CARROT, CELERY, PARSNIP AND PARSLEY

<table>
<thead>
<tr>
<th>Black canker</th>
<th>Black root rot/black mould</th>
<th>Carrot scab</th>
<th>Cavity spot</th>
<th>Crater rot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Page 80</td>
<td>Page 84</td>
<td>Page 88</td>
<td>Page 92</td>
<td>Page 96</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crown rot</th>
<th>Damping off</th>
<th>Leaf curl/ celery anthracnose</th>
<th>Root-knot nematode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Page 100</td>
<td>Page 104</td>
<td>Page 108</td>
<td>Page 112</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Root-lesion nematode</th>
<th>Root rot complex</th>
<th>Sclerotinia rot (white mould)</th>
<th>Sclerotium rot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Page 116</td>
<td>Page 120</td>
<td>Page 124</td>
<td>Page 128</td>
</tr>
</tbody>
</table>
**WHAT SHOULD I LOOK FOR?**

Orange-brown lesions often with a pale green-yellow halo form are seen on the leaves.

M. Kowalik-Kepler, APS

Red-brown to black cankers develop typically on the crown or shoulder of the root. Initially on the surface, but may decay further with secondary infection by other pathogens.

L. Tesoriero, NSW DPI

---

**WHERE WILL I SEE SYMPTOMS?**

- Leaves
- Carrot root

---

**FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT**

- Cool: • 18-22°C
- Wet: • Periods of extended rain

---

**DISTRIBUTION IN THE FIELD**

- Scattered: Individual/small patches of infected plants
- Free water
- Wind
- Contaminated plant debris

---

**HOW DOES IT SPREAD?**

- Scattered
  - Individuals/small patches of infected plants

---

**SURVIVAL TIME WITHOUT HOST**

- Less than 3-10 years
** HOW DO I CONTROL IT? **

**FALLOW/COVER CROP**

- **FARM HYGIENE**
  Stop movement of contaminated soil, water, plants and equipment

- **CROP ROTATION**
  Select non-host rotation or cover crops

- **BIO FUMIGATION**
  Grow a biofumigant crop

- **IMPROVE SOIL HEALTH**
  Add organic matter or amendments to boost beneficial microbes

  - Minimum 12 month break between parsnip crops

**PLANTING PREPARATION**

- **NO RESIDUE AT PLANTING**
  Ensure no plant residues from host crops at planting

- **ADJUST DATE**
  Adjust planting/harvest date to reduce infection risk

- **CROP SELECTION**
  Choose a resistant/less susceptible cultivar

- **AVOID PLANT INJURY**
  Avoid any physical damage to plant

- **GOOD NUTRITION**
  Ensure plants’ nutritional needs are met

  - Avoid an autumn planting/spring harvest which can favour infection

**HOST RANGE**

Parsnip, carrot
WHAT SHOULD I LOOK FOR?

• 17-25°C

WHERE WILL I SEE SYMPTOMS?

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

<table>
<thead>
<tr>
<th>CARROT ROOT</th>
<th>WET</th>
<th>WARM</th>
<th>PHYSICAL DAMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 17-25°C</td>
</tr>
</tbody>
</table>

HOW DOES IT SPREAD?

DISTRIBUTION IN THE FIELD

<table>
<thead>
<tr>
<th>SCATTERED</th>
<th>Individual/small patches of infected plants</th>
</tr>
</thead>
</table>

Blackened areas have a sooty appearance, do not have distinct margins and do not move beyond the skin of the carrot root

L. du Toit, WSU

Blackened areas develop on roots, mostly post harvest when spores rapidly spread on wet carrots that are not stored below 5°C

DPIRD

CARROT, CELERY, PARSNIP AND PARSLEY

BLACK ROOT ROT/BLACK MOULD

Thielaviopsis basicola (Chalara elegans) or Chalaropsis thielavioides

More than 10 years

SURVIVAL TIME WITHOUT HOST
### HOW DO I CONTROL IT?

| FALLOW/COVER CROP | FARM HYGIENE | Stop movement of contaminated soil, water, plants and equipment |
| | CROP ROTATION | Select non-host rotation or cover crops |
| | BIO FUMIGATION | Grow a biofumigant crop |
| | IMPROVE SOIL HEALTH | Add organic matter or amendments to boost beneficial microbes |

| PLANTING PREPARATION | NO RESIDUE AT PLANTING | Ensure no plant residues from host crops at planting |
| | DRAINAGE | Plant on raised beds or well-draining soil |

| POST-PLANT | IRRIGATION MANAGEMENT | Monitor crop and soil to optimize amount and timing |
| | | - Minimise irrigation splash |

| HARVEST | CLEAN WASH WATER | Ensure wash water is regularly sanitized and changed |
| | AVOID PLANT INJURY | Avoid any physical damage to plant |
| | POST-HARVEST STORAGE | Rapid cooling and store at 0°C |

### HOST RANGE
Wide host range including beans, peas, cotton, lettuce, lucerne, lupin and soybean
CARROT, CELERY, PARSNIP AND PARSLEY

CARROT SCAB

Streptomyces scabiei

WHAT SHOULD I LOOK FOR?

No visible symptoms on leaves. Dry corky lesions on root that may be raised or sunken; usually develop where lateral roots emerge from tap root

WHERE WILL I SEE SYMPTOMS?

CARROT ROOT

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

pH>7 ALKALINE SOIL

DRY SOIL

Multiple lesions may merge to form large scabby horizontal bands

WHERE WILL I SEE SYMPTOMS?

CARROT ROOT

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

pH>7 ALKALINE SOIL

DRY SOIL

DISTRIBUTION IN THE FIELD

SCATTERED

Individual/small patches of infected plants

FREE WATER

CONTAMINATED PLANT DEBRIS

MOVEMENT OF CONTAMINATED SOIL

HOW DOES IT SPREAD?

SURVIVAL TIME WITHOUT HOST

More than 10 years

Bayer Crop Science, UK
HOW DO I CONTROL IT?

FALLOW/Cover Crop

FARM HYGIENE
Stop movement of contaminated soil, water, plants and equipment

CROP ROTATION
Select non-host rotation or cover crops

IMPROVE SOIL HEALTH
Add organic matter or amendments to boost beneficial microbes

BIO FUMIGATION
Grow a biofumigant crop

HOST-FREE ZONE
Control volunteer host plants and weeds

• Preferably rotate with legumes. Avoid fields that have previously grown potatoes.

HOST RANGE
Carrot, potato, peanut, beetroot, swede, parsnip, radish

PLANTING PREPARATION

CROP SELECTION
Choose a resistant/less susceptible cultivar

SOIL PH
Use amendments to adjust soil pH

NO RESIDUE AT PLANTING
Ensure no plant residues from host crops at planting

FERTILISER SELECTION
• Use acidifying fertilisers e.g. ammonium sulphate to help lower pH

• Adjust soil pH to 5.5

POST-PLANT

AVOID WATER STRESS
Ensure plants receive adequate water

AVOID PLANT INJURY
Avoid any physical damage to plant

GOOD NUTRITION
Ensure plants’ nutritional needs are met

• 4-5 year break from carrot crop

CARROT, CELERY, PARSNIP AND PARSLEY | CARROT SCAB
WHAT SHOULD I LOOK FOR?

Pin-head sized dots that progress to small (10mm) sunken oval lesions, often with a yellow halo, anywhere along the root surface.

WHAT SHOULD I LOOK FOR?

Symptoms can begin one month before harvest and develop rapidly. Damage can make fresh carrots unmarketable.

WHERE WILL I SEE SYMPTOMS?

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

- **20-28°C**
- Optimum *P. sulcatum* -28°C
- *P. violae* -19°C
- **WARM**
- **WET**
- **ACIDIC SOIL**

HOW DOES IT SPREAD?

DISTRIBUTION IN THE FIELD

- **SCATTERED**
  - Individual/small patches of infected plants
- **FREE WATER**
- **CONTAMINATED PLANT DEBRIS**
- **INSECTS**

SURVIVAL TIME WITHOUT HOST

- More than 10 years

CARROT, CELERY, PARSNIP AND PARSLEY | CAVITY SPOT

*L. du Toit, WSU*
### How Do I Control It?

<table>
<thead>
<tr>
<th><strong>Fallow/Cover Crop</strong></th>
<th><strong>Host-Free Zone</strong></th>
<th><strong>Biofumigation</strong></th>
<th><strong>Crop Rotation</strong></th>
<th><strong>Improve Soil Health</strong></th>
<th><strong>Chemical Fumigation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>FARM HYGIENE</td>
<td>HOST-FREE ZONE</td>
<td>BIO FUMIGATION</td>
<td>CROP ROTATION</td>
<td>IMPROVE SOIL HEALTH</td>
<td>CHEMICAL FUMIGATION</td>
</tr>
<tr>
<td>Stop movement of contaminated soil, water, plants and equipment</td>
<td>Control volunteer host plants and weeds</td>
<td>Grow a biofumigant crop</td>
<td>Select non-host rotation or cover crops</td>
<td>Add organic matter or amendments to boost beneficial microbes</td>
<td>Always use with care and as per label</td>
</tr>
</tbody>
</table>

- Rotate with non-hosts such as broccoli, lettuce or beans
- 5 year break between host crops
- Consult APVMA or InfoPest website for current registered products

<table>
<thead>
<tr>
<th><strong>DRAINAGE</strong></th>
<th><strong>SOIL PH</strong></th>
<th><strong>Crop Selection</strong></th>
<th><strong>SOIL Test</strong></th>
<th><strong>No Residue at Planting</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>DRAINAGE</td>
<td>SOIL PH</td>
<td>CROP SELECTION</td>
<td>SOIL TEST</td>
<td>NO RESIDUE AT PLANTING</td>
</tr>
<tr>
<td>Plant on raised beds or well-draining soil</td>
<td>Use amendments to adjust soil pH</td>
<td>Choose a resistant/less susceptible cultivar</td>
<td>Conduct a pre-sowing soil test to help predict level of risk</td>
<td>Ensure no plant residues from host crops at planting</td>
</tr>
</tbody>
</table>

- On acidic soils adjust to pH 6.5-7.5
- Consult APVMA or InfoPest website for current registered products

<table>
<thead>
<tr>
<th><strong>Chemical Treatment</strong></th>
<th><strong>Irrigation Management</strong></th>
<th><strong>Avoid Plant Injury</strong></th>
<th><strong>Adjust Date</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEMICAL TREATMENT</td>
<td>IRRIGATION MANAGEMENT</td>
<td>AVOID PLANT INJURY</td>
<td>ADJUST DATE</td>
</tr>
<tr>
<td>Use registered soil drench at planting</td>
<td>Monitor crop and soil to optimize amount and timing</td>
<td>Avoid any physical damage to plant</td>
<td>Adjust planting/harvest date to reduce infection risk</td>
</tr>
</tbody>
</table>

- Consult APVMA or InfoPest website for current registered products

### Host Range

- *P. sulcatum* - Carrot, parsnips, celery, parsley
- *P. violae* - Carrot, parsnips, celery, parsley, broccoli, wheat, lucerne

### Avoid Plant Injury

- Avoid any physical damage to plant

### Avoid Summer or Autumn Harvest

- Monitor 1 month prior to expected harvest date to avoid over maturity
CRATER ROT
Rhizoctonia carotae

WHAT SHOULD I LOOK FOR?

Horizontal dark brown bands develop mostly on the crown and upper root
L. Tesoriero, NSW DPI

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

- Crown and upper part of root
- 16-20°C

WHERE WILL I SEE SYMPTOMS?

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

- Cool
- High humidity
- Moist soil

HOW DOES IT SPREAD?

- Scattered
  Individual/small patches of infected plants

DISTRIBUTION IN THE FIELD

- Free water
- Movement of contaminated soil
- Contaminated plant debris

WHERE WILL I SEE SYMPTOMS?

CARROT

- Cool
- Moist soil

WHAT SHOULD I LOOK FOR?

Rotted pits develop under the bands, joining to form craters as the disease progresses.
White cottony growth may develop in high humidity
Plant Disease Clinic, University of Minnesota

CARROT, CELERY, PARSNIP AND PARSLEY

CRATER ROT

WHERE WILL I SEE SYMPTOMS?

CARROT

- Cool
- Moist soil

WHAT SHOULD I LOOK FOR?

Rotted pits develop under the bands, joining to form craters as the disease progresses.
White cottony growth may develop in high humidity
Plant Disease Clinic, University of Minnesota

SOIL-BORNE DISEASES IN VEGETABLE CROPS
### Host Range

**Carrot**

### How Do I Control It?

<table>
<thead>
<tr>
<th>Farm Hygiene</th>
<th>Crop Rotation</th>
<th>Host-Free Zone</th>
<th>Improve Soil Health</th>
<th>Bio Fumigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop movement of contaminated soil, water, plants and equipment</td>
<td>Select non-host rotation or cover crops</td>
<td>Control volunteer host plants and weeds</td>
<td>Add organic matter or amendments to boost beneficial microbes</td>
<td>Grow a biofumigant crop</td>
</tr>
</tbody>
</table>

- **Fallow/Cover Crop**
  - 8 year rotation with non-host crop

<table>
<thead>
<tr>
<th>Drainage</th>
<th>No Residue at Planting</th>
<th>Biocontrol Products</th>
<th>Chemical Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant on raised beds or well-draining soil</td>
<td>Ensure no plant residues from host crops at planting</td>
<td>Treat seed/seedlings with registered fungicide</td>
<td>• Consult APVMA or InfoPest website for current registered products</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Irrigation Management</th>
<th>Adjust Date</th>
<th>Avoid Plant Injury</th>
<th>Good Nutrition</th>
<th>Biocontrol Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor crop and soil to optimize amount and timing</td>
<td>Adjust planting/harvest date to reduce infection risk</td>
<td>Avoid any physical damage to plant</td>
<td>Ensure plants’ nutritional needs are met</td>
<td>• Harvest early in high risk situations to reduce chance of infection</td>
</tr>
</tbody>
</table>

### Host Range

**Carrot, Celery, Parsnip and Parsley**

• Consult APVMA or InfoPest website for current registered products
CROWN ROT

**Fusarium spp. | Rhizoctonia spp.**

**WHAT SHOULD I LOOK FOR?**

Crown rot in carrots caused by *Rhizoctonia* spp. causes black lesions at the soil line that spreads to the top of the root. This often causes breaking off of leaves at harvest.

L. Tesoriero, Crop Doc Consulting

Crown rot symptoms may also be caused by *Fusarium* spp. as shown in mature carrots.

H. Pung, Peracto

Crown rot in parsley caused by *Fusarium* spp. causes (a) soft brown rot where the root meets the soil and (b) discolouration of the internal root tissue.

L. Tesoriero, Crop Doc Consulting

**WHERE WILL I SEE SYMPTOMS?**

- Leaves
- Carrot root

**FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT**

- Warm
- Wet
- pH<7
- Nutritional imbalance
- 18-25°C

**DISTRIBUTION IN THE FIELD**

- Scattered
  - Individual/small patches of infected plants

**HOW DOES IT SPREAD?**

- Free water
- Movement of contaminated soil

**SURVIVAL TIME WITHOUT HOST**

- 3-10 years

**CARROT, CELERY, PARSNIP AND PARSLEY | CROWN ROT**
### HOW DO I CONTROL IT?

<table>
<thead>
<tr>
<th>FALLOW/COVER CROP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FARM HYGIENE</strong></td>
</tr>
<tr>
<td>Stop movement of contaminated soil, water, plants and equipment</td>
</tr>
<tr>
<td><strong>HOST-FREE ZONE</strong></td>
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<tr>
<td>Control volunteer host plants and weeds</td>
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<tr>
<td><strong>CROP ROTATION</strong></td>
</tr>
<tr>
<td>Select non-host rotation or cover crops</td>
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<tr>
<td><strong>BIOFUMIGATION</strong></td>
</tr>
<tr>
<td>Grow a biofumigant crop</td>
</tr>
<tr>
<td><strong>IMPROVE SOIL HEALTH</strong></td>
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<tr>
<td>Add organic matter or amendments to boost beneficial microbes</td>
</tr>
</tbody>
</table>

- Minimum 3 year break between host crops

<table>
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<tr>
<th>PLANTING PREPARATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOIL PH</strong></td>
</tr>
<tr>
<td>Use amendments to adjust soil pH</td>
</tr>
<tr>
<td><strong>DRAINAGE</strong></td>
</tr>
<tr>
<td>Plant on raised beds or well-draining soil</td>
</tr>
<tr>
<td><strong>NO RESIDUE AT PLANTING</strong></td>
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<tr>
<td>Ensure no plant residues from host crops at planting</td>
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<tr>
<td><strong>BIOCONTROL PRODUCTS</strong></td>
</tr>
<tr>
<td>Treat seed/seedlings with registered fungicide</td>
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<td><strong>CHEMICAL TREATMENT</strong></td>
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- Consult APVMA or InfoPest website for current registered products

<table>
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<tr>
<th>POST-PLANT</th>
</tr>
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<tbody>
<tr>
<td><strong>IRRIGATION MANAGEMENT</strong></td>
</tr>
<tr>
<td>Monitor crop and soil to optimize amount and timing</td>
</tr>
<tr>
<td><strong>GOOD NUTRITION</strong></td>
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<tr>
<td>Ensure plants’ nutritional needs are met</td>
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<tr>
<td><strong>AVOID PLANT INJURY</strong></td>
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<tr>
<td>Avoid any physical damage to plant</td>
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<tr>
<td><strong>BIOCONTROL PRODUCTS</strong></td>
</tr>
</tbody>
</table>

- Stressed crops are more susceptible to infection

### HOST RANGE
Carrot, parsnips, celery
DAMPING OFF

Rhizoctonia or Pythium spp.

WHAT SHOULD I LOOK FOR?

Seedling emergence may be poor leading to bare patches. Seedlings may emerge but have stunted growth, as shown in parsley. Seedlings may also develop red-brown lesions at the soil junction, resulting in wilt and eventual death, as shown in carrots.

WHERE WILL I SEE SYMPTOMS?

- Seedlings
- Carrot root

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

- Cool
- Moist soil
- Delayed seedling emergence
- • 13-18°C

DISTRIBUTION IN THE FIELD

- Large areas of infected plants clearly visible

HOW DOES IT SPREAD?

- Free water
- Wind
- Movement of contaminated soil
- Contaminated plant debris

SURVIVAL TIME WITHOUT HOST

- More than 10 years
## HOW DO I CONTROL IT?

<table>
<thead>
<tr>
<th>FALLOW/COVER CROP</th>
<th></th>
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<td>Stop movement of contaminated soil, water, plants and equipment</td>
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<td><strong>CROP ROTATION</strong></td>
<td>Select non-host rotation or cover crops</td>
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<tr>
<td><strong>HOST-FREE ZONE</strong></td>
<td>Control volunteer host plants and weeds</td>
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<tr>
<td><strong>BIO FUMIGATION</strong></td>
<td>Grow a biofumigant crop</td>
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<tr>
<td><strong>CHEMICAL FUMIGATION</strong></td>
<td>Always use with care and as per label</td>
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• 3 to 4 years between host crops

<table>
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<tr>
<th>PLANTING PREPARATION</th>
<th></th>
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<tbody>
<tr>
<td><strong>DRAINAGE</strong></td>
<td>Plant on raised beds or well-draining soil</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>CHEMICAL TREATMENT</strong></td>
<td>Treat seed/seedlings with registered fungicide</td>
<td></td>
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<tr>
<td><strong>NO RESIDUE AT PLANTING</strong></td>
<td>Ensure no plant residues from host crops at planting</td>
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• Consult APVMA or InfoPest website for current registered products

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<tr>
<td><strong>IRRIGATION MANAGEMENT</strong></td>
<td>Monitor crop and soil to optimize amount and timing</td>
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<td><strong>GOOD NUTRITION</strong></td>
<td>Ensure plants’ nutritional needs are met</td>
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<tr>
<td><strong>AVOID PLANT INJURY</strong></td>
<td>Avoid any physical damage to plant</td>
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<tr>
<td><strong>BIOCONTROL PRODUCTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CONTROL PESTS</strong></td>
<td>Control insect pests that spread spores</td>
<td></td>
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</tr>
</tbody>
</table>

• Stressed crops are more susceptible to infection
• Sciarid flies can spread disease

## HOST RANGE

Carrot, parsnips, celery, parsley
Stunting of plants resulting in small cupped leaves. Older leaves may curl downward and become distorted. Brown lesions may develop on leaf margins. Lesions may become brittle and crack.

L. Tesoriero, Crop Doc Consulting

Stalks may become twisted with red to light-brown lesions, sometimes in stripes.

L. Tesoriero, Crop Doc Consulting

**WHERE WILL I SEE SYMPTOMS?**

| LEAVES | STALKS |

**FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT**

- Extended leaf wetness
- 23-27°C

**DISTRIBUTION IN THE FIELD**

- Scattered
- Individual/small patches of infected plants
- Free water
- Wind

**HOW DOES IT SPREAD?**

- Continuous water splash

**SURVIVAL TIME WITHOUT HOST**

Less than 3 years
### HOW DO I CONTROL IT?

<table>
<thead>
<tr>
<th>FALLOW/Cover Crop</th>
<th>Host-Free Zone</th>
<th>Crop Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Farm Hygiene</strong></td>
<td>Stop movement of contaminated soil, water, plants and equipment</td>
<td></td>
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<tr>
<td><strong>Crop Selection</strong></td>
<td>Choose a resistant/less susceptible cultivar</td>
<td></td>
</tr>
<tr>
<td><strong>No Residue at Planting</strong></td>
<td>Ensure no plant residues from host crops at planting</td>
<td></td>
</tr>
<tr>
<td><strong>Avoid Over Irrigation</strong></td>
<td>Saturated soils favour disease development and spread</td>
<td></td>
</tr>
<tr>
<td><strong>Chemical Treatment</strong></td>
<td>Treat plant with registered foliar fungicide</td>
<td></td>
</tr>
</tbody>
</table>

- **Host-Free Zone**
  - Select non-host rotation or cover crops
- **Crop Rotation**
  - 3 to 4-year break

### Host Range

Wide host range including celery

**Carrot, Celery, Parsnip and Parsley | Leaf Curl/Celery Anthracnose**
WHAT SHOULD I LOOK FOR?

Aboveground scattered areas of stunted, yellow and wilted plants may be visible.

B. Hammeraas, NIBIO, Bugwood.org

Belowground infection by *Meloidogyne* spp. can result in swollen galls on carrot roots.

S. Nelson FLICKR

Infection by *Meloidogyne hapla* can cause forking and severe distortion of carrot roots.

W. Peraza-Padilla, National University Costa Rica, Bugwood.org

WHERE WILL I SEE SYMPTOMS?

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

- Aboveground: Scattered areas of stunted, yellow and wilted plants
- Belowground: Swollen galls on carrot roots

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

- Active 15°C +
- Active 8.5°C +

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

DISTRIBUTION IN THE FIELD

- Large areas of infected plants clearly visible
- Prevailing conditions: Warm
- Sandy soil

HOW DOES IT SPREAD?

- Movement of contaminated soil
- Free water
- Contaminated plant debris

SURVIVAL TIME WITHOUT HOST

- Less than 3 years

WARM CLIMATE SPECIES: *Meloidogyne incognita* | *Meloidogyne javanica* | *Meloidogyne arenaria*

COOL-CLIMATE SPECIES: *Meloidogyne hapla* | *Meloidogyne fallax*
HOST RANGE

Very wide, with over 2000 plant species acting as hosts to root-knot nematode
CARROT, CELERY, PARSNIP AND PARSLEY

ROOT-LESION NEMATODE

Pratylenchus penetrans

WHAT SHOULD I LOOK FOR?

Aboveground scattered areas of stunted, yellow and wilted plants may be visible
B. Hammaaas, NIBIO, Bugwood.org

WHERE WILL I SEE SYMPTOMS?

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

• 20-25°C

SANDY SOIL

WHAT SHOULD I LOOK FOR?

Belowground infection by Pratylenchus penetrans can cause forking, distortion and prolific formation of lateral roots
S. Collins, DPIRD

HOW DOES IT SPREAD?

Movement of contaminated soil
Free water
Contaminated plant debris

SURVIVAL TIME WITHOUT HOST
More than 10 years

DISTRIBUTION IN THE FIELD

LARGE AREAS
Large areas of infected plants clearly visible

< 3 years
Survival time without host

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

WHAT SHOULD I LOOK FOR?

WHERE WILL I SEE SYMPTOMS?
**HOST RANGE**
Wide, infecting over 400 plant species including carrot, potatoes and fruit trees

<table>
<thead>
<tr>
<th>HOW DO I CONTROL IT?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FALLOW/COVER CROP</strong></td>
</tr>
<tr>
<td><strong>Farm Hygiene</strong></td>
</tr>
<tr>
<td>Stop movement of contaminated soil, water, plants and equipment</td>
</tr>
<tr>
<td><strong>Host-Free Zone</strong></td>
</tr>
<tr>
<td>Control volunteer host plants and weeds</td>
</tr>
<tr>
<td><strong>Crop Rotation</strong></td>
</tr>
<tr>
<td>Select non-host rotation or cover crops</td>
</tr>
<tr>
<td><strong>Chemical Fumigation</strong></td>
</tr>
<tr>
<td>Always use with care and as per label</td>
</tr>
<tr>
<td><strong>Bio Fumigation</strong></td>
</tr>
<tr>
<td>Grow a biofungicidal crop</td>
</tr>
<tr>
<td><strong>Soil Test</strong></td>
</tr>
<tr>
<td>Conduct a pre-sowing soil test to help predict level of risk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>PLANTING PREPARATION</strong></th>
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<tbody>
<tr>
<td><strong>Crop Selection</strong></td>
</tr>
<tr>
<td>Choose a resistant/less susceptible cultivar</td>
</tr>
<tr>
<td><strong>Soil Solarisation</strong></td>
</tr>
<tr>
<td>Cover soil with a tarp and kill harmful pathogens</td>
</tr>
<tr>
<td><strong>Irrigation Management</strong></td>
</tr>
<tr>
<td>Monitor crop and soil to optimize amount and timing</td>
</tr>
<tr>
<td><strong>No Residue at Planting</strong></td>
</tr>
<tr>
<td>Ensure no plant residues from host crops at planting</td>
</tr>
<tr>
<td><strong>Adjust Date</strong></td>
</tr>
<tr>
<td>Adjust planting/harvest date to reduce infection risk</td>
</tr>
</tbody>
</table>

**E.g. PREDICTA® B testing service. If numbers are high consider fallow or non-host break crop**
SOIL-BORNE DISEASES IN VEGETABLE CROPS

CARROT, CELERY, PARSNIP AND PARSLEY

ROOT ROT COMPLEX

Phytophthora/Pythium spp.

WHAT SHOULD I LOOK FOR?

Aboveground, yellowing and wilting of leaves followed by plant collapse and death, as shown in parsley

L. Tesoriero, Crop Doc Consulting

WHERE WILL I SEE SYMPTOMS?

FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT

• Especially waterlogged soils <10°C
• 8-15°C

COOL
WET

ROOT ROT COMPLEX

Belowground, reduction in side roots predominantly by Pythium spp., as shown in infected parsley (right) compared to healthy plant (left). Infection with Phytophthora spp. leaves roots intact but often causes browning

L. Tesoriero, Crop Doc Consulting

DISTRIBUTION IN THE FIELD

• SCATTERED
  Individual/small patches of infected plants

FREE WATER

MOVEMENT OF CONTAMINATED SOIL

HOW DOES IT SPREAD?

SURVIVAL TIME WITHOUT HOST

< 3 years

More than 10 years

Roots may also develop a brown spongy rot as shown in carrots

L. Tesoriero, Crop Doc Consulting
HOW DO I CONTROL IT?

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<tr>
<th>CROP ROTATION</th>
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<td>Select non-host rotation or cover crops</td>
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<table>
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<tr>
<th>BIO FUMIGATION</th>
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<tbody>
<tr>
<td>Grow a biofumigant crop</td>
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<th>CHEMICAL FUMIGATION</th>
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• 3 to 4 years between host crops

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<th>PLANTING PREPARATION</th>
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<tbody>
<tr>
<td><strong>DRAINAGE</strong></td>
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<tr>
<td>Plant on raised beds or well-draining soil</td>
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<th>POST-PLANT</th>
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<tr>
<td><strong>IRRIGATION MANAGEMENT</strong></td>
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<tr>
<td>Carrot, parsnip, celery, parsley</td>
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Always use with care and as per label

• Consult APVMA or InfoPest website for current registered products
CARROT, CELERY, PARSNIP AND PARSLEY

SCLEROTINIA ROT (WHITE MOULD)

*Sclerotinia sclerotiorum* | *S. minor*

**WHAT SHOULD I LOOK FOR?**

At base of stem fluffy white fungal growth is visible, leading to stem rot and collapse

*H.F. Schwartz. Bugwood.org*

**WHERE WILL I SEE SYMPTOMS?**

**COOL**

- 13-18°C

**WET**

**FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT**

**DISTRIBUTION IN THE FIELD**

**HOW DOES IT SPREAD?**

**SCATTERED**

Individual/small patches of infected plants

**WIND**

**FREE WATER**

**MOVEMENT OF CONTAMINATED SOIL**

**SURVIVAL TIME WITHOUT HOST**

3-10 years

**SURVIVABILITY**

- *Sclerotinia sclerotiorum* can survive up to 25mm long
- *S. minor* survival structures (sclerotia) much smaller (up to 3mm long)

*H.F. Schwartz. Bugwood.org*

**WHERE WILL I SEE SYMPTOMS?**

**CARROT ROOT**

**WHAT SHOULD I LOOK FOR?**

**CARROT, CELERY, PARSNIP AND PARSLEY | SCLEROTINIA ROT (WHITE MOULD)**

Survival structures (sclerotia) form later on and can be up to 25mm long in *S. sclerotiorum* and much smaller (up to 3mm long) in *S. minor*

*C. Balbalian, Mississippi State University, Bugwood.org*
### Host Range

Very wide (more than 400 different plant species). Infects most vegetable crops.

### How do I control it?

<table>
<thead>
<tr>
<th>Fallow/Cover Crop</th>
<th>Farm Hygiene</th>
<th>Host-Free Zone</th>
<th>Crop Rotation</th>
<th>Bio Fumigation</th>
<th>Improve Soil Health</th>
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<td>Stop movement of contaminated soil, water, plants and equipment</td>
<td>Control volunteer host plants and weeds</td>
<td>Select non-host rotation or cover crops</td>
<td>Grow a biofumigant crop</td>
<td>Add organic matter or amendments to boost beneficial microbes</td>
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<tr>
<th>Planting Preparation</th>
<th>Air Circulation</th>
<th>Drainage</th>
<th>No Residue at Planting</th>
<th>Biocontrol Products</th>
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<tr>
<td>Increase row/plant spacing to improve air flow</td>
<td>Plant on raised beds or well-draining soil</td>
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<tr>
<th>Post-Plant</th>
<th>Avoid Over Irrigation</th>
<th>Chemical Treatment</th>
<th>Avoid Plant Injury</th>
<th>Good Nutrition</th>
<th>Biocontrol Products</th>
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<tr>
<td>Saturated soils favour disease development and spread</td>
<td>Treat plant with registered foliar fungicide</td>
<td>Avoid any physical damage to plant</td>
<td>Ensure plants' nutritional needs are met</td>
<td></td>
<td></td>
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- Consult APVMA or InfoPest website for current registered products
WHAT SHOULD I LOOK FOR?

Watery rot, leading to stem collapse. Characteristic white ropey fungal growth seen at the soil line with light brown survival structures (sclerotia) resembling mustard seeds.

_D. Langston, University of Georgia, Bugwood.org_

**WHERE WILL I SEE SYMPTOMS?**

- CARROT ROOT
- STEM BASE

**FAVOURABLE CONDITIONS FOR DISEASE DEVELOPMENT**

- **WARM**
- **pH < 7**
- **WET**

- 25-35°C

**HOW DOES IT SPREAD?**

- **FREE WATER**
- **WIND**
- **MOVEMENT OF CONTAMINATED SOIL**

- Mostly through splash

**DISTRIBUTION IN THE FIELD**

- **SCATTERED**
  - Individual/small patches of infected plants

**SURVIVAL TIME WITHOUT HOST**

- 3-10 years
### Host Range

Very wide (more than 400 different plant species). Infects most vegetable crops including members of the bean, brassica and pumpkin families.

### Control Strategies

#### Fallow/Cover Crop

- **Farm Hygiene**: Stop movement of contaminated soil, water, plants and equipment.
- **Host-Free Zone**: Control volunteer host plants and weeds.
- **Crop Rotation**: Select non-host rotation or cover crops.
- **Bio Fumigation**: Grow a biofumigant crop.
- **Improve Soil Health**: Add organic matter or amendments to boost beneficial microbes.

*3 to 4 years between host crops*

#### Planting Preparation

- **Air Circulation**: Increase row/plant spacing to improve air flow.
- **Drainage**: Plant on raised beds or well-draining soil.
- **No Residue at Planting**: Ensure no plant residues from host crops at planting.
- **Biocontrol Products**: Avoid plant injury.

#### Post-Plant

- **Avoid Over Irrigation**: Saturated soils favour disease development and spread.
- **Chemical Treatment**: Treat plant with registered foliar fungicide.
- **Avoid Plant Injury**: Avoid any physical damage to plant.
- **Good Nutrition**: Ensure plants’ nutritional needs are met.
- **Biocontrol Products**: Stop movement of contaminated soil, water, plants and equipment.

*Consult APVMA or InfoPest website for current registered products*