditions for the vector to spread the virus.

Vein yellowing on melon leaf (left) and cracked, dried watermelon (D Jannsen, CABI Plantwise)

Cucurbit aphid-borne yellows virus

CROPS AFFECTED

Not present in Australia. Cucurbit aphid-borne yellows virus (CABYV) can infect melon, cucumber, squash, and watermelon.

SOURCE OF INFECTION

Mainly spread by melon aphids.

SYMPTOMS

Chlorotic spots on lower leaves, expanding until only veins remain green.

Stunting and flower abortion reduce yield, but quality of developing fruit is not affected. Symptoms resemble other yellowing viruses or some nutrient deficiencies.

FAVOURED BY

High inoculum, heavy aphid pressure. Higher disease levels and yield losses occur if younger plants are infected.

CABYV symptoms on melon leaves (left) and cucumber leaves (H Lecoq, CABI Plantwise)

Cucurbit yellow stunting disorder virus

CROPS AFFECTED

Not present in Australia.
Cucumber, pumpkin, melons, and squash.

SOURCE OF INFECTION

Silverleaf whitefly.

SYMPTOMS

Cucurbit yellow stunting disorder virus (CYSDV) initially causes mottling and chlorotic spots on leaves. Interveinal chlorosis develops, leaves turning bright yellow with green veins. Leaves often roll upwards and become brittle. Fruit can appear normal but lack sugar.

FAVOURED BY

High populations of whitefly.

CYSDV symptoms on honeydew (M Matheron, Arizona Uni., Bugwood.org)

Damping off

Pythium spp., *Phytophthora* spp., *Rhizoctonia* spp., *Fusarium* spp.

CROPS AFFECTED

All cucurbits.

SOURCE OF INFECTION

Soil-borne.

SYMPTOMS

Affected seeds may fail to germinate. Seedlings develop water-soaked brown lesions at the base of the stem, eventually collapsing and dying.

Young plants which survive damping off may be stunted, developing disease symptoms as they grow.

FAVOURED BY

Wet soil and damp, cloudy weather. The various fungi responsible for damping off can survive in the soil for extended periods as resting spores or in plant trash. Seedling trays not properly sterilised before reuse can carry over the disease.

Damping-off of watermelon seedlings (Purdue Uni.)

Downy mildew

Pseudoperonospora cubensis

CROPS AFFECTED

All cucurbits.

SOURCE OF INFECTION

Wind-transported spores and infected crop debris.

SYMPTOMS

Initially chlorotic lesions appear on the upper side of older leaves. Soft whitish mould develops on the undersides of the lesions.

Affected leaves may curl, turn brown and necrotic, and die. Lesions are generally irregular, but on cucumber they tend to be defined by the leaf veins. Can sometimes be confused with angular leaf spot.

FAVOURED BY

Cool, moist conditions. Spread by wind, splashing water, workers and/or equipment.

Symptoms on the upper (N Gregory, Uni. of Delaware, Bugwood.org) and lower (G Homes, Cal Poly, Bugwood.org) leaves of cucumbers

Fusarium crown rot

Neocosmospora solani (Fusarium solani f.sp. *cucurbitae)*

CROPS AFFECTED

Zucchini and pumpkin.

SOURCE OF INFECTION

Infected seed or crop residues.

SYMPTOMS

Initial wilting can be followed by plant death within days. Brown, water-soaked, necrotic rot at the soil surface, with white to pink fungal growth on the adjoining soil.

Fruits develop a soft, dry rot with bulls-eyes of white fungal growth, starting from where they contact the soil.

FAVOURED BY

Occurs sporadically, can survive in soil without viable hosts for 1 to 2 years.

Crown rot affected pumpkin (E Sikora, Auburn Uni., Bugwood.org)

Crown rot on pumpkin (MG Lloyd, UC ANR)

Fusarium wilt

Large group of related fungi, some of which are present in Australia.

CROPS AFFECTED

Fusarium mainly affects cucumbers and melons.

SOURCE OF INFECTION

Soil-borne and seed-borne.

SYMPTOMS

Infection can happen at any plant growth stage. Can cause damping-off on seedlings but infection of older plants is more common.

Leaves may turn chlorotic, then necrotic in the interveinal areas. One or more runner's wilt, then the whole plant. Sometimes plant collapse may happen without leaf chlorosis. Vascular discolouration and rotting can be observed in roots and stems. All true *fusariums* attack their hosts through the roots. It can also cause fungal fruit rot.

FAVOURED BY

Warm weather, lack of crop rotation and susceptible variety.

Typical salmon-coloured fruiting bodies (sporodochia) on cucumber stem (left, L Tesoriero) and vascular discolouration in watermelon (Clemson Uni.)

There are many other *formae speciales* and races within them that are specific to cucurbit hosts of secondary importance (gourds, luffas, bitter melons and winter melons) which are not currently present in Australia. It is important to remember they exist, since some of these secondary species are used as rootstocks for cucurbit crops.

Host	Forma specialis	In Australia
Cucumber	*cucumerinum*	YES
Cucumber	*radicis-cucumerinum*	NO
Rockmelon and honeydew	*melonis*	YES
Watermelon	*niveum (and melonis)*	YES
Luffa	*luffae*	NO
Bottle gourd	*lagenariae*	NO
Bitter melon	*momordicae*	NO
Winter melon	*benincasae*	NO

Fusarium fruit rot on rockmelon (top left), rockmelon field affected by fusarium wilt (bottom left) (L Tesoriero) and wilting of cucumber leaves (D.J Vakalounakis, CABI)

Grey mould

Botrytis cinerea

CROPS AFFECTED

All cucurbits

SOURCE OF INFECTION

Fungal spores are common in the environment, carried in wind or water. Infection often occurs during flowering.

SYMPTOMS

Fruit develop soft, water-soaked lesions from the blossom end. These may initially be covered in white mould but become grey and fluffy as spores develop. Fruit may fail to develop, or mature normally then develop rots postharvest.

Light brown lesions can also occur on leaves, which dry and crack.

FAVOURED BY

Cool, damp conditions, especially at flowering. The fungus can still grow at temperatures close to 0°C and is a major postharvest issue.

Grey mould on developing (SC Organic Nursery) and harvested cucumber

Gummy stem blight

Stagonosporopsis cucurbitacearum, S. citrulli, S. caricae

CROPS AFFECTED

Wide range of cucurbits.

SOURCE OF INFECTION

Gummy stem blight (GSB) can survive in soil, in weeds and on crop residues. It can also be carried in infected seed or spread in wind and water.

SYMPTOMS

Infection can occur at any time. Brown, water soaked lesions on stems produce a characteristic reddish gummy fluid. Tiny fruiting bodies later form within infected tissue.

Leaves develop circular brown to black spots, sometimes surrounded by a yellow halo, often starting at the leaf margins.

Blackened, soft, rotted areas can develop on fruit; this is sometimes called 'black fruit rot'.

FAVOURED BY

Warm, wet weather.

GSB symptoms on fruit (B Watt, Uni. of Maine, Bugwood.org)

GSB symptoms on watermelon leaves (IFAS)

GSB on rockmelon, showing red-brown exudate near the plant base and upper stem yellowing (U Calvo)

Melon necrotic spot virus

CROPS AFFECTED

Melons and cucumbers.

SOURCE OF INFECTION

Direct contact with infected material or vectored by the soil-borne fungus (*Olpidium bornovarus).*

FAVOURED BY

Cool, low light conditions and sensitive varieties. In summer, infected plants may appear symptomless. Wet soil is conducive to the vector's zoospores.

SYMPTOMS

Melon necrotic spot virus (MNSV) causes small, greasy spots on younger leaves which soon turn brown. Leaves may curl and wilt. Fruit develops dark spots and the flesh can change colour, becoming hollow, watery, and rotten.

MNSV symptoms on watermelon leaves (L Tesoriero)

MNSV symptoms on external (left) and internal watermelon fruit (L Tesoriero)

Monosporascus root rot

Monosporascus cannonballus

CROPS AFFECTED

Not present in Australia. Can infect all cucurbits but highest risk is to melons.

SOURCE OF INFECTION

Soil-borne.

SYMPTOMS

Initially stunting and poor growth with gradual death of crown leaves. Small roots die and lesions form on larger roots, typically around root junctions.

However, symptoms progress rapidly as plants approach harvest, causing catastrophic vine collapse and death.

Small, black spherical fruiting bodies appear on the dead roots, clearly visible to the naked eye.

FAVOURED BY

Warm soil temperatures and plant stress. Removing developing fruits delays symptom expression. Spores can survive in the soil for many years.

Collapse of a vine (left, W Chen) and detail of root with fruiting bodies (G Holmes, Cal Poly, Bugwood.org)

Mosaic – potyviruses

Papaya ringspot virus (PRSV), Watermelon mosaic virus (WMV), Zucchini yellow mosaic virus (ZYMV)

CROPS AFFECTED

All cucurbits.

SOURCE OF INFECTION

Mainly transmitted by aphids.

SYMPTOMS

Young leaves are deformed, with blistered or stringy appearance. Yellow to light and dark green mosaic patterns on leaves. Fruits can become distorted, mottled, lumpy and develop mosaic or ringspot patterns.

Symptoms are similar to other mosaic viruses.

FAVOURED BY

Aphid activity and non-resistant varieties. Can spread rapidly.

ZYMV symptoms on zucchini (L Tesoriero)

WMV symptoms on pumpkin leaves (left, RA Melanson, Mississippi State Uni., Bugwood.org) and watermelon.

Mosaic – other viruses

Cucumber mosaic virus (CMV) and Squash mosaic virus (SqMV)

CROPS AFFECTED

CMV has a broad range, even outside cucurbit family. SqMV is confined to cucurbits. Both are considered minor pests in Australia.

SOURCE OF INFECTION

CMV is spread by aphids, SqMV is seed-borne and can be spread by chewing beetles.

SYMPTOMS

Stunting and malformed, mottled, and blistered leaves, with fruit becoming distorted and mottled on heavily infected plants. In plants affected by SqMV green bands can sometimes appear along leaf veins.

FAVOURED BY

Insect activity and non-resistant varieties.

CMV symptoms on cucumber fruits (left, TA Zitter) and plants (P Seethapathy, Amrita School Ag Science, Bugwood.org)

Phytophthora blight

Phytophthora capsici

CROPS AFFECTED

All cucurbits.

SOURCE OF INFECTION

Surface and irrigation water, soil, crop residues and other hosts (Solanaceae).

SYMPTOMS

Sudden, permanent wilt. Foliar spots are circular and initially water-soaked, rapidly becoming tan to dark brown and irregular in shape. Circular and water-soaked lesions develop where fruit is in contact with soil, or with other infected parts of the plant, later becoming sunken and covered with white, mouldy growth.

Water-soaking in roots, crown and lower stem, with tissues becoming soft and brown. Stem may collapse with leaves still green. Often very quick, with plant death just days after appearance of first symptoms.

FAVOURED BY

Wet, warm soil, high air temperatures and weak, stressed plants.

Phytophthora blight on squash crown (left) and cucumber (G Holmes, Cal Poly Bugwood.org)

Plectosporium blight

Plectosporium tabacinum (syn. *Fusarium tabacinum, Plectosphaerella cucumerina)*

CROPS AFFECTED

Many cucurbit species, most commonly pumpkin and squash.

SOURCE OF INFECTION

Soil-borne and on crop residues, can survive several years without a living host. Spores are spread by wind and water.

SYMPTOMS

Diamond to lens-shaped white lesions on vines, petioles and leaf veins, usually round on fruit and leaves. Lesions increase in number and coalesce to form a scabby area.

FAVOURED BY

Warm, wet weather.

Plectosporium blight on squash leaf (left, G Holmes, Cal Poly, Bugwood.org) and on fruit (M.A Hansen, Virginia Poly, Bugwood.org)

Powdery mildew

Podosphaera xanthii

CROPS AFFECTED

All cucurbits.

SOURCE OF INFECTION

Wind-dispersed spores from infected weeds or other cucurbit crops.

SYMPTOMS

Patches of white, powdery mould appear mainly on the upper side of leaves and stems, particularly older leaves. These can spread to cover most of the leaf surface.

Mildew is also sometimes found on the lower leaf surface. Leaves turn yellow, wither, and die, becoming brown and brittle.

Fruits are not attacked directly, but may be small, malformed and ripen prematurely.

FAVOURED BY

Dense plant growth, low light intensity and warm, humid conditions. Spores spread easily in dry conditions.

Powdery mildew on cucumber leaf (left) and zucchini leaf (R Hall)

Scab / Gummosis

Cladosporium cucumerinum

CROPS AFFECTED

Most common on cucumber, but can affect melons, pumpkin and squash.

SOURCE OF INFECTION

Spores in crop residues in soil, wind and water and on insects.

SYMPTOMS

Brownish water-soaked spots on leaves and runners, gradually turning white and sometimes with a shot-hole appearance.

Water-soaked spots also appear on fruit, becoming sunken as the fruit matures. Usually shallow and spongy, these lesions can develop a scab-like appearance and produce a gummy ooze.

FAVOURED BY

Wet and cool weather.

Scab symptoms on zucchini and squash (D Blancard, INRA)

Sclerotinia rot / White mould

Sclerotinia sclerotiorum

CROPS AFFECTED

Wide range of hosts, also outside of the cucurbit family.

SOURCE OF INFECTION

Resting bodies (*sclerotia*) in the soil germinate, producing tiny mushrooms that release spores. These spread by water and soil movement.

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, including fruit, may be affected.

In later stages hard black sclerotia form. These can be up to 10 mm across and irregularly shaped.

FAVOURED BY

Cool, moist conditions. Although infection occurs in the field, the fungus can continue to develop and grow during storage.

Zucchini stem, with white fungus and sclerotia (D Blancard, INRA)

White mould and black sclerotia on summer squash (T Gulya)

Sclerotium rot

Agroathelia rolfsii (syn. *Sclerotium rolfsii)*

CROPS AFFECTED

Wide range of hosts, including non-cucurbits.

SOURCE OF INFECTION

Resting bodies (sclerotia) in the soil germinate, producing tiny mushrooms that release spores. These spread by water and soil movement.

SYMPTOMS

Brown rots develop on stems and fruit where they contact the soil. These become covered with white, cottony fungal growth. Plants wilt and may die.

Light to dark brown sclerotia resembling mustard seeds develop, especially on fruit and at soil level.

FAVOURED BY

Warm, wet weather.

Watermelon plant showing white fungus and sclerotia (IFAS)

Sclerotium rot with sclerotia on rockmelon (U Calvo)

Septoria leaf spot

Septoria cucurbitacearum

CROPS AFFECTED

Mainly on pumpkin. Not common in Australia.

SOURCE OF INFECTION

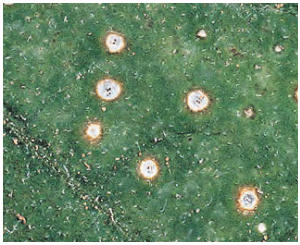
Crop residues.

SYMPTOMS

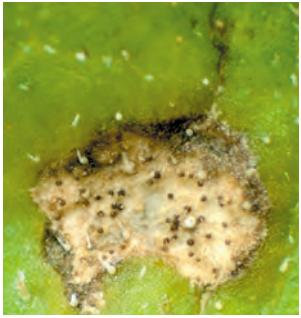
Light brown leaf spots with small black fruiting bodies. Small, circular, light brown raised scabs with star-shaped cracks on fruit.

FAVOURED BY

Rainy, humid and cool weather.



Lesions on pumpkin leaf (TA Zitter, Cornell Uni.)



Lesion on squash leaf (B Watt, Maine Uni., Bugwood.org)

Mature lesions on pumpkin (Ontario IPM)

Target leaf spot

Corynespora cassiicola

CROPS AFFECTED

All cucurbits, most common in cucumber.

SOURCE OF INFECTION

Infected plant residue, spores spread in wind and rain.

SYMPTOMS

Angular, yellow spots on older leaves. These enlarge, becoming brown and papery.

Lesions can drop out, giving the leaf a shot-hole appearance. In severe cases, elongated spots develop on stems and petioles and plants die.

Infected fruit develop sunken brown lesions with typical 'target spot' appearance

FAVOURED BY

Warm, wet or humid weather.

Symptoms on cucumber leaf (G Holmes, Cal Poly, Bugwood.org)

Tospoviruses

Melon yellow spot virus (MYSV), Watermelon silver mottle virus (WSMoV) and others

CROPS AFFECTED

Not present in Australia. Can infect a wide range of cucurbits including melons, cucumbers, and pumpkin.

SOURCE OF INFECTION

Spread by thrips, with a highly specific virus-vector relationship.

SYMPTOMS

Leaves are malformed with chloritic spots, mottling and dead areas. Fruit are malformed, with bubbling or distortion that makes them unmarketable. Rockmelons with MYSV have incomplete netting, giving them a blotchy appearance.

FAVOURED BY

Conditions that favour thrips, especially where weeds and volunteers act as reservoirs of disease.

Tospoviruses cause major losses in other countries and are a serious biosecurity threat.

MYSV symptoms on watermelon leaves (L Tesoriero)

Verticillum wilt

Verticillium dahliae

CROPS AFFECTED

Broad host range that includes non-cucurbits.

SOURCE OF INFECTION

Microsclerotia can survive in soil for years. Spores carried in water, soil and infected plant material.

SYMPTOMS

Crown leaves become yellowed then necrotic with a characteristic 'V' pattern from the margins. Leaves eventually collapse.

Can resemble Fusarium wilt. The vascular system near the base of the plant is discoloured and whole vines may die.

Symptoms may be only on one side of the plant and are more likely to be expressed after fruit set. Vascular discolouration can be observed inside the lower stem.

FAVOURED BY

Cool soil temperatures. Wilting appears during warm, dry periods when plants are stressed. High nitrogen levels increase symptoms.

Characteristic V-shaped necrosis on pumpkin leaf (J Ekman)

Vine decline / Sudden wilt

Pythium, Macrophomina, Fusarium, Stagonosporopsis

CROPS AFFECTED

All melons.

SOURCE OF INFECTION

The causal agents might be seed-borne or soil-borne.

SYMPTOMS

Rapid onset of severe wilt and near uniform collapse of the vines close to harvest, making management very difficult.

FAVOURED BY

Thought to be caused by a complex of pathogenic fungi, including the causal agents of Fusarium wilt, Charcoal rot, Gummy stem blight and Pythium. The combination of the pathogens causing the symptoms is site-specific.

The conditions that trigger vine decline are unclear and currently under investigation.

Severe vine decline symptoms in watermelon field (L Tesoriero)

Disorders

Air pollution injury

SYMPTOMS

Small white dead flecks, reddening and going necrotic, on older leaves, which can cup downwards and become mottled with pronounced veins. Younger leaves can be small and pale with dark veins. Severe damage can result in leaves falling off the plant.

CAUSED BY

Ozone and other pollutants, especially in hot, humid weather.

Ozone damage on watermelon leaf (G Holmes, Cal Poly, Bugwood.org)

Blossom end rot / Calcium deficiency

SYMPTOMS

Browning of the blossom end of the fruit, which becomes dark, sunken and soft. This can be infected by fungi or bacteria. Developing fruit often turn yellow and abort.

CAUSED BY

Blossom end rot is due to low calcium at the blossom end of fruit.

Symptoms usually occur when plants are growing vigorously but hot, humid conditions and/ or inconsistent watering reduce uptake of water and, therefore, calcium. This is a frequent challenge in greenhouses.

Blossom end rot can also be caused by low calcium availability in the soil or nutrient imbalances that inhibit calcium uptake.

Symptoms on watermelon (left, Paret, Uni. of Florida) and zucchini (Kim)

Boron deficiency

SYMPTOMS

Distortion of young leaves, and sometimes death of the growing point. A broad yellow border at the margin of older leaves. Fruit aborts or is stunted. Cucumbers develop long yellow streaks, which turn into corky markings.

CAUSED BY

Insufficient boron, especially if soil is acidic or alkaline. Inadequate watering during spring, when boron demands are high, can also cause symptoms.

Boron deficiency symptoms on cucumber leaves (J Ekman; NSW DPI)

Brown etch

SYMPTOMS

Associated with fungal diseases. Occurs exclusively on butternut pumpkin *(Cucurbita moschata)* and hybrids such as Kent pumpkins.

Reddish brown stains on fruit usually start at contact points with the ground, a stem or another fruit. These can either spread as a series of concentric rings or irregular, blotchy patches.

Discoloured areas eventually dry out, leaving a white, “petrified wood” appearance.

Brown etch is superficial, discolouration not extending into the underlying flesh. However, fruit may be unmarketable.

Symptoms can appear, and increase postharvest.

CAUSED BY

While the causes of brown etch are still unclear, it appears to be a hypersensitive response to wet conditions, including high relative humidity, heavy rain and dew.

Symptoms usually occur as pumpkins ripen, just before harvest.

Brown etch symptoms in the field (J Ekman)

Chloride toxicity

SYMPTOMS

Reduced plant vigour, dark, leathery leaves, yellowing and scorching of leaf margins and premature leaf drop.

CAUSED BY

Excess salinity and chloride in water or fertilisers.

Chloride toxicity symptoms on cucumber leaf (J Ekman; NSW DPI)

Chilling injury

SYMPTOMS

Variable, but often includes sunken or pitted areas, discolouration, failure to ripen and increased rots. For example, in cucumbers, symptoms include dry pitting, disease, and separation of the outer skin.

CAUSED BY

Storage at low temperatures (below 7°C for most cucurbits) for an extended period. Symptom development accelerates when the product is returned to warmer conditions.

Symptoms of chilling injury on zucchini (J Ekman)

Symptoms of chilling injury on rockmelon (left, S Thach) and cucumbers (J Ekman)

Herbicide damage

SYMPTOMS

Curled, deformed, pale green to yellow leaves. Plants can be severely stunted.

CAUSED BY

Contamination of the spray tank due to insufficient cleaning, inappropriate herbicide selection or residual activity. Herbicide can also drift onto crops from an adjacent area.

Herbicide damage on zucchini stem and leaves (NSW DPI)

Herbicide damage on cucumber leaves (NSW DPI)

Hollow heart

SYMPTOMS

Watermelon flesh is cracked and has a hollow section. The fruit may not be completely round, but angled in shape.

CAUSED BY

Associated with poor pollination. Some varieties are more prone, but excessive soil moisture and excess nitrogen cause the rind to grow more quickly than the flesh.

Hollow heart internal (top) and external symptoms (G Holmes, Cal Poly, Bugwood.org)

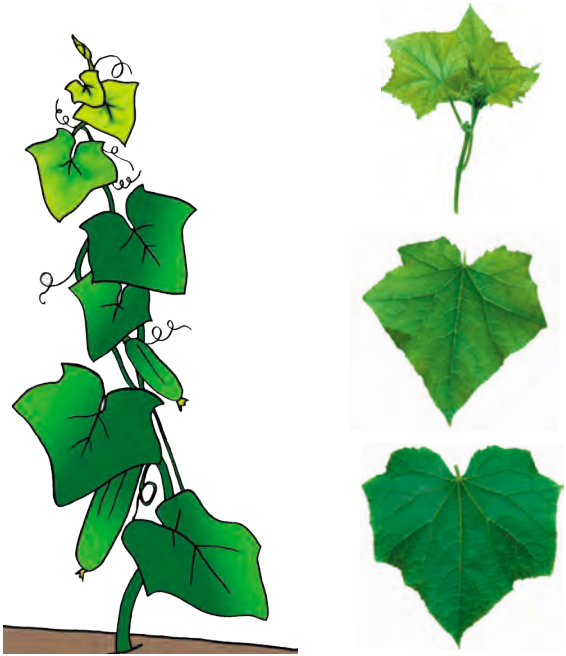
Iron deficiency

SYMPTOMS

Pale yellow to green chlorosis between the veins on young leaves, with older leaves remaining dark.

CAUSED BY

Alkaline soils with pH over 7. Symptoms can also occur due to over-liming, poor drainage or manganese toxicity.



Iron deficiency symptoms on cucumber leaves (J Ekman; NSW DPI)

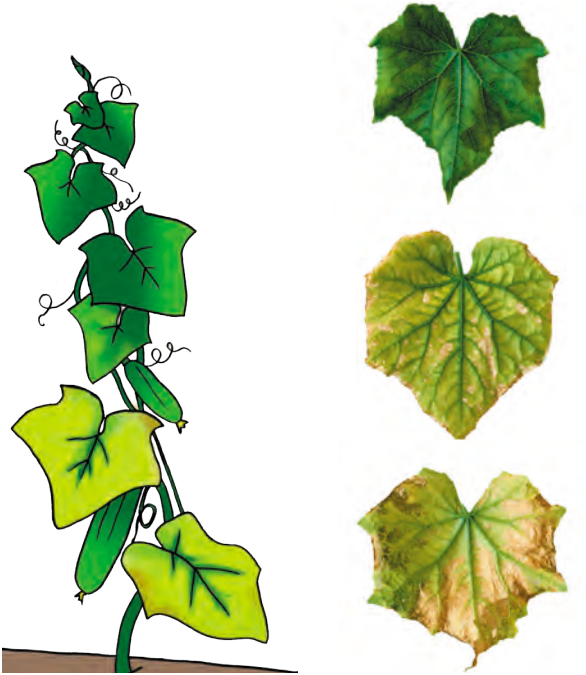
Magnesium deficiency

SYMPTOMS

Yellowing of older leaves, especially between the major veins, which remain green. The yellowing can increase to a tan burn if deficiency is severe.

CAUSED BY

Most likely in light, sandy, acidic soils with high rainfall. High rates of potassium can reduce magnesium uptake.



Magnesium deficiency symptoms on cucumber leaves (J Ekman; NSW DPI)

Manganese deficiency

SYMPTOMS

Plants are stunted, leaves are yellow and mottled, with symptoms initially visible on younger leaves.

CAUSED BY

High soil pH makes manganese unavailable for plants.

Cucumber leaf with symptoms of manganese deficiency (NSW DPI)

Manganese toxicity

SYMPTOMS

Areas between the veins of older leaves turn light green to yellow. Can resemble foliar disease. Tiny pin-holes form in the leaves and grow together, easily seen when looking through the leaves toward the sun.

CAUSED BY

Low soil pH and waterlogging, common in sandy soils.

Severe manganese toxicity on rockmelon leaf (E Maynard)

Measles

SYMPTOMS

Small, water-soaked lesions appear on the skins of smooth skinned melons and cucumbers. These expand and darken, potentially covering the whole fruit, but do not penetrate the flesh.

CAUSED BY

Cool, humid conditions cause guttation, where liquid squeezes out from the leaf vascular system. The high salt content in the droplets burns the skin of the fruit. Can appear similar to bacterial fruit blotch.

Guttation on cucumber leaf (top) (L Tesoriero) and measles on honeydew (Texas A&M)

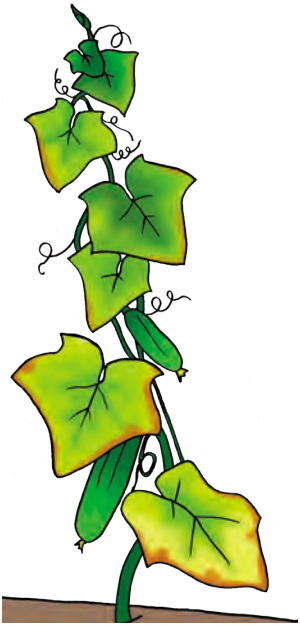
Molybdenum deficiency

SYMPTOMS

Without molybdenum plants are unable to use nitrates absorbed from the soil. Initial symptoms therefore resemble nitrogen deficiency, the plant appearing pale and stunted. Unused nitrates accumulate at the edges of the leaves, causing them to become scorched and distorted. Older leaves are most severely affected.

CAUSED BY

Often associated with acid soils with pH less than 5.5, as low pH makes molybdenum unavailable to plants.



Molybdenum deficiency symptoms (J Ekman; Texas A&M Uni.)

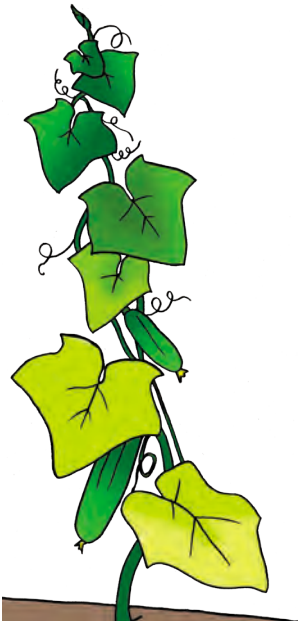
Nitrogen deficiency

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. Plants are small, with few flowers, poor fruit set and low-quality fruit.

CAUSED BY

Insufficient nitrogen, either under-applied, leached or lost as gas from the soil. High carbon soil amendments such as straw can lock up available nitrogen, reducing availability to plants.



Nitrogen deficiency symptoms on leaves (J Ekman; SK. Flickr)

Oedema

SYMPTOMS

Raised, wart like lumps appear, especially in areas where the fruit contacts the soil. These can heal, forming a corky scar.

CAUSED BY

Wet conditions mean that roots take up water faster than it can be used by the plant, building up pressure within the vascular system. External cells become blistered and burst.

Oedema symptoms on cucumber (top) and pumpkin (J Ekman)

Phosphorus deficiency

SYMPTOMS

Plants are weak and stunted with small, dark, dull grey-green leaves. Older leaves turn yellow and drop prematurely. Scorch spots can appear between the leaf veins.

CAUSED BY

Insufficient fertilisation. Uptake of phosphorus is reduced in acidic and/or cold soil.

Note that phosphorous toxicity can occur in hydroponic systems, with symptoms similar to salinity.

Phosphorus deficiency symptoms on cucumber leaf (J Ekman; NSW DPI)

Poor pollination

SYMPTOMS

Young fruit may die off soon after starting to develop. Fruits that do grow are misshapen, curved, or bulbous.

CAUSED BY

Low pollinator activity due to weather conditions, pesticides, insufficient numbers. Many cucurbits produce male and female flowers on the same plant. At low temperatures, more female than male flowers are produced, increasing the risk of poor pollination.

Poor pollination symptoms on cucumbers (top left, S Thach; top right, G Holmes, Cal Poly, Bugwood.org) and misshapen watermelon due to poor pollination (Paret, Uni. of Florida)

Potassium deficiency

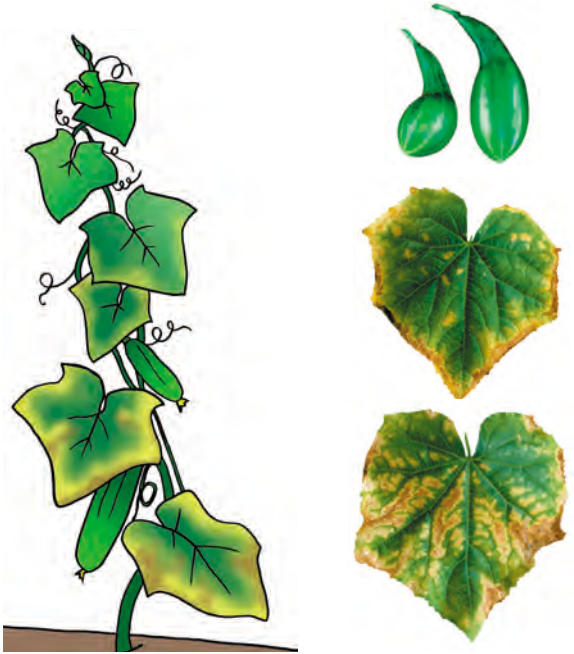
SYMPTOMS

Yellowed, scorched areas develop around the leaf margins and between the veins. Brown, necrotic areas appear, mainly on the older leaves, and leaf tips curl. Plants are short and stunted and fruit is malformed.

CAUSED BY

Insufficient or leached potassium, unbalanced fertilisation. Symptoms can develop rapidly in hot weather.

Excess potassium can reduce uptake of calcium and magnesium.



Potassium deficiency symptoms on cucumber leaves (J Ekman; NSW DPI)

Rind necrosis

SYMPTOMS

Browning of the rind inside watermelon fruits, not visible from outside and rarely affecting the flesh. In rockmelon dead tissue extends into the flesh with no symptoms on the outside. No symptoms on leaves.

CAUSED BY

Unknown. Symptoms are associated with environmental stresses such as extreme heat, wet soils or dry conditions. There have been detections of *Erwinia* spp. and MNSV in affected fruit, but causality is unproven.

Symptoms on watermelon (G Holmes, Cal Poly, Bugwood.org)

Salt injury

SYMPTOMS

Reduced growth. In severe cases leaves develop bleached, burned areas, typically at the leaf tip and around the edges. Older leaves develop problems first and may detach.

CAUSED BY

High salinity levels in soil or irrigation water. Most common inland, but can also occur in coastal areas where irrigation water is brackish.

Salt injury on plant leaves (G Brust, Uni. of Maryland)

Sunburn

SYMPTOMS

Scalded fruits develop bleached soft lesions, which can dry out and form scar tissue. Secondary infections can attack the weakened fruit.

CAUSED BY

Sun exposure, often associated with lack of good leaf cover.

Sunburn damage on watermelon (U Calvo)

White choko

SYMPTOMS

Vines lack chlorophyll and turn pale, nearly white, with white fruits developing. White and green vines can coexist on the same plant. Plants grown from a white fruit can develop normal green fruit.

CAUSED BY

Unknown. Associated with high temperatures at peak production. Australian chokoes have been reproduced vegetatively for many years; symptoms may be the result of stress triggering dormant genetic traits.

White choko symptoms on fruit (top left), discarded fruit (top right) and on vines (J Ekman)

Zinc toxicity

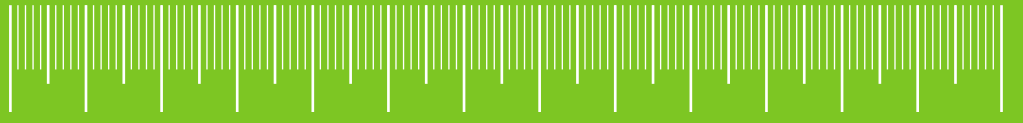
SYMPTOMS

Pale green chlorosis of younger leaves. If severe, small light-brown spots can appear between veins. Older leaves may wilt and have a dull appearance.

CAUSED BY

Polluted soils or contaminated water, especially in hydroponic systems.

Zinc toxicity symptoms (J Ekman; NSW DPI)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