Pests, diseases and disorders of carrots, celery and parsley

A FIELD IDENTIFICATION GUIDE

Jenny Ekman and Len Tesoriero

Second Edition published March 2023

National Library of Australia Cataloguing-in-Publication entry

Author:	Jenny Ekman (AHR), Len Tesoriero
Title:	Pests, diseases and disorders of carrots, celery and parsley: a field identification guide
ISBN:	978-0-9925251-5-6 (paperback)
Subjects:	Carrots, celery and parsley—Diseases and Pests—Australia.
Dewey number:	635

This project has been funded by Hort Innovation, using the vegetable research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Guide produced by Applied Horticultural Research.

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This project has been funded by Hort Innovation using the vegetable research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

Acknowledgments

This project was made possible by funding from Hort Innovation using the national vegetable levy and matched funds from the Australian Government.

Production of the guide would not have been possible without the generous assistance of fellow researchers, agronomists, extension officers and interested amateur photographers who have allowed us to use photographs from their collections.

Special thanks are due to Lindsay DuToit, Washington State University; Lowan Turton, NSW DPI; Hoong Pung, Peracto.

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Pest icons


Beneficial


Damaging


Exotic


Pre-harvest


Post-harvest

PESTS & BENEFICIALS

DISEASES

DISORDERS

Contents

Insects

Diseases

Disorders

Insects

Aphid — carrot-willow aphid

Cavariella aegopodii

DESCRIPTION

Nymph: Yellowish to green, similar to adult.

Adult: The wingless summer form is greenish with darker feet and antennae tips. Slightly flattened in shape with what appear to be twin tails. Winged adults appear in winter and are black with a green abdomen and clear wings.

DAMAGE

Heavy infestations can cause yellowing and distortion of foliage. Main potential damage is through virus transmission; it can vector carrot virus Y, celery mosaic and cauliflower mosaic viruses.

MOST COMMON

Carrot-willw aphids are believed to overwinter and sexually reproduce on willow trees, migrating onto carrots and other apiaceous crops from early spring. They prefer dry conditions.

Mature carrot willow aphid (A Jensen)

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

Aphid — green peach aphid

Myzus persicae

DESCRIPTION

Nymph: Varies from yellowish to green.

Adult: Wingless adults are pale yellow to green and around 2mm 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

Aphid — hawthorn parsley aphid

Dysaphis apiifolia

DESCRIPTION

Nymph: Cream to grey, becoming waxy as they mature.

Adult: Wingless adults are well rounded with velvety bluish grey or brown colouring. Winged females are predominantly black with translucent wings.

DAMAGE

Can stunt growth, contaminate the product and possibly act as a virus vector. However, not usually a major problem.

MOST COMMON

During warmer months.

Hawthorn parsley aphids (influentialpoints.com)

Heavy aphid infestation on celery, causing leaf distortion (J Ekman)

Beet 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 brown and grey moth around 15mm long, light grey hindwings with a dark line around the edge.

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 during summer in southern areas. Attacks a large range of hosts including celery and parsnip.

Beet armyworm caterpillars (Portioid (top); A Abela (right)) *showing colour variations, and adult moth* (M Shepard Bugwood.org)

Carrot rust fly

Psila rosae

DESCRIPTION

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

Adult: Slender 6mm 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 yet in Australia, but present in New Zealand, South Africa and much of Europe and North America. Adult flies overwinter as pupa, emerging to lay eggs in spring.

Carrot rust fly damage (Rasbak), *close up of the larva responsible, and an adult fly* (E Santarelli)

Carrot weevil

Listronotus oregonensis

DESCRIPTION

Larva: Creamy grub with reddish brown head.

Adult: Mottled, dark brown weevil around 6mm 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 yet in Australia, but a major pest in North America.

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

Cutworm

Agrotis spp.

DESCRIPTION

Egg: Ribbed, creamy yellow domes around 0.5mm diameter. Usually laid in a compact cluster on vegetation or moist ground.

Caterpillar: Initially grey-green and feed as a group but separate as they mature. Caterpillars darken as they age, becoming dark green-grey to black with red, yellow and cream markings. Adults reach up to 50mm length. Tend to curl into a ball if disturbed.

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

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; Mature cutworm (K Yukich)

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 15mm 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.

MOST COMMON

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

Black field (R Reiner) *and European* (Flagstaffotos) *earwigs*

Heliothis / Native budworm

Helicoverpa armigera, H. punctigera

DESCRIPTION

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

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

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

DAMAGE

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 (J Ekman)

Hoverfly

Syrphidae spp.

DESCRIPTION

Larva: Cream coloured, slug-like maggot with a stripe on the upper surface and dark mouth hooks, up to 10mm 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 adult (R Richter)

Hoverfly larva on celery (J Ekman)

Lacewings — brown and green

Micromus tasmaniae; Mallada signatus

DESCRIPTION

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

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

BENEFIT

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

MOST COMMON

Year round.

Brown lacewing nymph attacking aphids (P Scanlon DAFWA)*; Adult green (above) and brown (opposite) lacewings* (J Ekman)

Ladybirds – various

Coccinella transversa, Hippodamia variegate and others

DESCRIPTION

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

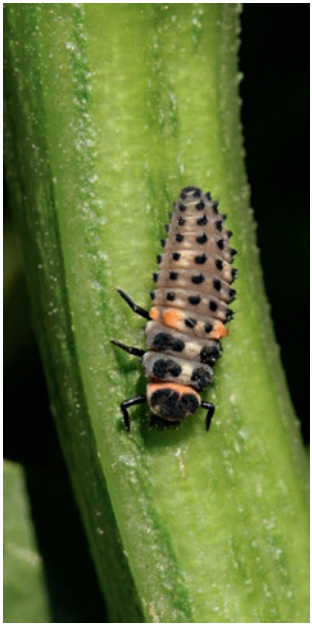
Adult: Most are brightly coloured, dome shaped beetles 3 to 5mm long with distinctive spots and stripes on their outer wing covers.

BENEFIT

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

MOST COMMON

Late spring to autumn.



Larva and adult white collared ladybirds H. variegata (J Ekman)

Adult ladybird Coleophora inaequalis and larva (species unconfirmed) (J Ekman)

Adult transverse ladybird Coccinella transversalis (J Ekman)

Looper

Chrysodeixis spp.

DESCRIPTION

Caterpillar: Slender green caterpillars which move with a distinct looping motion. Mature larvae are 35 to 40mm long and feed openly on a wide range of host plants.

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

DAMAGE

Holes in leaves; leaves can be skeletonised.

MOST COMMON

Summer–autumn.

Adult moth (L Craggs)

Looper on parsley (J Ekman)

Looper caterpillar, showing typical movement (L Craggs)

Lucerne leafroller

Merophyas divulsana

DESCRIPTION

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

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

Lucerne leafroller moth (R Richter)

Leafroller caterpillar (NSW DPI)

Nematode — root-knot

Meloidogyne spp.

DESCRIPTION

Nematodes are microscopic, wormlike organisms usually less than 1mm long so 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 roots
(MA Hansen Virginia 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 less than 1mm 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 to 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 and prolific lateral roots caused by infestation* (S Collins DAFWA)

Parasitoid wasps

Trichogramma spp., *Telenomus* spp., *Aphidius* spp.

DESCRIPTION

There are many different types of parasitoid wasps, a number of which are sold commercially for control of caterpillars and aphids.

Adult: Most parasitoids that prey on pests of Apiaceae are small, black wasps.

BENEFIT

Female wasps lay their eggs inside moth eggs or aphids. The wasp larvae develop inside their host, consuming it from the inside. Eventually a young wasp emerges from the mummified aphid or moth egg.

MOST COMMON

Any time of year.

Parasitoids such as Telenomus (Corunastylis) *and Trichogramma* (P Sinkyrik) *lay their eggs inside caterpillar eggs, such as these Heliothis*

Aphidius spp. lays its eggs inside aphids (K Martin-Smith)

Plague soldier beetle

Chauliognathus lugubris

DESCRIPTION

Larva: 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 15mm long. Feeds mainly on pollen and nectar.

BENEFIT

Predatory on aphids, caterpillar eggs and other pests. However, beetles can be a significant contaminant in leafy products such as parsley.

MOST COMMON

Summer in south-eastern Australia. Large swarms gather periodically to mate, the triggers of which are not understood.

Adult plague soldier beetle (J Ekman)

Redlegged earth mite

Halotydeus destructor

DESCRIPTION

Nymph: Reddish pink with six legs, 0.2mm 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: Initially reddish and pear-shaped with developing wing buds, becoming brown to grey and mottled as they mature.

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

DAMAGE

Not usually a significant pest although it can cause some feeding damage through sap sucking. 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 (J Ekman)

Rutherglen bug nymph (Queensland Department of Agriculture and Fisheries)

Rutherglen bugs on parsley flowers (L Mata)

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 less than 1mm long.

Adult: Light to dark brown with thin bodies approx 1 to 2mm 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. Not usually a major pest in apiaceous crops.

MOST COMMON

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

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

Vegetable leafhopper

Austroasca viridigrisea

DESCRIPTION

Nymph: Initially reddish and pear-shaped with developing wing buds, becoming brown to grey and mottled as it matures.

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

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

Vegetable weevil

Listroderes difficilis

DESCRIPTION

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

Adult: Mottled brown beetle about 8mm 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 (V Engel)

Vegetable weevil larva (A Prather) *and adult weevil* (JD Hopkins)

Wireworms — false and true

Gonocephalum spp. *and others; Family Elateridae*

DESCRIPTION

Larva: False wireworm larvae are smooth, golden to brown and up to 30mm 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 and are often found in the soil. True wireworm adults are known as 'click beetles' because they can right themselves with a 'click' if placed upside down.

False (D Young WSU) *and true* (T Klejdysz) *wireworm larvae with damage to carrot roots*

DAMAGE

Carrots are particularly attractive to wireworm larvae. Larvae live in the soil where they tunnel into roots, forming cavities and providing entry points for disease.

MOST COMMON

Most likely to be a problem when the soil has high levels of organic matter.

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.

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 to 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.

Alternaria leaf blight on carrot leaves (G Holmes Bugwood.org)

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 to 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. Crop rotation is therefore an important control strategy.

Bacterial leaf blight symptoms (L DuToit WSU)

Bacterial leaf spot

Pseudomonas spp.

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.

FAVOURED BY

Damp, humid conditions, such as occur in a dense crop canopy. Risk is increased if leaves remain wet for at least seven hours over several days. The bacterium is seed borne, but also spreads through irrigation water and runoff.

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

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 infection can cause collapse due to rotting of the crown or roots. For example, parsley plants can suffer complete collapse as well as distinct white bleaching of leaves.

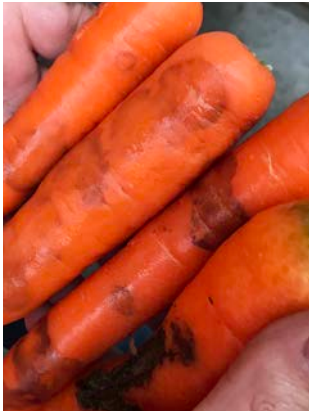
FAVOURED BY

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

Bacterial soft rots are extremely important postharvest, particularly affecting carrots and leafy greens. Packing products wet and poor temperature control resulting in condensation inside packaging are major risk factors.

Symptoms of bacterial soft rot on carrots (B-Ming Wu Oregon State University) *and celery* (J Ekman)

Postharvest development of bacterial rot on parsley (T Kristensen) *and cavities left after washing carrots affected by bacterial rot* (L DuToit WSU)



External bacterial rot symptoms (S Tabone) *and internal progression* (Nunhems BASF)

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. Small (1 to 2mm 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—increases risk of infection, so several different fungal pathogens may be present. Can be seed borne or carried by air borne spores washed into the crown. Itersonilia is favoured by temperatures around 20°C. Superficial symptoms at harvest can grow and extend into the core during postharvest storage.

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

Berkeleyomyces basicola, Chalaropsis thielavioides

CROPS AFFECTED

Carrots and parsley

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. Occurs when washed carrots are not properly dried and cooled below 5°C before packing. Spores present at harvest can infect the roots through the injuries produced by harvest and packing processes, multiplying during postharvest storage.

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

Black rot

Alternaria radicina

CROPS AFFECTED

Carrots.

SYMPTOMS

Symptoms resemble Alternaria leaf blight. Dark brown to black, irregularly shaped lesions appear on foliage. Seedlings may establish poorly or die. In mature plants infection often occurs through the older leaves, resulting in a black, decayed ring with a distinct margin at the junction of leaves and root.

FAVOURED BY

Infection is increased in warm, humid weather. Carrots that appear healthy at harvest can develop symptoms during long term storage. 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) *and symptoms on a root* (Nunhems BASF)

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 often appear when carrots are within one month of harvest, and increase fastest on overmature roots.

Cavity spot lesions on carrots (L DuToit WSU) *and in closeup* (Nunhems BASF)

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* diseases.

Symptoms on carrot petioles (L DuToit)

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

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 carrot (L Tesoriero)

Crater rots on carrots (S Tabone)

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, a 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 (18 to 25°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 affecting carrot seedlings (S Tabone)

Damping off effects on a mature parsley crop (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.

FAVOURED BY

Warm (15 to 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)

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

Grey mould

Botrytis cinerea

CROPS AFFECTED

All.

SYMPTOMS

Blackened, water-soaked lesions appear on roots, followed by growth of fluffy grey mould.

FAVOURED BY

Infection is increased by cool, damp conditions. Symptoms can develop at the crown or at damage points during growth. However, disease is most likely to develop postharvest, especially if products are packed wet. Grey mould continues to grow at close to 0°C, so is difficult to control during storage.

Grey mould on carrots and celery (T Kristensen)

Late blight / Septoria spot

Septoria apiicola

CROPS AFFECTED

Celery, celeriac.

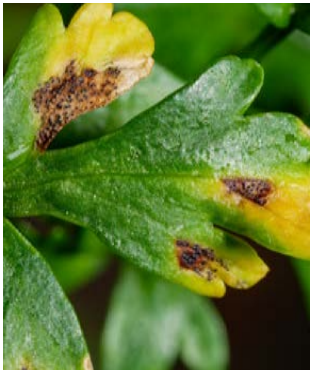
SYMPTOMS

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 (J Ekman)

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 spores
(D Lamont)

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)

Leaf curl symptoms in the field (J Ekman)

Licorice rot

Mycocentrospora acerina

CROPS AFFECTED

All.

SYMPTOMS

Infection of seedlings can cause stunting and early death. In more advanced plants, particularly celery, spots develop on stems and leaves.

For carrots and parsnips the most severe symptoms occur during postharvest storage. Large, water soaked lesions develop. These are initially brown but turn black and expand as they age.

FAVOURED BY

Humid or moist conditions.

Licorice rot on stored carrots (A Hayes)

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 on parsley (G Holmes Bugwood.org)

Powdery mildew symptoms on carrot (L DuToit WSU)

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.

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

Rubbery brown rot

Phytophthora spp.

CROPS AFFECTED

Carrots.

SYMPTOMS

Dark brown, watery sections appear from the carrot shoulders, extending part way down the roots. Affected tissue often remains rubbery to soft. In humid conditions dense white mould develops.

FAVOURED BY

Infection occurs in the field if conditions are humid and damp. However, symptoms most commonly appear during postharvest storage.

Rubbery brown rot (D Breton)

Sclerotium rot / southern blight

Sclerotinia rolfsii

CROPS AFFECTED

Carrots.

SYMPTOMS

Initial symptom is yellowing and wilting of the leaves. Fine white fungal strands appear around the base of the plant. The leaf petioles darken and creamy, mustard seed sized sclerotia develop, soon darkening to brown. The plants wilt and are easily pulled from the soil, sometimes with part of the carrot attached.

FAVOURED BY

Warm, wet conditions. The sclerotia can survive long periods in the soil.

Sclerotium rot in the field (University of Florida IFAS)

Septoria leaf spot

Septoria petroselini

CROPS AFFECTED

Parsley.

SYMPTOMS

Small, tan leaf spots appear with a pronounced dark red-brown margin. Black spores develop inside the lesions, which enlarge and become papery. Foliage yellows and can die.

FAVOURED BY

Mild temperatures (20 to 25°C) combined with high humidity, especially if foliage remains wet for several hours.

Septoria leaf spot on curly (OMAFRA) *and flat leaf parsley* (OMAFRA) *and closeup of spores* (J Cooper)

Sour rot

Geotrichum candidum

CROPS AFFECTED

Carrots.

SYMPTOMS

Tissues become extremely soft, colourless and watery with a pronounced vinegary odour. As the disease develops fine white mould appears on the carrot surface.

FAVOURED BY

Infection is initially through wounds such as broken root tips, skin scuffs or damage created during postharvest processing. Infection can spread during storage. The disease continues to develop at normal refrigeration temperatures of 2 to 5°C but is slowed at close to 0°C.

Sour rot of carrots (T Kristensen)

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)

Carrot red leaf virus (CarRLV); Carrot mottle virus (CarMV)

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, knobbly 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 Coutts, DAFWA)

Virus — Mosaic

Celery mosaic, alfalfa mosaic, Tomato spotted wilt virus (TSWV); Carrot virus Y (CarVY); Cucumber mosaic virus (CMV)

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 coriander (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

CROPS AFFECTED

All.

SYMPTOMS

Water-soaked rots soon become covered by white, cottony fungal growth. In the later stages hard black resting bodies (sclerotia) up to 10mm across form within the decayed tissue.

FAVOURED BY

Cool (15 to 21°C), moist conditions, such as may occur with rain, fog or use of overhead irrigation. Storing products wet increases the risk of postharvest rots. Sclerotia can survive in the soil for many years, re-infecting other crops.

White mould on celery (ST Koike UC Ext), *carrots* (H Pung Peracto) *and bulk stored carrots during extended storage* (Nunhems BASF)

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)

Cracking

CROPS AFFECTED

Carrots and parsnips.

SYMPTOMS

Growth cracks can extend the length of the root. If these have occurred early in growth they are covered by a suberised layer. Shatter that has occurred immediately before or during harvesting results in narrower, unhealed cracks.

CAUSED BY

Fluctuations in soil moisture, especially if a dry period is followed by wet conditions. The risk of shatter cracking is increased if soil is cold and wet at harvest.

Growth cracks (left) compared to shatter cracking (right) (S Tabone)

Ethylene damage

CROPS AFFECTED

All.

SYMPTOMS

Premature leaf yellowing and increased incidence of disease (e.g. grey mould) in celery and parsley. Carrots become bitter.

CAUSED BY

Exposure to the plant hormone ethylene. Ethylene gas is produced by ripening fruit, combustion engines and rotting vegetation. Carrots are very sensitive to ethylene. Concentrations as low as 0.5ppm during two weeks storage have been demonstrated to stimulate formation of bitter compounds. Effects are reduced by storage close to 0°C.

Premature yellowing of parsley (T Kristensen)

Forking / misshapen

CROPS AFFECTED

Carrots, parsnips.

SYMPTOMS

Roots are deformed, with forks, twists or branching. They may also be short and stubby or be unevenly sized.

CAUSED BY

There are many potential causes. Uneven soil texture is often a cause, as rocks or clods trigger forking. Compacted areas within the field result in short, stubby roots.

Excess nitrogen, attacks by insects or nematodes and damage from chemicals and fertilisers can also trigger forking.

Overly high plant density results in carrots which are twisted and unevenly sized.

Minor forking of carrots and parsnips (S Tabone)

Forking / misshapen, *cont.*

Stubby carrots, likely due to having grown in compacted soil (S Tabone)

Badly forked carrots (N So)

Freezing

CROPS AFFECTED

All.

SYMPTOMS

Watersoaked areas develop postharvest, particularly on leaf edges and exposed areas. Carrots which have been frozen have a rubbery texture and white bloom over the surface due to collapsed cells.

CAUSED BY

Leaf tissue can freeze at temperatures -0.5°C and below, whereas carrots and parsnip roots can tolerate temperatures down to approximately -1.2°C. Freezing damage can result if leafy products are placed directly under the delivery air in cold rooms set at close to 0°C. Using ice to pack products and cool room malfunction / poor calibration can also cause freezing damage.

Freezing damage to celery leaves (J Ekman)

A carrot which has been frozen then allowed to defrost (J Ekman)

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, as this 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 celery (L Tesoriero NSW DPI)

Overmaturity / bolting

CROPS AFFECTED

All.

SYMPTOMS

Flowering stems start to form, drawing energy reserves away from the rest of the plant. Carrots shrink and toughen, becoming stringy, and the leaf base thickens. Parsley loses flavour and celery becomes pithy and soft.

CAUSED BY

Cold weather of 4 to 10°C for more than ten days, especially if followed by warmer conditions, can cause plants to bolt prematurely. This can occur at any time once plants have passed the juvenile phase, with sensitivity increasing with age. The likelihood of bolting varies between species and cultivars. Warm temperatures (over 20°C) may reverse the progress, but quality is likely to be reduced.

Bolted carrot (C Allender Uni Warwick) *and overmature / extremely overmature celery showing pithy internal tissue* (J Ekman)

Carrots from plants that have started to bolt (top, at left), showing the thickened leaf base and shrunken root diameter (S Tabone)

White blush / browning

CROPS AFFECTED

Carrots, celery.

SYMPTOMS

Whitish bloom over the surface of carrots which becomes more noticeable with age. Trimmed ends of celery develop a brownish tinge.

CAUSED BY

Symptoms are caused by damage to the product surface. The damaged skin cells of abraded carrots dehydrate extremely easily if not stored under high humidity.

Browning of cut celery is due phenolic compounds and enzymes mixing in damaged cells. Keeping cutting blades sharp, humidity high and temperature low reduces symptoms.

Whitish bloom on a carrot that has been abraded-peeled then allowed to dehydrate (J Ekman)

Celery cut with a blunt knife (left) or sharp knife (right) following storage; more browning occurs when a blunt knife is used (J Ekman)

Waterlogging

CROPS AFFECTED

All.

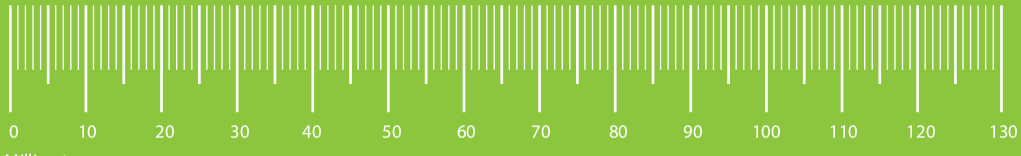
SYMPTOMS

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)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