



**Horticulture
Innovation
Australia**



Pests, Diseases and Disorders of Carrots, Celery and Parsley

A FIELD IDENTIFICATION GUIDE





**Horticulture
Innovation
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Jenny Ekman and Len Tesoriero

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Abbreviations

DAFWA	Department of Agriculture and Food WA
Ext	Extension
IPM	Integrated pest management
IPNI	International Plant Nutrition Institute
MSU	Michigan State University
NSW DPI	NSW Department of Primary Industries
OMAFRA	Ontario Ministry of Agriculture, Food and Rural Affairs
PaDIL	Pest and Disease Image Library
TAMU	Texas A&M University
UC	University of California
WSU	Washington State University

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Insects

Aphid — carrot willow

Cavariella aegopodii

DESCRIPTION

Nymph: Yellowish to green, similar to adult.

Adult: Greenish to straw coloured with darker feet and antennae tips. Up to 3 mm long with slightly flattened shape. Winged adults are predominantly black to grey with clear wings.

DAMAGE

Heavy infestations can cause yellowing and distortion of foliage. Can act as a vector for Carrot virus Y, but transmission rates are low compared to other aphid species.



Leaf curling of dill due to aphid infestation and colony on a fennel plant (W Cranshaw WSU Bugwood.org)

MOST COMMON

These aphids overwinter and sexually reproduce on willow trees. They migrate onto carrots and other apiaceous crops from early spring, and are favoured by dry conditions.



Close-up of the aphid (A Jensen)



Aphid — green peach

Myzus persicae

DESCRIPTION

Nymph: Varies from yellowish to green.

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

DAMAGE

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

MOST COMMON

During warmer months on a wide range of host plants.



Green peach aphids

Beet / lesser armyworm

Spodoptera exigua

DESCRIPTION

Egg: Laid in a mass on the leaf underside and covered with white, cottony material.

Caterpillar: Hairless caterpillar, initially pale green, becoming darker green with variable brown, yellow and white stripes as it matures.

Adult: Mottled grey and brown moth around 15 mm long, wings held flat along the body.



Young (R Smith Auburn Uni Bugwood.org) and mature (W Cranshaw CSU Bugwood.org) armyworm caterpillar and adult moth (M Shepard Bugwood.org)

DAMAGE

Young caterpillars often feed in groups, skeletonising leaves. Mature larvae feed singly, particularly preferring the centre of the plant.

MOST COMMON

Warmer months, particularly summer in southern areas. Attacks a large range of hosts including celery and parsnip.



Carrot rust fly

Psila rosae

Exotic pest X

DESCRIPTION

Larvae: Creamy yellow, legless maggot up to 10 mm long.

Adult: Slender 6 mm long black fly with clear wings, yellow head and legs and large reddish brown eyes.

DAMAGE

Larvae feed on carrot and parsnip roots, burrowing into the plant tissue and leaving irregular brown channels under the surface. In celery, larvae bore into the roots, crown and petioles. Parsley taproots can also be infested. Seedlings are often killed, older crops are unsaleable.

MOST COMMON

Not currently in Australia, but present in NZ, South Africa and much of Europe and North America. Adult flies overwinter as pupae, emerging to lay eggs in spring.

Carrot rust fly damage (Rasbak), close up of the larvae responsible, and an adult fly (R Collier Warwick HRI)



Carrot weevil

Listronotus oregonensis

Exotic
pest X

DESCRIPTION

Larvae: Creamy grub with reddish brown head.

Adult: Mottled, dark brown weevil around 6 mm long with prominent snout.

DAMAGE

Both adults and larvae infest carrots, celery, parsnips and parsley. Adults feed mainly on foliage, larvae burrow into the petioles and the top parts of roots, forming zigzag tunnels. Young plants may be defoliated and die, roots are unmarketable.

MOST COMMON

Not currently in Australia, but a major pest in North America.



Carrot weevil (LDPC Quebec) and damage to roots (TAMU Ext)

Cutworm

Agrotis spp.

DESCRIPTION

Egg: Creamy spheres around 0.5 mm diameter with a slightly ribbed appearance. Usually laid in a large mass on vegetation or moist ground.

Caterpillar: Initially grey-green, caterpillars darken as they age, becoming grey to black with red, yellow and cream markings. Mature caterpillars can reach 50 mm long. Tend to curl into a ball if disturbed.

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

DAMAGE

Larvae initially feed on leaves, leaving irregular holes. Older larvae cut off seedlings at soil level, usually during the night. Plants may be dragged underground to feed on during the day.

MOST COMMON

Damage most likely during spring, especially in damper areas.



Cutworm attacking young celery plants; Active cutworm and Bogong moth

Earwig – black field, European

Nala lividipes, Forficula auricularia

DESCRIPTION

Nymph: Similar to adult, although lighter in colour and with less developed pincers.

Adult: Black field earwigs are dark brown to black, European earwigs are reddish brown. Both are slender with flattened bodies up to 15 mm long and beaded antennae. Obvious pair of pincers at the end of the body; curved in males and straighter in females.

DAMAGE

Usually a minor pest that feeds on decaying plant matter. Can be a contamination issue in crops such as celery.

MOST COMMON

Young nymphs emerge during spring. Populations increase most rapidly in cool to moderately warm (around 24°C), moist conditions.



Black field and European (Flagstaffotos) earwigs

Heliothis / Native budworm

Helicoverpa armigera, H. punctigera

DESCRIPTION

Egg: Ribbed, white domes 1 mm diameter that darken before hatching. Eggs are laid singly or in small clusters on foliage.

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

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

DAMAGE

Feeding damage to leaves, frass can be a contamination issue.

MOST COMMON

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



Heliothis caterpillar and adult moth

Hoverfly

Syrphidae spp.

Beneficial insect ✓

DESCRIPTION

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

Adult: Resembles a small 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 attack small insects such as aphids and thrips.

MOST COMMON

Warm weather, especially summer.



Hoverfly larvae and adult photographed mid-air (Flagstaffotos)

Lacewing — brown and green

Micromus tasmaniae, *Mallada signatus*

Beneficial insect ✓

DESCRIPTION

Nymph: Brown lacewing nymphs are slender, brown and up to 10 mm long with a smallish head but large jaws and a long tail. Green lacewing nymphs are thicker bodied, up to 8 mm long and usually camouflage themselves with the remains of their prey.

Adult: Brown lacewings are up to 8 mm long with large green eyes. Green lacewings are up to 15 mm long with large round red eyes and long antennae. Both have large, delicately-veined wings held upright along the body.

BENEFIT

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

MOST COMMON

Year round.



Brown lacewing nymph attacking aphids (P Scanlon DAFWA); Adult green lacewing

Ladybird

Coccinella transversa, Hippodamia variegata

**Beneficial
insect** ✓

DESCRIPTION

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

Adult: Most are brightly coloured, dome shaped beetles 3–5 mm long 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.



Nymph and adult of the white collared ladybird (*H. variegata*)

Leafhopper / Jassid

Austroasca viridigrisea

DESCRIPTION

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

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

DAMAGE

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



MOST COMMON

Warmer months, only occasionally a major pest.



Leafhopper damage to celery and parsley, and adult leafhopper (CSU)

Looper

Chrysodeixis spp.

DESCRIPTION

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

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

DAMAGE

Holes in leaves, leaves can be skeletonised.

MOST COMMON

Summer–autumn.



Looper on parsley and adult moth (P Hampson Bugwood.org)

Lucerne leafroller

Merophyas divulsana

DESCRIPTION

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

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

DAMAGE

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

MOST COMMON

Most common during late summer–autumn, mainly a pest of parsley.



Leafroller caterpillar and adult moths (NSW DPI)

Nematode — root knot

Meloidogyne spp.

DESCRIPTION

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

DAMAGE

Root knot nematodes cause severe damage to many crops, but particularly carrots.

Juveniles hatch from eggs in the soil, penetrate plant roots and set up a permanent feeding site. The root cells around this site swell, forming a knot or gall. Upper parts of the plants fail to thrive, yellow and wilt easily. Carrots can be hairy, stunted and misshapen, with branch roots or knobby growths attached.



Root knot nematode damage to celery (MA Hansen Virg Polytech Bugwood.org)

MOST COMMON

Symptoms are increased in warm environments (over 25°C), with major egg hatching during spring. Nematodes are spread

in irrigation water, on machinery and by infested seedlings, making farm hygiene and crop rotation important control methods.



Root knot nematode damage to carrots (L DuToit, WSU) and symptoms in a carrot crop (DAFWA)

Nematode — root lesion

Pratylenchus spp.

DESCRIPTION

Nematodes are microscopic, wormlike organisms <1 mm long rarely visible to the naked eye. Root lesion nematodes can reproduce in the soil or inside plant roots.

DAMAGE

Unlike root knot nematodes, root lesion nematodes move around inside the plant roots, rupturing cells and digesting the cell contents. Small feeder roots die; black lesions appear on larger roots. Above ground symptoms are stunting, yellowing and wilting of the plant, while carrots can be stunted and misshapen. Feeding injuries to the roots increase the chance of infection by soil borne fungi, causing secondary damage.

MOST COMMON

Optimum development temperature is around 23°C, with populations potentially increasing a thousandfold over 3–4 months. Nematodes are spread in irrigation water, on machinery and by infested seedlings, making farm hygiene and crop rotation important control methods.



Root lesion nematode (Uni of Nebraska-Lincoln); Nematode damage to a carrot crop

Plague soldier beetle

Chauliognathus lugubris

DESCRIPTION

Larvae: Carnivorous, soil-dwelling grub that eats pupae, insect eggs, small caterpillars and other small insects.

Adult: Slender beetle with bright orange abdomen and metallic, olive green wing covers. Up to 15 mm long. Feeds mainly on pollen and nectar.

DAMAGE

Although larvae are potentially beneficial, the adult beetles can create significant contamination problems in leafy crops such as parsley and celery.

MOST COMMON

Summer and early autumn in south-eastern Australia. Large swarms can form, possibly to mate. Little is known about this insect.



Adult plague soldier beetle

Redlegged earth mite

Halodytus destructor

DESCRIPTION

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

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

DAMAGE

Lacerates plant leaves to release sap, resulting in large, whitish patches on leaves.

Mainly feeds in the morning or in overcast conditions. If disturbed, mites 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 mites (CSIRO)

Rutherglen bug

Nysius vinitor

DESCRIPTION

Nymph: Reddish brown and pear-shaped with developing wing buds.

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

DAMAGE

Not usually a significant pest although it can cause some

feeding damage through sap sucking leaves. Can be a contamination issue for leafy crops such as celery or parsley.

MOST COMMON

Multiplies during spring in weed species. Usually moves into vegetable crops during summer when other hosts are unavailable.



Rutherglen bug adult and nymph

Thrips — onion, plague, tomato, WFT

Thrips tabaci, *T. imagines*, *Frankliniella schultzei*, *F. occidentalis*

DESCRIPTION

Identification of the many different species of thrips is difficult due to their tiny size — significant magnification is required.

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

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

DAMAGE

Onion, tomato and Western Flower Thrips (WFT) can transmit Tomato Spotted Wilt Virus (TSWV) in the crop. Plague thrips are the most commonly found species in celery, but these insects do not carry TSWV and usually cause only minor feeding damage. Generally a minor pest in apiaceous crops.

Onion thrips (W Cranshaw CSU Bugwood.org); Western flower thrips (S Broughton DAFWA)

MOST COMMON

Onion thrips are most common in early summer, WFT and tomato thrips most common in mid–late summer. Thrips tend to hide in the centre of the plant, particularly around the new shoots and the inner petioles.



Vegetable weevil

Listroderes difficilis

DESCRIPTION

Larvae: Up to 12 mm long, cream to greenish grub with brownish orange head. Pupates in the soil in early spring.

Adult: Mottled brown beetle about 8 mm long with pale V-shaped mark on its back and a prominent snout.

DAMAGE

Usually nocturnal, the larvae cause the most damage. They feed on carrot roots, making small, irregular holes mainly in the upper parts. Both adults and larvae make distinctive round chewing holes in the leaves of many crops. While damage is usually

superficial it affects saleability and can kill seedlings.

MOST COMMON

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



Vegetable weevil larvae (A Prather) and adult weevil (JD Hopkins)

Wireworms — false, true

Gonocephalum spp., Family Elateridae

DESCRIPTION

Larvae: False wireworm larvae are smooth, golden to brown and up to 30 mm long with a round head and dark mouthparts. True wireworm larvae are creamy to light brown with a darker, reddish head and tail. They are softer bodied than false wireworms and the tail is usually forked with a serrated edge.

Adult: False wireworms mature into 'darkling' beetles. These dark, oval-shaped beetles have a thorax with flanged edges (like a pie dish). Adult true wireworms are known as 'click beetles' because they can right themselves with a 'click' if placed upside down.



False wireworm larvae with damage to a carrot root (D Young WSU) and in closeup (L DuToit WSU)

DAMAGE

Larvae live in the soil where they feed on young plant roots. They can tunnel into carrot roots, forming cavities and providing entry points for disease.

MOST COMMON

Most likely to be a problem when crop is in a field formerly planted with pasture or mulches.



Click beetle, the adult form of the true wireworm



Diseases

Alternaria leaf blight

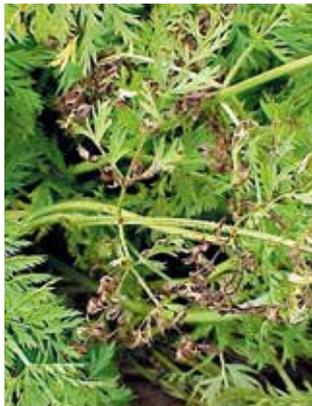
Alternaria spp.

CROPS AFFECTED

Carrots

SYMPTOMS

Small, dark grey to black spots initially develop on the older leaves. These are irregularly shaped and have distinct yellow halos. As the disease develops the spots grow and combine, resulting in the whole leaf yellowing and collapsing. Lesions also develop on petioles, resulting in death of the leaf and breakage during harvest.



Alternaria leaf blight on carrot leaves (DB Langston Uni Georgia Bugwood.org); Effects of Alternaria leaf blight on a carrot crop (RM Davis UC IPM)

FAVOURED BY

Rainy weather and/ or overhead irrigation especially during autumn and winter. Although the optimum temperature for development is around 28°C, infection can occur over a wide temperature range (approx 13–35°C). The disease is usually seed-borne and spread in water. Although the fungus can survive on carrot debris in the soil, it dies once this decomposes.

Bacterial leaf blight

Xanthomonas hortorum pv. *carotae*

CROPS AFFECTED

Carrots

SYMPTOMS

Small, yellow, angular spots that rapidly enlarge and turn brown. Spots are initially at the leaf margins, particularly at the junctions of the lobes of individual leaflets. As they spread, leaves become chlorotic, twisted and distorted. Disease can spread into the petioles, which become shrivelled and brown.

FAVOURED BY

Warm (25–30°C), wet weather, especially if overhead irrigation is used extensively.

The bacterium is seed borne, but spreads through irrigation water and runoff as well as carried on machinery and by insects. The bacterium can survive in the soil on crop residues, but has a limited host range so crop rotation is an important control strategy.



Bacterial leaf blight symptoms (L DuToit WSU)

Bacterial leaf spot

Pseudomonas syringae pv. *apii*

CROPS AFFECTED

Celery, parsley

SYMPTOMS

Initially appears as bright yellow spots, which turn brown in the centre as the disease progresses. Spots are usually roughly circular, surrounded by a yellow halo. Leaves may die and saleability is reduced.



Moderate and severe symptoms of bacterial leaf spot (L Tesoriero NSW DPI)

FAVOURED BY

Damp, humid conditions, such as in a dense crop canopy. Leaves remaining wet for at least 7 hours over several days will increase infection. The bacterium is seed borne, but spreads through irrigation water and runoff.

Bacterial soft rot

Erwinia spp., *Pectobacterium* spp.

CROPS AFFECTED

All

SYMPTOMS

Water-soaked lesions can appear on stems, leaves or roots. As these enlarge the tissues collapse into a slimy mess, often with an unpleasant smell. Pre-harvest can cause plant collapse due to rotting of the crown or roots. Parsley plants can suffer complete collapse and distinct white bleaching of leaves. Bacterial soft rots are also important postharvest, especially affecting carrots and celery.

FAVOURED BY

Warm, wet conditions, particularly if combined with high levels of nitrogen. A common secondary infection following physical damage or injury.



Symptoms of bacterial soft rot on carrots in the field (B-Ming Wu Oregon State University); Symptoms of bacterial soft rot on celery in the field

Black canker / *Itersonilia* canker

Itersonilia perplexans, *Cylindrocarpon* spp., *Mycocentrospora acerina*

CROPS AFFECTED

Parsnips

SYMPTOMS

Dark reddish brown to black cankers develop on the parsnip roots, particularly around the crown. These are initially superficial but extend into the inner tissues as the disease progresses. Small (1–2 mm diameter) yellow spots appear on leaves. These spread and turn brown as they age.

FAVOURED BY

Superficial root damage—particularly damage by root rot fungi such as *Pythium*—predispose parsnips to this disease. Symptoms are often the result of infection by a complex of fungal pathogens, many of which can survive in the soil and on crop residues. Can also be seed borne or the result of infection by air borne spores washed into the crown. The *Itersonilia* fungus is favoured by temperatures around 20°C.



Symptoms of black canker on parsnips, here shown on the crown but can occur anywhere on roots (L Tesoriero NSW DPI); *Itersonilia* infection on parsnip leaves (M Kepler APS)

Black root rot

Thielaviopsis basicola, *Chalaropsis thielavioides*

CROPS AFFECTED

Carrots and parsnips

SYMPTOMS

Dark grey to black fungal growth develops on the surface of the carrot crown, particularly around remnant leaf bases. Blackened areas with diffuse margins develop on roots.

FAVOURED BY

Predominantly a postharvest problem that occurs when washed carrots are not properly dried and cooled below 5°C before packing. Spores are often present in the soil and can grow rapidly in the injuries produced by harvest and packing processes.



Black root rot on carrots (L DuToit WSU) and close-up of symptoms (DAFWA)

Carrot black rot

Alternaria radicina

CROPS AFFECTED

Carrots

SYMPTOMS

Dark brown to black, irregularly shaped lesions occur on leaves, similar to *Alternaria* leaf blight. Black rot can result in poor establishment or death of seedlings, similar to damping off. In mature plants infection often occurs through the older leaves, resulting in a black, decayed ring at the junction of leaves and root. This area has a distinct margin, unlike black root rot.

FAVOURED BY

Warm, humid weather. The disease is seed borne and can survive in crop residues in the soil for several seasons.



The blackened area at the junction of leaves and root typical of carrot black rot (R Coles PaDIL) and symptoms on the roots (L Tesoriero NSW DPI)

Cavity spot

Pythium sulcatum, P. violae

CROPS AFFECTED

Carrots, parsnips

SYMPTOMS

Small, oval, sunken spots develop on the surface of roots. The carrot skin may disintegrate, revealing a sunken cavity in the underlying tissue. Carrots are likely to fork or branch if the centre of the taproot is infected early in development. Even moderate infection makes carrots unmarketable.

FAVOURED BY

A common problem in many areas, particularly where carrots are rarely rotated with other crops and/or

crops develop during late summer to autumn. Also associated with acid soils and poor drainage. Sunken spots usually appear when carrots are within one month of harvest, and increase fastest on overmature roots.



Cavity spot lesions (L DuToit WSU)

Cercospora leaf spot

Cercospora carotae

CROPS AFFECTED

Carrots

SYMPTOMS

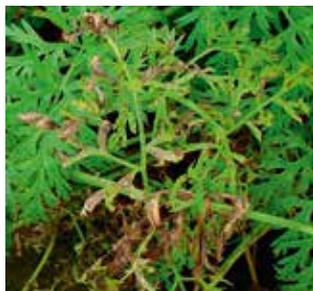
Usually occurs first at the margins of younger leaves. Small, round spots develop with pale centres and dark brown margins. Areas around the spots become yellowed and leaflets curl. Infected petioles turn dark brown.

FAVOURED BY

Warm conditions, with development fastest at around 28°C. Spores are mainly carried on seeds but survive in plant debris. Although superficially similar, usually not as damaging as *Alternaria* leaf blights.



Cercospora leaf spot symptoms on carrot foliage (L DuToit WSU) and in close-up (M Grabowski Uni Minnesota); Symptoms on carrot petioles (L DuToit WSU)



Crater rot

Rhizoctonia carotae

CROPS AFFECTED

Carrots

SYMPTOMS

Horizontal bands of dark brown canker-like lesions appear on the roots, mainly on the crown and upper parts. Pits then develop under the lesions, enlarging into sunken, brown craters. White fungal growth may be observed under high humidity.

FAVOURED BY

Cool weather (less than 23°C) combined with high humidity.



Crater rot on carrots (L Tesoriero NSW DPI, S Kurt Uni Mustafa Kemal)

Crown rot

Fusarium spp., *Rhizoctonia* spp.

CROPS AFFECTED

All

SYMPTOMS

Above ground, plants become yellowed, wilted and stunted. In carrots, blackened lesions initially develop at the junction between the root and the leaves. These can spread, encircling the top part of the root. This results in the leaves breaking off during lifting and harvest. In parsley and celery, soft, brown rot develops at the

junction with the soil surface, roots become brown and discoloured and the root mass is severely reduced.



Crown rot due to *Rhizoctonia* spp. in young (L Tesoriero NSW DPI) and mature (H Pung Peracto) carrots

FAVoured BY

Mild conditions (over 18°C) and wet soils. Symptoms have been associated with low soil pH, nutritional imbalances and high organic

matter in soil. Crown rot is common in Tasmania, and during winter in more northern production areas.



Crown rot of carrots due to *Fusarium* (H Pung Peracto)



External and internal symptoms of crown rot caused by *Fusarium* spp. infection in parsley (L Tesoriero NSW DPI)

Damping off

Rhizoctonia spp. *Pythium* spp.

CROPS AFFECTED

All

SYMPTOMS

Pre-emergence, damping off can cause seeds to rot within the seed coat. Seedling emergence is poor and plants are stunted. Post-emergence, reddish brown lesions develop near the soil junction. Seedlings collapse and die.

FAVOURED BY

Mild weather and wet conditions, especially if soil becomes waterlogged. Fungal

species are present in soils, and can also cause symptoms in mature plants, such as 'collar rot' (*R. solani*) in parsley.



Damping off of carrots (B Conde NT DPIF) and parsley (L Tesoriero NSW DPI);

Early blight

Cercospora apii

CROPS AFFECTED

Celery, celeriac

SYMPTOMS

Initially appears as small yellow spots on the outer leaves. These develop into irregularly shaped, orange-brown lesions that become dry and papery. Lesions may also develop on the petioles. In the later stages, fuzzy grey mould may become visible in the centres of the spots.



Early (W Sae-Uang) and advanced (RS Nelson) symptoms of early blight on celery

FAVOURED BY

Warm (15–30°C) and wet conditions, such as during showery weather or with prolonged heavy dews. The fungus is seed borne but may also be carried on wind or in irrigation water.



Detail of early blight infection of celery (L Tesoriero NSW DPI)



Late blight / Septoria spot

Septoria apicola

CROPS AFFECTED

Celery, celeriac

SYMPTOMS

Small yellowish spots appear first on the older and lower leaves. These enlarge, turn brown, and become speckled with small black fruiting bodies. Leaves become discoloured, wither and die. Greyish spots and lesions may also develop on the petioles.



Septoria spots on celery leaves

FAVoured BY

Leaves remaining wet for extended periods due to cool, rainy weather. Spores spread on seeds and in irrigation water, and can survive in the soil on crop residues.



Closeup of the spores (Len Tesoriero NSW DPI)



The effects of severe late blight infection on celery petioles and crop growth

Leaf curl / Celery anthracnose

Colletotrichum acutatum, *C. orbiculare*

CROPS AFFECTED

Celery

SYMPTOMS

Early symptoms include leaf cupping and translucent lesions on petioles. As the disease develops, leaves and petioles become distorted, curled and twisted. Leaves brown off, becoming brittle. Spots on the petioles turn brown and spread through the vascular system, producing a striped appearance.

FAVOURED BY

Warm, moist conditions. Disease spreads in irrigation water.



Leaf curl effects on petioles (L Tesoriero NSW DPI); Leaf curl symptoms in the field

Licorice rot

Mycocentrospora acerina

CROPS AFFECTED

Carrots, celery, parsnips

SYMPTOMS

Although infection can occur any time, symptoms mainly develop during postharvest storage. Large, water soaked lesions develop

on the roots. Initially brown, these turn black as they develop, but retain a margin of water-soaked tissue.

FAVOURED BY

Humid or moist conditions.



Licorice rot on stored carrots

Powdery mildew

Erysiphe heraclei

CROPS AFFECTED

Carrots. Parsnips and parsley can be weakly affected.

SYMPTOMS

Powdery white fungal growth initially appears on the oldest leaves but spreads to cover all leaf surfaces. Infected foliage becomes brittle and distorted and the petioles turn brown and die. Yield is reduced and petiole breakage affects mechanical harvesting.

FAVOURED BY

High humidity and moderate temperatures. Spores are easily spread by wind.



Powdery mildew symptoms on carrot (L DuToit WSU) and at top, parsnip (T Isakeit TAEX Weslaco)

Root rot complex

Phytophthora spp., *Pythium* spp.

CROPS AFFECTED

All

SYMPTOMS

Above ground— rapidly progressing wilting, plant collapse and death. Below ground, the roots develop a brown, spongy rot. *Pythium* particularly destroys the lateral roots, while *Phytophthora* infections leave the root system intact but brown.



FAVOURED BY

Soils which are wet or waterlogged and cool, especially if below 10°C. Plants of any age can be affected. Spores are carried in irrigation water or runoff and may survive in the soil for extended periods.



Root rot complex symptoms in parsley (L Tesoriero NSW DPI); Comparison of the root systems of a healthy plant (L) and one infected with *Pythium* spp. (L Tesoriero NSW DPI)

Septoria leaf spot

Septoria petroselini

CROPS AFFECTED

Parsley

become papery. Foliage yellows and can die.

SYMPTOMS

Small, tan leaf spots develop with a pronounced dark red-brown margin. Black spores develop inside the lesions, which enlarge and

FAVOURED BY

Mild temperatures (20–25°C) combined with high humidity and foliage remaining wet for several hours.



Septoria leaf spot on curly parsley (OMAFRA); Flat leaf parsley with slight (OMAFRA) and severe (R, B Watt Uni Maine Bugwood.org) septoria leaf spot

Virus — Apium virus Y

CROPS AFFECTED

Celery, parsley

SYMPTOMS

Older leaves become mottled with yellowing around the veins, brown lesions and distorted leaflets. Mosaic or mottling is fainter on the younger leaves. Some celery cultivars develop long, brown lesions on the petioles. Plants may appear stunted.

FAVOURED BY

Virus persists in weed species and is transmitted by aphids. Susceptibility varies greatly between cultivars.



Symptoms on celery petioles (ST Koike UC Ext) and dill (L Tesoriero NSW DPI)

Virus — Carrot motley dwarf disease (red leaf)

CROPS AFFECTED

All

SYMPTOMS

Carrot leaves become reddened, plants are stunted, and seedling roots are prone to developing rots. Mature roots are more likely to have internal browning. Parsley also becomes chlorotic; especially the outer leaves which can develop a pink tone. Although a serious disease in the past, now rarely causes commercial losses.

FAVOURED BY

Outbreaks are most likely when carrots are cropped continuously, especially if volunteer carrot plants remain after harvest. Virus is transmitted mainly by the carrot willow aphid, which remains able to infect plants for its lifespan. Symptoms are caused by the combined effects of two viruses: Carrot redleaf virus and Carrot mottle virus.



Red foliage typical of carrot motley dwarf disease (Uni Warwick)

Virus — Carrot virus Y

CarVY

CROPS AFFECTED

Carrots, parsnips, dill

SYMPTOMS

Leaves develop yellow mottled patches with browning of the leaf margins. Plants may be mildly stunted with a feathery appearance. If infection occurs within the first six weeks of growth, the mature roots tend to be short, knobby and malformed, making them unmarketable. Symptoms are less severe if infection occurs later, but can still significantly reduce yield.

FAVOURED BY

Outbreaks are most likely when carrots are cropped continuously, especially if volunteer carrot plants remain after harvest. The virus is spread by aphids, particularly green peach aphid. Infectivity is lost once the aphid feeds on a non-host plant.



Symptoms of virus infection on leaves, showing mottling and chlorosis, and severe infection of carrot roots (B Coultts, DAFWA)

Virus — Mosaic

Celery mosaic, alfalfa mosaic

CROPS AFFECTED

All

SYMPTOMS

Symptoms vary but include leaf distortion, stunting, discolouration of the vascular system and development of a bright yellow mosaic pattern on the leaves. Thickening of the interveinal tissue can produce a crinkled effect.

FAVOURED BY

Virus persists in weed species such as sowthistle and clover. It is transmitted by aphids and through

infected seeds. Outbreaks are most likely where celery is cropped continuously or plants are grown next to pastures of lucerne or clover.



Mosaic virus symptoms on celery and in the field (L Tesoriero NSW DPI)

Virus — Yellow blotch

CROPS AFFECTED

Celery

SYMPTOMS

Veins become yellowed and yellow blotches with diffuse margins appear on the leaves. Foliage may be mildly deformed and stunted.

FAVOURED BY

Unknown



Symptoms of yellow blotch on a parsley leaf and on coriander in the field (L Tesoriero NSW DPI)

White mould

Sclerotinia sclerotiorum, *S. minor*, *S. rolfsii*



CROPS AFFECTED

All

SYMPTOMS

Soft, water-soaked rots develop on lower leaves and stems, initially at the soil junction but spreading into upper parts as the disease progresses. The affected areas are covered with white cottony fungal growth. In the later stages hard black resting bodies (sclerotia) form within the decayed



White mould on celery (ST Koike UC Ext); Dieback of a carrot crop due to white mould infection

tissue. These can be up to 10 mm across and irregularly shaped. Rots can also develop during postharvest storage.

FAVOURED BY

Cool (15–21°C), moist conditions, such as may occur with rain, fog or use of overhead irrigation. Sclerotium rot caused by *S. rolfsii* is favoured by warmer conditions. Storing products wet increases postharvest rots. Sclerotia can survive

in the soil for many years, re-infecting other crops.



White mould or 'sclerotium rot' (*S. rolfsii*) in the field (L Tesoriero NSW DPI) and white mould on stored carrots (H Pung Peracto)



Disorders

Black heart

CROPS AFFECTED

Celery

SYMPTOMS

Light to dark brown and black lesions appear on the developing leaf tips inside the celery heart. Leaf tips may continue to die back as the plant grows and can develop secondary fungal infections.

CAUSED BY

Similar to tip burn in lettuces and other leafy vegetables, blackheart is caused by rapid growth under humid conditions. This results in calcium deficiency at the growing tips. Associated with warm conditions, uneven irrigation and high rates of fertiliser application.



Black heart of celery (ST Koike UC Ext)

Bolting

CROPS AFFECTED

All

SYMPTOMS

Flowering stems start to form. This draws energy reserves away from the rest of the plant. Carrots will shrink and toughen, parsley loses flavour and celery becomes pithy and soft.

CAUSED BY

Cold conditions (4–13° C for more than ten days), especially if followed by warmer conditions, can cause premature bolting of plants still at seedling stage.



Bolting parsley



Bolting carrot (C Allender Uni Warwick)

Iron deficiency

CROPS AFFECTED

All

SYMPTOMS

Young leaves are pale or yellowed with green veins.

CAUSED BY

Can be caused by high soil pH (above 6.5), waterlogging or heavy fertilisation with other micronutrients which can tie up available iron in the soil.



Iron deficiency in celery (R Lucas IPNI)

Nitrogen deficiency

CROPS AFFECTED

All

SYMPTOMS

Older leaves and petioles become yellow and die off prematurely. Plant may be generally pale with stunted growth.

CAUSED BY

Insufficient fertiliser or loss from the soil. Heavy rain and irrigation leach nitrogen from the soil, especially if organic matter is low. Waterlogging can result in nitrogen loss

as gas, while incorporation of woody crop residues can temporarily lock up nitrogen in the soil. Most likely late in the cropping cycle.



Nitrogen deficient parsley (L Tesoriero NSW DPI) and celery

Waterlogging

CROPS AFFECTED

All

SYMPTOMS

Plants grow poorly, develop root diseases and eventually die.

CAUSED BY

Excess water in the root zone.



Waterlogged parsley and resulting development of root rots (L Tesoriero NSW DPI)

Carrots, celery and parsley problem solver

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Carrots, celery and parsley problem solver (cont.)

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