Guide to Common Diseases and Disorders of Parsley

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Hydroponic parsley production in Queensland

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INTRODUCTION

Crop failures of up to 100% have been recorded for parsley in both Queensland and Victoria. Diseases causing major commercial losses in Australia are root rots, which occur in Queensland during warm, wet weather and in Victoria during cool, wet weather. Leaf spot, caused by *Septoria petroselini*, is the predominant foliage disease of parsley. Leaf blight caused by *Alternaria petroselini* and root-knot nematode damage caused by *Meloidogyne* sp. have caused major economic losses on individual farms. Viral diseases appear to be more of a curiosity, than the cause of crop losses in Australia.

There is little information on parsley diseases, especially in Australia. State herbaria have limited collections of parsley diseases (see appendix). A number of diseases occur on parsley in Australia and overseas, with some better documented than others. Whilst it is easy to identify the causal agent of some parsley diseases, others remain elusive. Many diseases that occur on related Apiaceae, such as carrots and celery, also occur on parsley.

This handbook is part of a project sponsored by HAL, Ausveg and the National Vegetable Levy. When referring to this book it is important to realise that more than one disease can occur on plants at any one time. Also symptoms can be difficult to distinguish and diagnostic tests may be required to identify the cause accurately.

Note:

- **The chemical information contained in this book is accurate as of June 2006.**
- **The registration status of chemicals can change.**
- **Always check the label before use.**

Alternaria petroselini blight

Advanced *Alternaria* infection

Alternaria Leaf Blight (Scorch)

Cause: Fungal species of *Alternaria petroselini, A.selini* and *A. smyrnii*.

Comment:
It caused severe crop losses in Queensland during 2005. It is rarely observed in Victorian crops.

Symptoms:
Infection begins as a brown to black patch at leaf margins. This patch expands and the entire leaf yellows, then browns and collapses. In severe cases, complete defoliation occurs. *A. petroselini* can infect at all stages of growth, but very young or very old leaves tend to be more susceptible.

Disease development:
The disease is associated with temperatures around 28°C, heavy rains and humid weather. Spores can be dispersed by wind, rain splash or through handling. The disease can be seed-borne.

Management and control:
- Avoid long periods of leaf wetness by overhead irrigating when dew is normally on the leaf.
- Plant in fields where parsley or carrots have not been planted for several years.
- Rotate crops regularly to discourage re-infection.
- Purchase high quality seed from a reputable source.
- Hot water treat seed at 50°C for 20 min.
- Old plantings should be destroyed and disked in to avoid spread of the fungus to younger plantings.

Chemical use:
The only chemical permit available for *Alternaria* on parsley is fungicides containing copper in the form of copper hydroxide or mancozeb to December 2006. This covers NSW, Tasmania and South Australia only. For the ACT, Queensland, NT and WA, the only registered fungicide for fungal leaf diseases of parsley, including Alternaria leaf spot, are fungicides containing copper in the form of cupric hydroxide alone.

Bacterial leaf spot

Photo courtesy of R.M. Davis

Bacterial Leaf Spot

Cause: The bacterium *Pseudomonas syringae* pv *apii*.

Comment:
The disease can be difficult to distinguish from leaf spots caused by the fungus *Septoria*.

Symptoms:
Symptoms initially appear as small angular water-soaked lesions on leaves. They turn a rusty brown and develop a greasy appearance, especially at the margins of the lesion. Lesions may coalesce causing extensive leaf death. During dry conditions they have a papery texture and turn a light brown colour.

Disease development:
The bacterium can be seed borne and survive on tissue without causing symptoms (epiphytically) until conditions are conducive to a disease outbreak. The bacterium enters plants through wounds and natural openings. It can be transmitted from plant to plant by overhead irrigation, machinery, by insects and by hand. The disease prefers warm temperatures, high humidity and long hours of leaf wetness, at least 7 hrs/day over several days. On celery, leaf spots appear 7–10 days after infections.

Management and control:
- If seed contamination is suspected, soak seed in hot water at 50°C for 25 minutes.
- Irrigate when long periods of leaf wetness can be avoided, such as around sunrise, when dew is normally formed on leaves.
- Avoid fertilisers high in nitrogen as they stimulate lush growth that is very susceptible to bacterial leaf spot.

Chemical use:
No chemicals are registered for control of this parsley disease.

Blight of young leaves

Bacterial Shoot Blight

Cause: Associated with *Pseudomonas* sp.

Symptoms:
The disease appears as a wet, tan coloured rot of young foliage at the leaf margins which progresses down the stalk. Symptoms are generally hidden by older, symptomless foliage.

Disease Development:
Little is known of this disease and pathogenicity has not been confirmed. The disease appears to occur in autumn and is associated with dense canopies. It has been an issue on crops grown in Tasmania. In Victorian crops it does not appear to be associated with crop losses. It is rare in NSW and Queensland parsley crops.

Management and control:
It has been reported that application of copper and mancozeb can be beneficial.

Chemical Use:
There are currently no chemicals listed for the control of this disease.

Above ground collapse and bleaching of parsley foliage

Basal soft root rot of parsley plant

Photo courtesy of J. Telford

Bacterial Soft Rot (Leaf Drop)

Cause: *Erwinia* species and *Stentrophomonas maltophilia*.

Symptoms:

Above ground symptoms first appear as a wilt of foliage which rapidly progresses to canopy collapse with a distinctive white bleaching of leaves. Infected plants may be stunted. Infections may be associated with a soft watery basal root rot or crown rot. In advanced stages a cross section of the crown often reveals complete break down and rot of the cortex. It is often difficult to remove the root system intact. The disease has been associated with severe crop losses in Queensland.

Disease development:

Little is known of this disease and the cause is not completely certain. It is prevalent on parsley grown in-ground in Queensland during the wet season and especially after heavy rains. Bacteria are ubiquitous in soils and most likely survive in crop debris in the soil in surface water sources. Bacteria enter plants through wounds and natural openings.

Management and control:

Avoid excessive soil moisture and mechanical damage to roots and maintain a well-drained site.

Chemical Use:

No bactericides are currently registered for leaf drop on parsley.

Grey sporulation of *Botrytis cinerea*

Photo courtesy of S.T. Koike

Botrytis Blight (Grey Mould)

Cause: The fungus *Botrytis cinerea*.

Symptoms:

The disease appears as tan to brown spots on leaves, which can be accompanied by a greyish mould colonising the damaged area. The mould produces masses of grey spores and black irregular shaped sclerotia may form in infected plants. The fungus also causes post-harvest rots.

Disease development:

The fungus is widespread in nature and the disease is highly weather-dependent. Plants are infected when cool wet weather leads to persistent humidity in the canopy. Spores are dispersed by air and need water to germinate. Low temperatures will slow disease development.

Management and control:

Avoid leaf wetness:

- A short heavy watering in the morning will allow the leaves to dry.
- Increase ventilation by reducing overcrowding, since this will allow rapid leaf drying.

This fungus is capable of overwintering, so after harvest, either remove all plants or cleanly plough leftover plant material into the ground.

Chemical use:

A permit against Botrytis blight in parsley, covering all states except Victoria, was for fungicides containing copper hydroxide as the sole ingredient that expired in February 2006. Renewal of the permit is being sort.

White-grey spores of downy mildew on the undersurface of a leaf

Downy Mildew

Cause: The fungus *Plasmopara petroselini.*

Comment:
It has not yet been reported in Australia.

Symptoms:
Initial symptoms consist of white spots on the upper leaf surface. As the disease progresses, the spots enlarge, become angular, and turn yellow. On the under surface of the leaf spots, white-to-greyish mycelia and spores develop. Eventually infected leaves and leaf stalks rot.

Disease Development:
The fungus requires living tissue to grow. It infects young leaf tissues under cool, wet conditions. Spores are produced overnight on the undersurface of leaf spots and released in the morning as the humidity drops. These airborne spores are dispersed by wind. They are deposited on leaf surfaces and require water for germination and infection. Resting spores (oospores) are produced in leaf tissue and survive in crop debris or in seed.

Management and control:
- Avoid long periods of leaf wetness.
- Increase ventilation.
- Deter carry over of crop debris, which may contain fungal spores.
- Plough in crop debris to encourage its decomposition and rotate ground out of parsley crops.

Chemical use:
For control of downy mildew in parsley, there is a temporary permit for copper hydroxide until 31 December 2006 in the states of NSW, Tasmania and South Australia.

Upper surface of leaf

Powdery mildew in parsley bunch

Stalk infection

Photo courtesy of ADAS UK Ltd

Powdery Mildew

Cause: The fungus *Erysiphe heraclei*.

Comment:

Although common in parsnip, powdery mildew has not yet been reported on parsley in Australia. *E. heraclei* can also infect celery.

Symptoms:

Powdery mildew causes pale yellow areas on the upper leaf surface associated with whitish sporulation on the lower surface. In the advanced stages, sporulation occurs on the upper surfaces and the lesions turn brown. Both petioles and stalks can be colonised. The fungus lives on live plant tissue and grows primarily on the outer surface of the plant.

Disease development:

Powdery mildew spores are spread by wind and do not require water to germinate. Conditions of high humidity and moderate temperatures favour infection and disease development. Powdery mildew is more severe under shaded areas since sunlight damages the spores and the mycelium. Older plants tend to be more susceptible to powdery mildew.

Management and control:

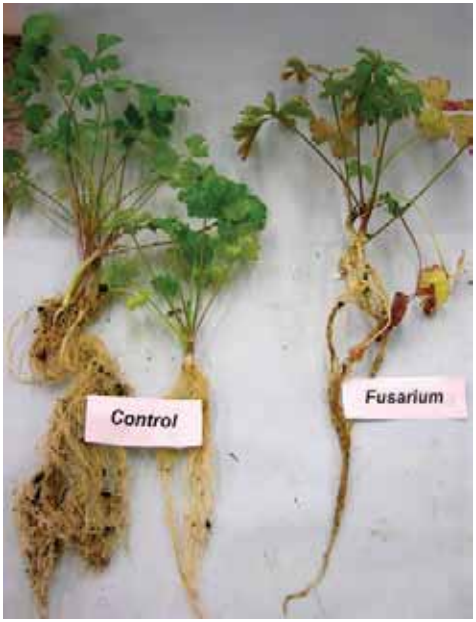
- Avoid shady growing conditions, water stress and excess fertilisation.
- Maintaining good plant vigour.
- Heavy rainfall deters powdery mildew.

Chemical use:

Permits for fungicides containing sulphur as the sole component for use against powdery mildew (oidium stage of *E. heraclei*) on parsley and other herbs expired in all states except Victoria in February 2006. Renewal of the permit is being sort.

Crown and root rot of parsley

Photo courtesy of H. Martin
QDPI&F



Mild infection of parsley root rot by *Fusarium* showing browning of roots and some yellowing of foliage

Photo courtesy of L. Tesoriero
NSW DPI

Fusarium Root Rot

Cause: The fungus *Fusarium* species.

Comment:
Fusarium species are often implicated along with *Pythium* and *Rhizoctonia* as causing root and crown rot of parsley.

Symptoms:
In severe infections *Fusarium* fungi produce a crown and root rot. *Fusarium* fungi are also associated with milder symptoms consisting of yellowing of foliage, especially the older foliage, loss of vigour, wilt, a brown discolouration of roots and a reduction in root mass.

Disease development:
Fusarium species survive in plant debris, weeds or as spores in the soil. Their ability to cause disease depends on temperature, their density in soil and the susceptibility of host plants. Symptoms develop more rapidly at warmer temperatures. In some vegetable crops symptom development is associated with low nitrogen (N) and phosphorous (P) and high potassium (K), low soil pH, short day lengths and low light intensity. The disease is enhanced by ammonium nitrogen and decreased by nitrate nitrogen.

Management and control:
- Crop rotation is marginally effective.
- Avoid flooding production areas, as this will spread the fungus.
- Prevent movement of *Fusarium*-infested plants and soils that may cling to machinery, transplants, vehicles and tools.
- In some vegetable crops, raising the soil pH to 6.5–7.0 and using nitrate rather than ammonium forms of nitrogen has been beneficial.

Chemical use:
No fungicides are registered for *Fusarium* diseases of parsley.

Reddish brown sunken lesions developing on parsley roots

Rhizoctonia Crown and Collar Rot

Cause: The fungus *Rhizoctonia solani*.

Symptoms:

Rot of the root, crown and leaf stalk which leads to plant collapse. It has also been associated with pre- and post-emergence damping off of seedlings. Lesions are reddish-brown and often sunken.

Disease development:

The fungus is ubiquitous in the soil. It survives as either growing or resting mycelium or sclerotia and can colonise dead plant material. Moderate weather conditions and moderate soil moisture promote *Rhizoctonia* infections. Fungal development is inhibited by dry or waterlogged soils.

Management and control:

- Plant good quality seed.
- Maintain optimum growing conditions with respect to temperature, moisture and nutritional requirements.
- Avoid nematode damage as this can provide the fungus with a mode of entry into plants.

Chemical Use:

At present, there are no chemicals registered for use against crown and collar rot caused by *Rhizoctonia* in parsley.

Plant collapse of mature parsley due to *Phytophthora* and/or *Pythium* infection

Parsley field with post-emergence damping off

Root Rot

Cause: Species of *Phytophthora* and/or *Pythium*.

Symptoms:

Shoot symptoms: For *Phytophthora* and *Pythium* root rots, the above ground symptoms are similar and include pre- and post-emergence damping off of seedlings, decline and death of mature plants. Above-ground symptoms are a rapid wilt of foliage, rot of leaf stalk bases, collapse of the shoot system and plant death. Surviving plants are stunted, show a general yellowing of foliage and are often surrounded by healthy looking plants.

Root symptoms: Root rots associated with *Pythium* and *Phytophthora* tend to be dull brown and spongy in appearance and feel. *Pythium* attacks the tips of lateral roots, and infects at the crown or at the upper root near ground level, leaving little or no lateral root system.

For *Phytophthora*, infections start at the root tips and travel up the roots, but can also occur elsewhere on the root. Infected roots are light to dark brown and lateral roots are still present in many cases. *Phytopthora* infections tend to be slower with *Pythium*-infected plants showing plant collapse and root rot symptoms earlier.

Disease development:

In Victoria root rot appears in crops during late autumn and winter when soil temperatures are 10°C or less and especially after a period of heavy rainfall. Plants of any age appear to be susceptible. In field trials, the disease appeared 8 weeks after emergence. Species of *Phytophthora* and *Pythium* are ubiquitous in soils. They produce two types of spores, oospores and zoospores. The thick-walled oospores can survive in soil during adverse conditions and serve to carry the fungus 'over' from one crop to the next and thus one season to the next. The motile zoospores are the principal means of dispersal and infection, enabling the fungus to move in irrigation water or in saturated soils. Both *Pythium* and *Phytophthora* species can have broad host ranges.

Rapid wilt of foliage (left) and collapse of shoot (right)

Pythium symptoms of soft, watery rot of basal stems, lack of lateral roots and dull, spongy appearance of upper tap root

….. Root Rot

Management and control:

Farming practices for management and control of both *Pythium* and *Phytophthora* are identical:

- Raise beds to improve drainage and reduce water logging or saturation around roots.
- Time irrigation to avoid wet or dry extremes of soil water.
- Avoid irrigation when heavy winter rain is forecasted.
- Avoid planting on low-lying areas.
- Rapidly incorporate crop debris into soil to encourage breakdown, as *Pythium* and *Phytophthora* have a broad host range and can survive saprophytically.
- Rotating crops, especially with barley, beet or onions was beneficial in Northern Ireland, perhaps due to the addition of lime with the former.

Chemical use:

A temporary permit for the use of phosphonic/phosphorous acid has been granted for parsley and other culinary herbs in all states except Victoria to combat root rot by *Phytophthora* only until September 2006. There is a one-day withholding period for this fungicide. At this time, no permits have been issued against root rot caused by *Pythium*.

Sclerotinia rot, note white cottony mould

A sclerote 0.3-1.0 cm long

Sclerotinia Rot (Basal Stem Rot)

Cause: The fungus *Sclerotinia sclerotiorum*

Symptoms:

The first sign of infection is a white cottony mould at the soil line, which is characteristic for this disease. Eventually, the infected tissue turns brown and watery. As the rot progresses, leaves drop off and the parsley plant will decay and collapse. In advanced stages of infection, this fungus produces black irregular shaped sclerotia, which are visible to the naked eye as small black spheres, in infected plant parts. They can also be seen around the parsley plant.

Disease development:

The fungus has a wide host range. Dense canopies and cool wet conditions associated with rain, fog or overhead irrigation as well as temperatures in the range of 15–21°C favour disease development. It survives in the soil as sclerotia or as mycelium on living or dead plants. Sclerotia and mycelium are spread in soil and/or on plant material by implements, animals, in irrigation water and with seed. Sclerotia can over-winter and reinfect the following crop, and can survive in the soil for many years.

Management and control:

- Avoid wet conditions in the field as much as possible.
- Weed control is essential in order to eliminate potential hosts for the fungus (note: wide host range).
- Fields must be deeply ploughed (to at least 25 cm) to encourage the decay of plants and sclerotia (the survival form of the fungus) and prevent re-infection in subsequent years.

Chemical use:

There is a current permit valid until December 2006 for the treatment of Sclerotinia rot in parsley as well as other culinary herbs. Fungicides containing procymidone are permitted in all states except Victoria. There is a nine-day withholding period for this particular fungicide. The following restrictions also apply: DO NOT use in protected or covered situations such as glasshouses, greenhouses or plastic tunnels.

Flat parsley leaves showing Septoria leaf blight

Leaf blight on parsley leaf

Note black spots inside lesions

Septoria Leaf Spot

Cause: The fungus *Septoria petroselini.*

Comment:

It is the most common foliage disease of both flat and curly parsley in Australia. This is often called rust but is not caused by a true rust fungus.

Symptoms:

The disease appears as small, tan leaf spots with black dots across the surface indicating the presence of black spores. The leaf spots are surrounded with a pronounced dark red-brown margin. As the disease progresses the foliar tissue turns yellow and leaves eventually die.

Disease development:

The disease can be seed borne and spores may survive and remain infectious on dead or dried leaf material. Wet leaf surfaces are required for spores to emerge. Rain, dew, overhead irrigation, workers and equipment in fields of wet foliage can transmit the spores to healthy plants. Mild temperatures and high humidity are conducive to disease. Optimum temperatures for infection are 20-25°C with high humidity (eg. period of leaf wetness with morning dew). Disease symptoms appear 14-21 days after infection.

Management and control:

- Purchase of quality seed is the best method of disease prevention.
- Flat-leaf parsley varieties are generally more susceptible to the disease than curly-leaf types.
- Use of drip or trickle irrigation rather than overhead sprinklers can reduce the spread of this disease.
- Crop rotation can also assist in preventing the redevelopment of the disease. In the USA, it has also been recommended that a 2-year rotation crop system be implemented to prevent re-infection.

Chemical Use:

A temporary permit to use copper-based fungicides containing cupric hydroxide as the only active ingredient, expired at the end of February 2006. Renewal of the permit is being sort.

Field infested with root-knot nematodes

Main taproot of parsley showing galls.

Parsley affected by root-knot nematodes

Photo courtesy of
H. Martin QDPI&F

Root-Knot Nematodes

Cause: The nematodes *Meloidogyne hapla* and *M. incognita.*

Comment:

They have not been observed on parsley in Victoria, but can occur in NSW and Queensland.

Symptoms:

Symptoms include stunted growth, leaf yellowing and wilting during the hottest part of the day. Affected plants are somewhat smaller. Symptoms spread rapidly through a site as the season progresses and succeeding generations of juveniles hatch out. That is why fields affected by root-knot nematodes tend to be patchy. Plants rarely die prematurely unless pest pressure is very high. Root-knot nematode feeding stimulates the development of abnormally large cells, resulting in 1-20mm in size forming along the roots. These galls prevent adequate water and nutrient uptake resulting in stunted plants. Unlike nitrogen-fixing nodules of legumes, these galls cannot be rubbed off the root. Pinhead-sized worms visible to the naked eye may be seen when galls are sliced open.

Disease development:

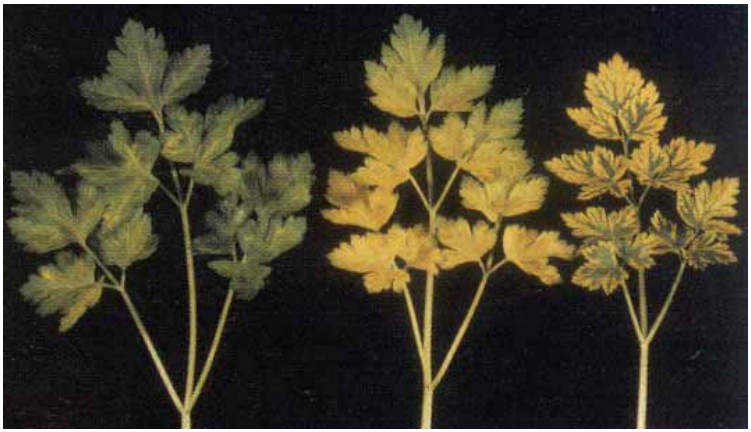
The optimum temperature range for nematode development is 15-30℃. They are generally more severe in sandy than clay soils. Nematodes are less active in cool weather and low soil temperatures.

Chemical use:

There are currently no permits for the control of root-knot nematodes in parsley.

Photo courtesy
of V.Taicecski,
DPI Vic

Celery Mosaic Virus on parsley



Calico of parsley caused by Alfalfa Mosaic Virus.

Photo courtesy of R N Campbell

Viral diseases

The viruses reported in Australia are CeMV and Apium virus Y (parsley virus Y). A number of other viruses have been recorded worldwide. There is carrot motley dwarf (CMD) which consists of carrot red leaf virus (CRLV) and carrot mottle virus (CmoV). Red leaf symptoms consistent with CRLV have been observed in parsley crops in northern Australia, but are rare in Victoria. As yet, CRLV has not been confirmed in Australia.
Other viral diseases recorded on parsley include alfalfa mosaic virus (AMV) and chicory yellow mottle virus, which produces a line pattern on leaves. Symptoms of parsley green mottle virus are self-explanatory. A number of other viruses occur on parsley but they are symptomless.

All the above mentioned viruses are aphid-transmitted, so the management and control strategies are similar.

Yellowing of parsley leaves caused by *Apium Virus Y*

Photo courtesy of V. Taicecski, DPI Vic

Apium virus Y

Cause: Previously thought to be Celery Mosaic virus.

Comment:
Parsley is also susceptible to celery mosaic virus (CeMV), but its occurrences are rare.

Symptoms:
On young leaves the virus causes vein clearing and a yellow or light green coloured inter-venial mottling. On mature foliage it causes narrow, twisted and mottled leaflets. Plants may be slightly stunted.

Disease development:
Apium virus Y is not seedborne, but can be transmitted mechanically by farming practices and by many species of aphids. Aphids can acquire it from feeding on an infected plant in 5–30 seconds and transmit it to a healthy plant in 5–30 seconds. The virus does not persist in the aphid. Sources of the virus are umbelliferous crop plants such as celery, carrot and dill as well as umbelliferous weeds.

Management and control:
Sequential or overlapping crops are considered to be the most important sources of the virus. Remove weed hosts. In severe infections implement a host-free period for 1 to 3 months. Fungicides will not control viral diseases. Systemic insecticides for aphids are not an effective preventative measure for viral disease unless aphids are in plague proportions.

Chemical use:
Viruses cannot be controlled by chemical treatments.

Suspect symptoms of Carrot Red Leaf Virus

Photo courtesy of R. Baddman,
CD Herbs

Carrot Red Leaf Virus

Cause: CRLV

Symptoms:

A leaf reddening of carrots, dill and parsley is associated with the presence of carrot red leaf virus (CRLV) and plants infected in the seedling stage will be severely stunted and yellow to red in colour. Infected plants appear as if they are suffering a nutritional deficiency. Symptoms observed vary depending on the time of infestation and susceptibility of the cultivar. These range from varying degrees of leaf reddening and stunting to symptomless infections that primarily occur in cooler production areas.

Management and control:

Carrot Red Leaf Virus is transmitted by aphids. Weed control and a break in production are the best mechanisms for control.

Chemical use:

Insecticides have not been proven to be effective for control of virus transmission to new crops.

Root balling
of parsley

Abiotic Disorders

A number of apparently abiotic disorders have been observed on parsley plants in Australia. Their cause is unclear, but they may be associated with nutrient deficiency, salinity or stress.

Root balling

Root balling of transplants has caused major losses for some hydroponic growers, especially in Queensland. Roots wrap around the plant and fail to spread beyond the cell. In extreme cases plant are stunted and unproductive. It is thought to be associated with stress whilst plants are growing in trays.

Reverse osmosis

Symptoms consist of bleached foliage with a completely healthy, white root system. The symptom has been observed in summer during extremely hot weather in ground where salinity was an issue.

These symptoms could be confused with bacterial soft rot (page 13). However with reverse osmosis roots show no signs of rotting and the foliage does not wilt and collapse.

Best bet management practices for parsley

- Irrigate when dew is normally on the leaf to avoid long periods of leaf wetness.
- A short heavy watering is preferable to a long, light watering.
- Avoid watering in the evening as this may provide long periods of leaf wetness.
- Increase ventilation by reducing plant overcrowding and run planting rows in the direction of wind.
- Avoid shady growing conditions.
- Remove sources of infection.
- Implement a good standard of hygiene practices.
- Alternate fungicides from different chemical groups to avoid fungi developing resistance.
- Increase drainage to reduce humidity.
- Plant high quality seed from a reputable source.
- Avoid mechanical damage to roots.
- Maintain a balanced program of nutrition.
- Control insect vectors with registered pesticides.

APPENDIX

State Herbaria collections of parsley pathogens

Pathogen	Disease
Alternaria petroselini	Alternaria Leaf Spot / Leaf Scorch
Apium virus Y	Leaf chlorosis
Fusarium oxysporum	Root lesions
Fusarium solani	Collar rot
Meloidogyne incognita, *M. hapla*	Root-knot nematodes
Pseudomonas sp.	Bacterial leaf spot
Rhizoctonia solani	Root lesions
Sclerotinia minor, *S. sclerotiorum*	Stem rot
Septoria petroselini	Leaf spot
Stentrophomonas maltophilia	Bacterial crown rot

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