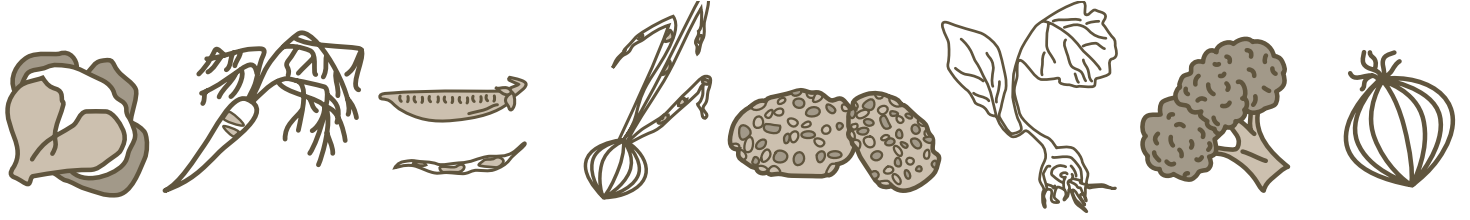




COMMON
VEGETABLE DISEASE

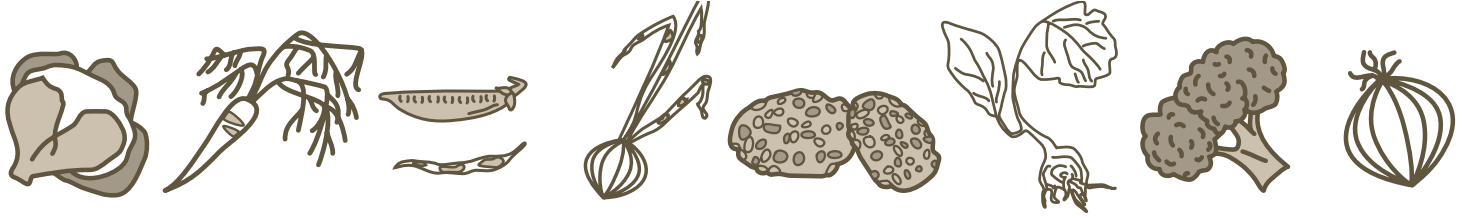




Contents

Common vegetable diseases	3
Plant disorders	4
Integrated disease management	6
Management of fungicide resistance	7
Diseases of brassicas	8
Management options for brassica diseases	13
Diseases of carrots	14
Management options for carrot diseases	17
Diseases of green beans	18
Management options for green bean diseases	22
Diseases of green peas	23
Management options for green pea diseases	26
Diseases of onions	27
Management options for onion diseases	32
Diseases of potatoes	33
Management options for potato diseases	38





Common vegetable diseases

This section should be used as a basic introduction to disease identification and disease management. It was not possible to cover every vegetable disease, disorder and virus in this manual. However, at the end of this manual you will find a list of useful references that will provide you with links to information on plant diseases. Your local agricultural adviser should be able to provide specific information regarding particular diseases and their management.

Causes of plant disease

Plant diseases are commonly caused by one of four types of pathogens - fungi, bacteria, viruses and nematodes. If all three factors of the pest triangle (refer to IPM Section) are favourable for the pathogen to survive, it will multiply, spread and cause disease. Symptomatic characteristics of the disease develop on the host and it is these visual symptoms that allow us to identify the specific pathogenic disease. For example, on some hosts the fungal pathogen downy mildew may cause yellow and brown lesions to develop with a distinct white cottony growth forming near the lesions. On the other hand, the fungal pathogen *Sclerotinia* is identified by small black reproducing bodies called sclerotia. Disease identification is difficult in some cases, and a laboratory diagnosis may be required for accurate identification. Disease management may not be successful if the disease is not properly identified.

The four main pathogens covered in this manual are:

Fungi

Fungi are small organisms producing thread-like hyphae or mycelium. Fungi often produce reproductive structures, which produce spores that are released into the air and water. Once the spores land on a host they require moist and humid conditions to germinate and initiate the infection on the plant. An example of a major fungal pathogen in many vegetable crops is downy mildew (Figure 3.1).

Bacteria

Bacteria are single celled organisms that can survive and rapidly multiply in crop residue, plants and seeds, soil and water. Bacteria infect the plant via wounds or natural openings such as stomata on the leaf. Movement of machinery, insects, rain and soil can spread bacteria. An example of a bacterial pathogen is bacterial soft rot, which can cause wet slimy rots to develop on the plant in the field or in storage (Figure 3.2). Bacterial rot usually infects via damaged areas on the plant.

Plant diseases are caused by one of the four pathogens - fungi, bacteria, viruses and nematodes.



Figure 3.1 Downy mildew (QLD/DPI)



Figure 3.2 Bacterial soft rot



Figure 3.3 Potato leaf roll virus symptoms

Viruses

Viruses are extremely small pathogens that can only be seen under the electron microscope. Viruses are made up of small pieces of RNA or DNA and a protein coat. Different viruses are transmitted in different ways e.g by contact with sap sucking insects such as aphids, thrips and leafhoppers and mechanically by planting and harvesting implements. No chemical treatments are available for the control of viruses. Early detection and identification of virus symptoms and the relevant insect vectors are important to prevent rapid spread and potential crop destruction. Potato leaf roll virus (PLRV) is an example of one of the most severe viruses of potatoes (Figure 3.3).



Figure 3.4 Root-knot nematode

Nematodes

Nematodes are small worm like organisms that are visible only under a microscope. They live in every part of soil and water, but only certain species cause plant disease. Pathogenic nematodes, such as root-knot nematode and bloat nematode, have distinct mouthparts that pierce the roots of plants to feed on them. Large populations of nematodes cause plants to wilt, become stunted or distorted. Nematodes are spread via water movement and on soil particles attached to machinery. Root-knot nematode is an example of a common pathogenic soil borne nematode that attacks many root and tuber vegetable crops (Figure 3.4).

Plant disorders

Environmental factors, including insufficient or excess soil water and nutrients, and adverse weather patterns, may cause symptoms similar to many diseases. Knowing the difference between the two is important for successful disease management. Some disorders you may find are:

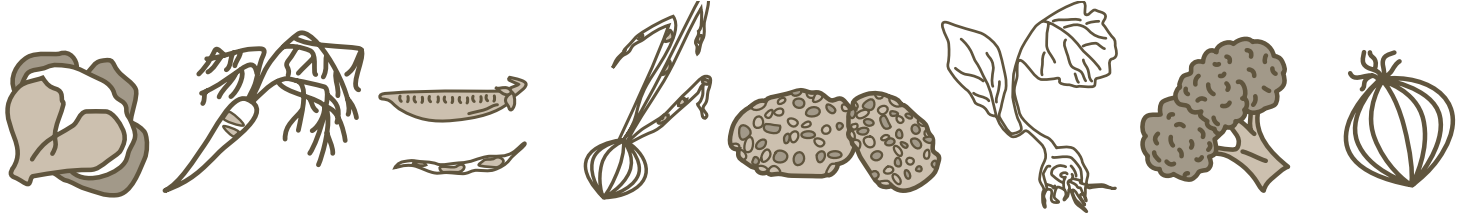
Nutritional disorders



Nitrogen deficiency



Iron deficiency



Boron deficiency



Magnesium deficiency

Figure 3.5 Symptoms of some plant nutritional disorders

Chemical and environmental disorders



Herbicide leaf damage



Herbicide leaf damage



Herbicide drift damage



Frost damage

Figure 3.6 Symptoms of some plant chemical and environmental disorders



Integrated disease management

Monitoring the crop to forecast and detect disease symptoms, as well as having an understanding of the environmental conditions that favour disease infection, are the best tools to manage disease outbreaks. This allows crop quality and yield to be maintained, while a disease outbreak can be managed using a selection of the most effective options applied at the most effective time.

The primary aim in disease management is to use tools that aim to protect the host and to exclude the pathogen. Some general approaches are listed below.

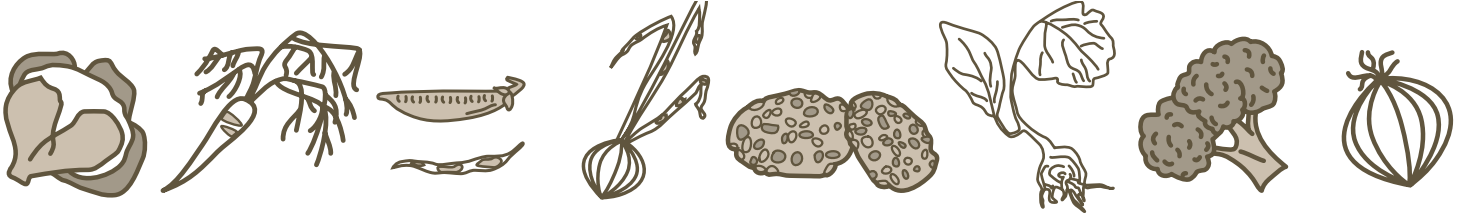
The primary aim in disease management is to use tools that aim to protect the host and to exclude the pathogen.

Protecting the host

- Use resistant varieties to prevent or minimise infection of the host.
- Apply chemicals and biological sprays, drenches or mulches. Chemicals are often far more effective when used in conjunction with other disease management options as mentioned below.
- Maintain healthy plants through effective nutrition, irrigation, protection from injury and weed competition.

Excluding the pathogen

- Rotate crops to break the disease cycle. A 4 to 5-year cropping rotation is adequate for most soil borne pathogens. However, some pathogens live much longer in soil. You should be aware of this and avoid infected areas.
- Monitor for disease symptoms. This allows diseased plants to be identified and treated before the infection spreads. Early intervention allows for better timing of sprays and better control.
- Good farm hygiene, such as foot baths and washing down all machinery, is essential to stop pathogens moving from paddock to paddock and spreading disease.
- Remove crop debris to prevent carry over of pathogens.
- Use clean seed from a reputable source. Registered seed treatments provide protection against early infection.
- Remove surrounding weeds that can act as hosts for pathogens.
- Monitor environmental conditions such as temperature, humidity, leaf wetness and rainfall. Determine the most favourable conditions for diseases to occur and be aware of when they occur so you can take preventative action.



- Incorporate organic manures and mulches to increase the level and activity of soil micro-organisms. These often play an important role in managing soil borne pathogens. However, do not use green manure crops that will harbour diseases for the next crop. Choice of green manure species can impact on disease level.
- Keep records of disease incidence and avoid planting susceptible hosts in high risk areas.

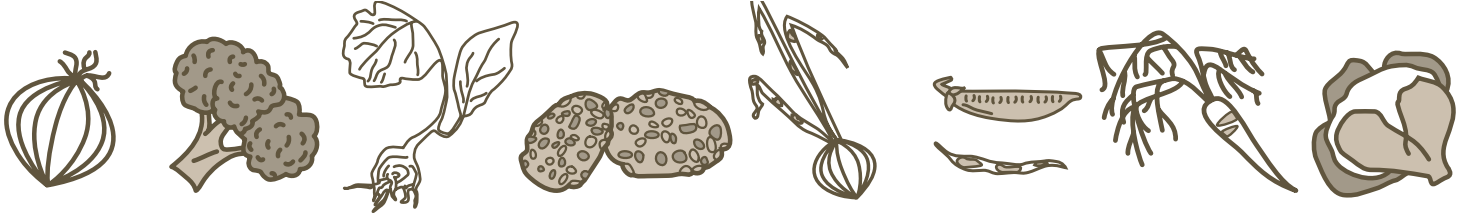
Management of fungicide resistance

Some diseases have been known to develop resistance to some fungicides, making these fungicides useless for disease control. When resistance occurs, the fungus will also be resistant to other fungicides belonging to the same group. Appendix A provides fungicide groupings. Managing the development of resistance involves adopting the following principles:

- Apply fungicides at the recommended rate. Too many applications may accelerate the resistance development process.
- Incorporate cultural strategies into disease management to maintain and manage disease and to minimize the need to use chemicals.
- Regularly monitor your crop and spray as soon as you see symptoms of the disease or if conditions favour disease development, rather than allowing the disease to build up.
- Minimise regular use of specific fungicides. Alternate with different fungicide groups to reduce the chance of resistance developing.
- Optimise chemical efficacy through correct application techniques, eg. cone jets, wetting agents and correct pressure.

For further details on proper use of pesticides it is recommended that you consult your local agronomic adviser.

Some diseases have been known to develop resistance to some fungicides, making these fungicides useless for disease control.



The following sections deal with diseases of specific crops and highlight the growth stage of the crop that particular diseases are most likely to occur. This is an indication only, because given the right set of circumstances in the pest triangle (see section 1), diseases may occur at any time in the cropping cycle.

Detailed descriptions on many of the diseases mentioned are located in the appendix section of the manual.

Diseases of brassicas

Crop growth stages

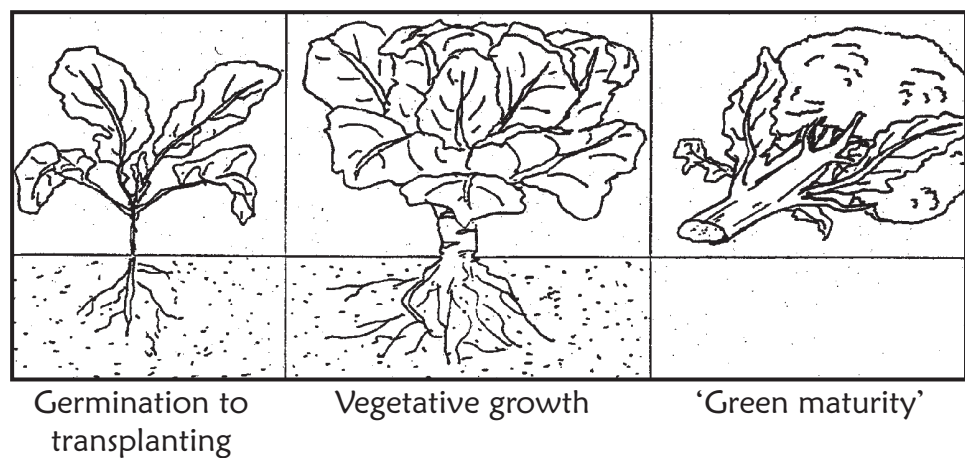


Figure 3.7 Growth stages of brassica crops.

The following diseases that affect brassicas are discussed:

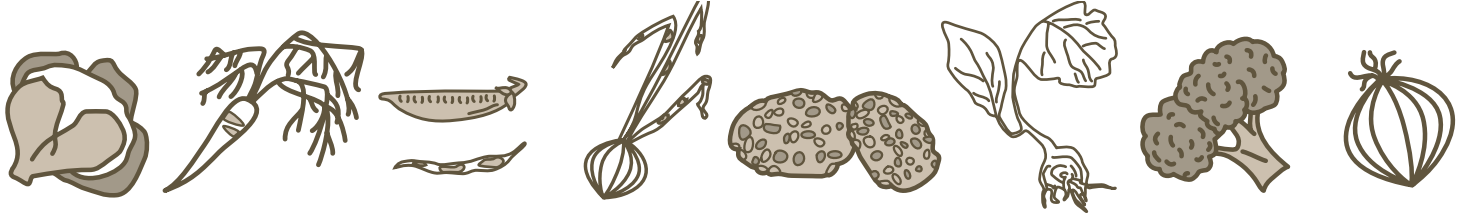
- bacterial soft rot
- black rot
- clubroot
- damping-off
- downy mildew
- light leaf spot
- powdery mildew
- ring spot
- target spot
- wirestem
- white blister rust
- white mould

Bacterial soft rot (*Pseudomonas spp.*)

- Rotting of the head, stem and leaves.
- Slimy liquid will surround rotting area, releasing a foul odour.
- See Figure 3.8.



Figure 3.8 Rotting of the head (DPI/DSE)



Black rot (*Xanthomonas campestris*)

- Bacterial disease.
- A v-shaped, bright yellow lesion on margins of leaves containing blackened veins.
- See Figure 3.9.

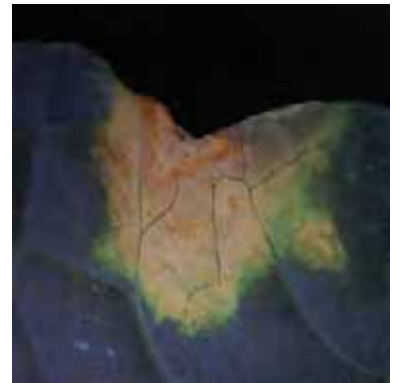


Figure 3.9 Typical v-shaped lesions on a leaf (DPI/DSE)

Clubroot (*Plasmodiophora brassicae*)

- Large, swollen club shaped galls will appear on the root system.
- Plants will wilt in warm conditions and may become distorted.
- See Figures 3.10 and 3.11.



Figure 3.10 Large swollen clubs on roots (DPIWE)



Figure 3.11 Wilted and distorted brassica plants

Damping-off (*Pythium* or *Rhizoctonia* spp.)

- The stem of young transplants will form a hardened dark rot near the base of the stem. The plant may wilt, collapse or die (*Rhizoctonia solani* fungus).
- The stem of the transplant will develop a soft wet rot near the base of the stem and the plant will wilt, collapse or die (*Pythium* species).
- See Figure 3.12.



Figure 3.12 Damping-off symptoms (DPI/DSE)



Figure 3.13 Downy mildew on a seedling (DPI/DSE)



Figure 3.14 Yellow lesions from downy mildew (DPI/DSE)

Downy mildew (*Peronospora parasitica*)

- Symptoms will appear on the leaves and seedlings.
- Small, pale yellow-green, round lesions will appear on the upper surface of the leaves.
- Small, black lesions will appear on the upper side of the cotyledon leaves.
- Deep, black-grey lesions will appear on the older leaves.
- Cottony growth may be seen on the underside of leaves.
- See Figures 3.13 and 3.14.

Light leaf spot (*Cylindrosporium concentricum*)

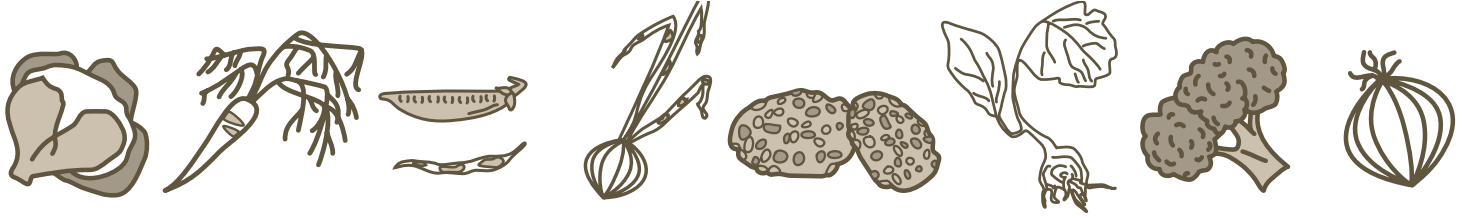
- Spotting or mould on leaves.
- Concentric rings of pale pink dots, slight tissue damage may occur.



Figure 3.15 Symptoms of powdery mildew (DPI/DSE)

Powdery mildew (*Erysiphe cruciferarum*)

- White-grey, powdery mould will appear on the upper leaf surface and will rapidly spread over the plant.
- See Figure 3.15



Ringspot (*Mycosphaerella brassicicola*)

- Circular lesions that are grey\brown in colour appear.
- Small black, pinhead dots appear as 'growth' rings.
- See Figures 3.16 and 3.17.



Figure 3.16 Close up of circular ringspot lesion (DPI/DSE)



Figure 3.17 Ringspot lesions on brassica leaf (DPI/DSE)

Target spot (*Alternaria*)

- Grey-black lesions with a distinct yellowing halo surrounding the well defined infection area. The lesions will rapidly spread releasing a powdery mass of spores.
- The lesion area will eventually become dry and brittle and may disintegrate forming small holes in the leaves.
- See Figure 3.18.



Figure 3.18 Leaf symptoms of target spot (DPI/DSE)

Wirestem (*Rhizoctonia solani*)

- Dry, brittle rot of stem at or above soil level generally in more advanced seedlings.
- Plant may wilt, collapse then die.
- See Figure 3.19.



Figure 3.19 Wirestem symptoms in seedlings (DPI/DSE)



Figure 3.20 Small white blister on floret (DPIWE)

White blister rust (*Albugo candida*)

- Small, white, blistery spots appear on the leaves and florets.
- The white lesions will become powdery as they release their spores.
- See Figures 3.20 and 3.21.



Figure 3.21 Floret infected with white blister rust (DPIWE)



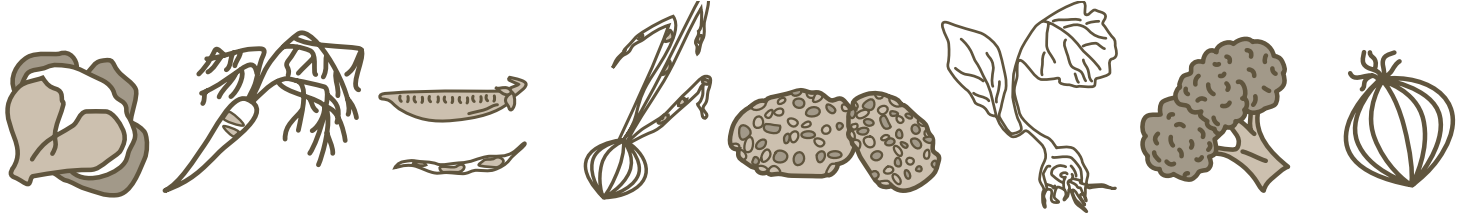
Figure 3.22 White mould symptoms (DPI/DSE)

White mould (*Sclerotinia spp.*)

- Soft rot of curd, head, stem and leaves with abundant white cottony like growth.
- Breakdown associated with profuse white mould and black resting bodies (sclerotia).
- Small, hard, black, resting bodies called sclerotes (10 mm x 5 mm) will appear in latter stage of fungus development.
- See Figures 3.22 and 3.23.

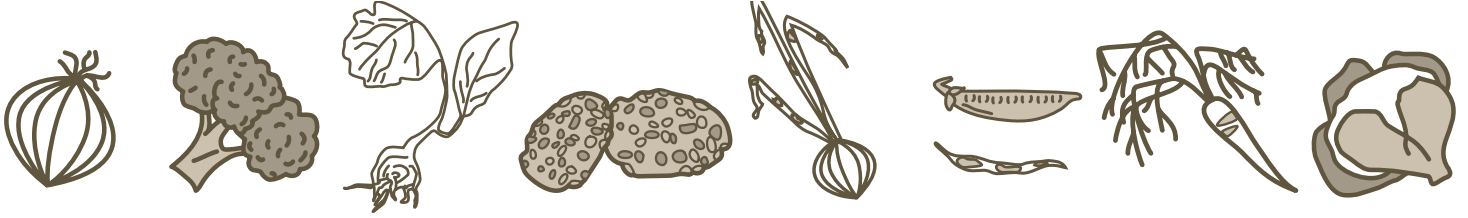


Figure 3.23 White mould symptoms (DPI/DSE)



Management options for brassica diseases

Disease	Cultural/Mechanical	Chemical
Bacterial soft rot	<ul style="list-style-type: none"> • Minimum crop rotation of 2-3 years, with non-susceptible crops planted in the rotation. • Remove plants and produce that is infected. Infected heads should not be stored. • Avoid harvesting produce in wet conditions. 	<ul style="list-style-type: none"> • Copper spray
Black rot	<ul style="list-style-type: none"> • Good crop hygiene - wash down all machinery and use a footbath. • Use clean seed. • Hot water seed treatment may be an option. 	<ul style="list-style-type: none"> • Controlled by regular applications of copper fungicides.
Clubroot	<ul style="list-style-type: none"> • Minimum crop rotation of about 3-4 years. Plant non-brassica plants in the rotation to prevent inoculum build up. • Lime soil 3 months before planting. • Good crop hygiene • Remove all crop residue and weeds. • Use clean transplants. 	<ul style="list-style-type: none"> • Band placing lime and fluazinam (Shirlan®) at planting has been shown to reduce clubroot infection.
Damping-off	<ul style="list-style-type: none"> • Minimum crop rotation of 3 years, planting non-susceptible crops in the rotation. • Destruction of crop residue. • Plant in raised seedbeds to improve soil drainage. • Crop rotation. 	<ul style="list-style-type: none"> • Coat the seed with a registered fungicide as a preventative treatment.
Downy mildew	<ul style="list-style-type: none"> • Good crop ventilation. • Avoid irrigating in the morning. Spores are released in the morning and require water to germinate. 	<ul style="list-style-type: none"> • Registered protectant fungicides should be applied as soon as the first symptoms appear or when conditions favour disease infection.
Light leaf spot	<ul style="list-style-type: none"> • Removal of all crop debris is essential to prevent carryover of the disease. • Not likely to cause severe damage. 	
Powdery mildew	<ul style="list-style-type: none"> • Uncommon disease in brassicas with no control required. 	
Ringspot	<ul style="list-style-type: none"> • Minimum three-year rotation between brassica crops. • Remove all crop residue. • Disease can be seed borne. • Seed may be treated with hot water to remove the disease. Temperature and duration are critical factors. • Avoid cross contamination between old and younger plantings. 	<ul style="list-style-type: none"> • Registered fungicides are available. • Begin preventative program at earliest sign of disease or it can be hard to control. • Good coverage and canopy penetration is essential. • Dropper nozzles can help increase penetration as canopy closes.
Target spot	<ul style="list-style-type: none"> • Completely remove crop residue as soon as possible. 	<ul style="list-style-type: none"> • Apply registered fungicides if necessary.
White blister rust	<ul style="list-style-type: none"> • Immediately remove and dispose of any plants that show any sign of infection. 	<ul style="list-style-type: none"> • Only apply fungicides that are registered for white blister rust.
White mould	<ul style="list-style-type: none"> • Good crop hygiene - wash down all machinery and use a footbath. • Plants with structures where leaves touch the soil will be more likely to get infected. 	<ul style="list-style-type: none"> • Registered fungicides. • Lime.
Wirestem	<ul style="list-style-type: none"> • Avoid conditions that promote damage or reduce vigour • Minimise crop injury at the time when seedlings are most vulnerable to infection. • Orientate rows to avoid excessive movement by wind, as scouring at stem can allow pathogens to enter the plant at soil level. 	



Diseases of carrots

Detailed descriptions on many of the diseases mentioned are located in the appendix section of the manual.

Crop growth stages

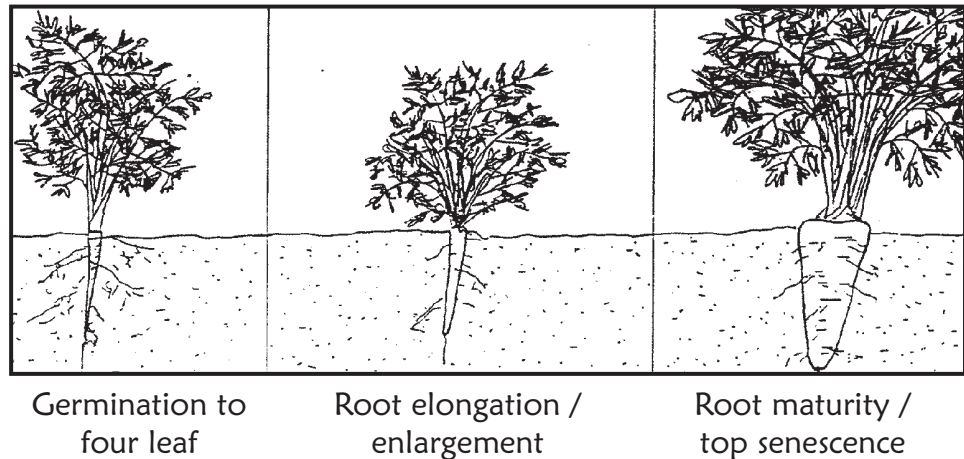


Figure 3.24 Growth stages of carrot crops.

The following diseases that affect carrots are discussed:

- bacterial soft rot
- black ring
- carrot virus Y
- cavity spot
- damping-off
- leaf spot
- *Rhizoctonia*
- root-knot nematode
- *Sclerotinia*

Bacterial soft rot (*Erwinia spp.*)

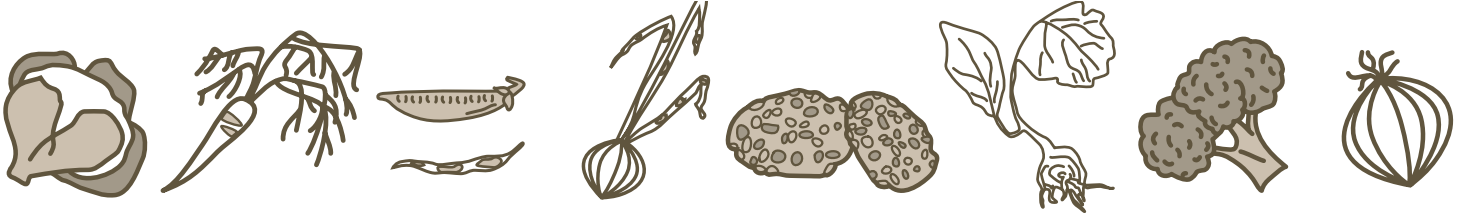
- Wet soft rot of the roots.

Black ring

- Caused by a variety of fungi and physiological disorders.
- A distinct black ring develops at the top of the carrot.
- The carrot will not rot from the disease.
- The black stain remains right through to processing.
- See Figure 3.25.



Figure 3.25 Black ring symptoms develop on the crown of the carrot (QLD/DPI)



Carrot Virus Y

- Carrot virus Y is spread by aphids in a non-persistent manner - ie. they acquire the virus by feeding on an infected plant and lose the virus once they feed on another healthy plant.
- Green peach aphid is a very efficient vector.
- Infected plants suffer significant quality reduction. Anise, chervil, dill, coriander, cumin and parsnip also act as a virus source.
- Leaf symptoms include chlorotic mottling and necrosis. The leaves also take on a feathery appearance.
- Root symptoms include distortion, stubbiness and shortening.
- No cure for infected plants.

Cavity spot (*Pythium spp.*)

- Grey-black eye shaped discolouration about root hairs.

Damping – off (*Pythium or Rhizoctonia spp.*)

- Pre-emergence damping-off results in rotting of the seedling before emergence.
- Post-emergence damping-off results in soft rotting of the tap root, causing the seedling to collapse and die.
- See Figure 3.26.



Figure 3.26 Typical damping off symptoms (QLD/DPI)

Leaf spot (*Septoria, Cercospora, Alternaria spp.*)

- Brown coloured flecking will develop on the foliage.
- Leaves may shrivel and die prematurely.
- The disease will gradually build up during the life of the crop as wind and water quickly spread the infection.
- See Figure 3.27.



Figure 3.27 Leaf spot symptoms on carrots (QLD/DPI)

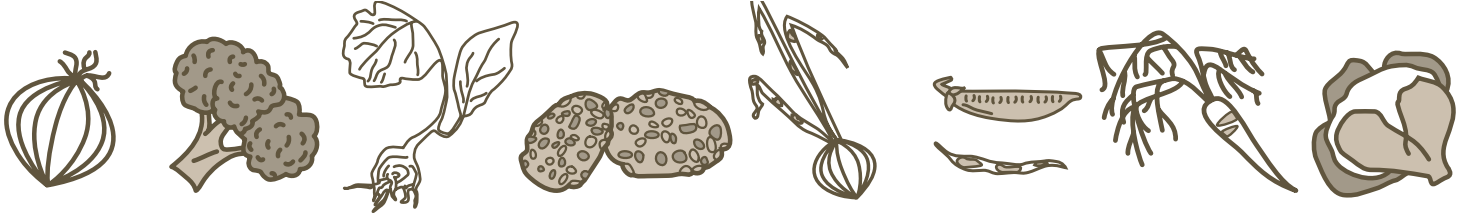


Figure 3.28 Common symptoms caused by *Rhizoctonia* (QLD/DPI)

Rhizoctonia

- Dry, scurfy, ginger-brown cankers on mature roots.
- See Figure 3.28.



Figure 3.29 Galls on roots limit uptake of water and nutrients (DPIWE)

Root-knot nematode (*Meloidogyne spp.*)

- Galls will develop on lateral roots.
- Forking of the taproot will cause the plant to become stunted.
- See Figure 3.29.

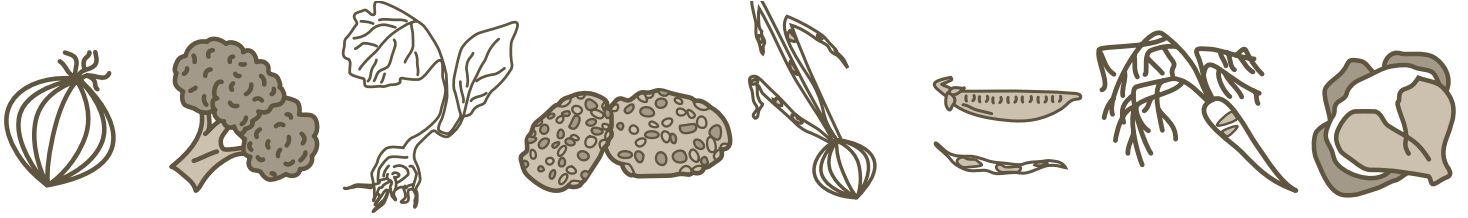
Sclerotinia

- Infection usually starts at the base of the stem and spreads down towards the crown of the plant.
- Infected parts of the plant become covered in fluffy white mycelium.
- Small, black, resting sclerotes may also be present.



Management options for carrot diseases

Disease	Cultural/Mechanical	Chemical
Bacterial soft rot	<ul style="list-style-type: none"> The disease is only present in wet or moist conditions. Provide adequate soil drainage. Avoid damage that allows entry of bacteria into the plant. 	
Black ring	<ul style="list-style-type: none"> Maintain healthy plant growth. Use plant varieties that have rounded tops. Increase plant spacing. 	
Cavity spot	<ul style="list-style-type: none"> Minimum crop rotation of 3 years. Provide good drainage and well-structured soils. 	<ul style="list-style-type: none"> Addition of hypochlorite to the final wash before packing can help limit development of post-harvest bacterial rots.
Damping-off	<ul style="list-style-type: none"> Avoid over watering. Wash all machinery moving in and out of infected paddocks. Adjust sowing density and row configuration to improve crop ventilation. 	<ul style="list-style-type: none"> Treat seeds with registered fungicides prior to planting. Apply fungicide as outbreaks occur in the crop.
Leaf spot	<ul style="list-style-type: none"> Rotate carrots with other crops. Use clean seed (seed borne diseases). 	<ul style="list-style-type: none"> Spray with recommended fungicides. Preventative sprays must be applied at or before the first signs of disease. Thorough coverage on leaves is essential for good control.
Rhizoctonia	<ul style="list-style-type: none"> Minimum 2-3 year crop rotation moving away from carrot or parsnip crops may prevent the build up of strains most pathogenic to the host. 	
Root - knot nematode	<ul style="list-style-type: none"> Minimum crop rotation of 3 years between host crops is recommended. Provide good soil drainage – eg. use raised seedbeds. 	
Sclerotinia	<ul style="list-style-type: none"> Increase planting density to reduce humidity within the crop. Orientate rows to allow air flow through the crop for as long as possible. Don't plant into a paddock after another susceptible crop, eg potatoes and poppies. 	<ul style="list-style-type: none"> Spray with recommended fungicides. Increase the water volume to improve leaf coverage and canopy penetration. Effective spray cover is critical.
Carrot virus Y	<ul style="list-style-type: none"> No cure for infected plants. Use best management practices to reduce the reservoir of infection. Remove and destroy all volunteer carrots as they can act as a source for infection. Monitor aphid populations. Change sowing date so young carrots are not growing during peak aphid periods. Introduce a 3-year cropping rotation. Avoid side by side plantings of carrots as this can cause young crops to become infected by older crops. A barrier non-host crop or a fallow period around the crop will reduce virus spread. Clean up fencelines and headlands to remove viruses and vector reservoir. 	<ul style="list-style-type: none"> Chemical control is being studied. Preliminary results have shown a reduction in the spread of the virus with applications of a 'new chemistry' insecticide.



Diseases of green beans

Detailed descriptions on many of the diseases mentioned are located in the appendix section of the manual.

Crop growth stages (of peas and beans)



Germination to
five leaf

Early flowering to
pod set

Pod fill to
maturity

Figure 3.30 Growth stages of green bean crops.

The following diseases that affect green beans are discussed:

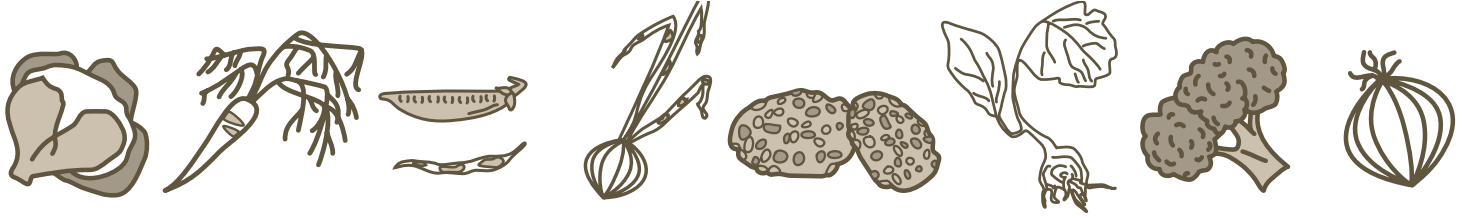
- anthracnose
- *Ascochyta*
- bacterial brown spot
- damping-off
- fusarium foot and/or root rot
- grey mould
- *Rhizoctonia*
- rust
- white mould



Anthracnose (*Colletotrichum spp.*)

- Uncommon in Tasmania because of healthy seed.
- Brown-red coloured lesions develop on the pods and stems, often having small spore masses in the centre of the lesions.
- Small rot will usually develop on the lower stem near the soil.
- Spores are spread by water.
- See Figure 3.31.

Figure 3.31 Brown red lesions that may appear on pods (QLD/DPI)



Ascochyta (Ascochyta spp.)

- Small, round spots will appear on the leaf and pods.
- The round lesions will often have ‘growth rings’ around the lesion, giving a ‘target spot’ appearance.
- The infection areas will be brown with small black fruiting bodies in the centre of the lesions.
- See Figures 3.32 and 3.33.



Figure 3.32 *Ascochyta* pod lesions (QLD/DPI)



Figure 3.33 Lesions with distinct ‘growth rings’ (QLD/DPI)

Bacterial brown spot (*Pseudomonas syringae*)

- Caused by the naturally occurring bacteria *Pseudomonas syringae* entering via wounds on the plant and starting the infection.
- Small, red-brown, rounded lesions will appear on the leaves.
- The centre of the lesion dries and may cause small holes to appear and leaves can appear tattered.
- See Figures 3.34 and 3.35.



Figure 3.34 Small rounded lesions on leaves (QLD/DPI)



Figure 3.35 Bacterial brown spot on pods (QLD/DPI)



Figure 3.36 Typical symptoms of damping off (QLD/DPI)

Damping-off (*Pythium* or *Rhizoctonia* spp.)

- Poor seedling emergence.
- Young seedling will collapse or die.
- Small rot will usually develop on the lower stem near the soil.
- See Figure 3.36.

Fusarium foot and/or Root rot (*Fusarium solani*)

- The root system dies, the plant will turn yellow, remain small and die.
- The lower stem tissue becomes a distinct red-brown colour and will take on a streaky appearance.

Grey mould (*Botrytis cinera*)

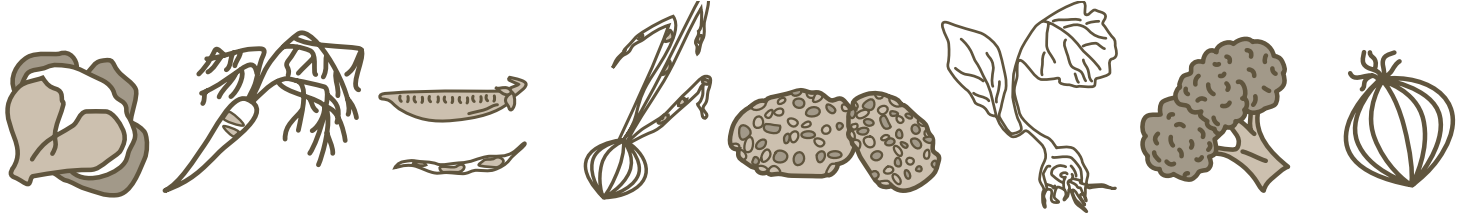
- Grey-brown mouse fur like fungus develops on pods, leaves and stems.
- Large, flat, black fruiting bodies (sclerotia) will develop within the mould and around the infected part of the plant.
- The sclerotia are about 0.2- 2 mm in diameter.



Figure 3.37 *Rhizoctonia* root and stem lesions (QLD/DPI)

Rhizoctonia (*Rhizoctonia* spp.)

- Ginger-brown lesions will appear on the stem just below ground level.
- See Figure 3.37.



Rust (*Uromyces spp.*)

- Small, light-brown spots usually on the underside leaves and sometimes on the pod and stem.
- The rust lesions are slightly raised from the leaf surface with a yellowing halo effect surrounding the infection sites.
- See Figures 3.38 and 3.39.



Figure 3.38 Disinct spotting on leaves (QLD/DPI)



Figure 3.39 Yellow halo effect



Figure 3.40 White cottony growth on pods and stems (QLD/DPI)

White mould (*Sclerotinia, sclerotium & S. minor*)

- Pods and stem become soaked in a watery liquid and will gradually rot.
- White, cottony mould will grow on leaves, stems and pods.
- Hard, black, mouse-dropping like, fruiting bodies or sclerotes will develop in the white mould.
- See Figures 3.40 and 3.41.

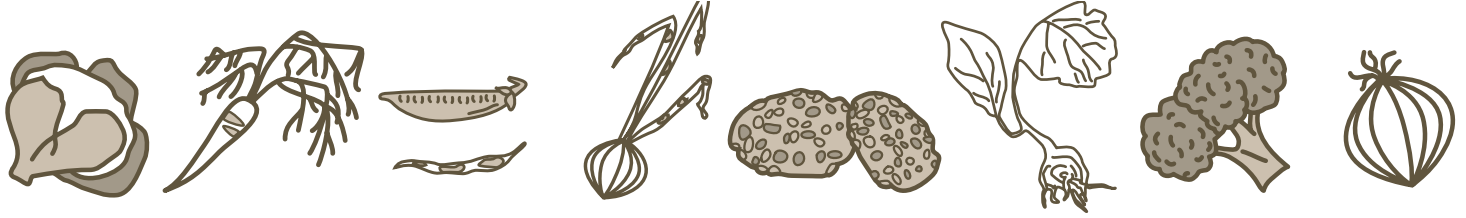


Figure 3.41 Fruiting bodies will develop on the fungi (QLD/DPI)



Management options for green bean diseases

Disease	Cultural/Mechanical	Chemical
Ascochyta	<ul style="list-style-type: none"> • Always purchase clean seed from a reliable source. • Good crop rotation practices. 	
Brown spot	<ul style="list-style-type: none"> • Use seed that is clean and disease free. • Plough in diseased plants immediately after harvest. • Minimise movement into and out of infected paddocks. • Avoid exposed paddocks to minimise crop damage from wind. 	<ul style="list-style-type: none"> • Copper sprays may assist with control.
Colletotrichum	<ul style="list-style-type: none"> • Use clean and disease free seed. • Good crop rotation practices. 	
Damping-off / pythium	<ul style="list-style-type: none"> • Avoid over watering. • Maintain good crop ventilation by reducing plant density and increasing row spacing. • Plant into raised beds and fumigate soil. • Clean all machinery before and after being in the infected area. 	<ul style="list-style-type: none"> • Treat seeds with registered fungicides prior to planting.
Fusarium root rot	<ul style="list-style-type: none"> • Plant into raised beds to improve soil drainage. • Good crop rotation practices. 	
Grey mould (<i>Botrytis</i>)	<ul style="list-style-type: none"> • Increase plant spacing to improve crop ventilation and reduce crop humidity. 	<ul style="list-style-type: none"> • Registered fungicides can be used. Limit application to reduce the risk of fungicide resistance.
Rhizoctonia	<ul style="list-style-type: none"> • Remove all infected plant residue after harvest. • Plant seeds in raised beds to encourage good root growth. 	<ul style="list-style-type: none"> • Treat seeds with registered fungicides.
Rust	<ul style="list-style-type: none"> • Plough in diseased plants following harvesting. • Good crop rotation practices. • Use resistant varieties if available. 	<ul style="list-style-type: none"> • Spray with registered fungicides.
White mould	<ul style="list-style-type: none"> • Increase plant spacing to improve crop ventilation and reduce crop humidity. • Keep crop healthy and vigorous. • Remove all decaying host plants and crop residue. • Do not plant immediately after another susceptible crop. 	<ul style="list-style-type: none"> • Registered fungicides can be used. Limit application to reduce the risk of fungicide resistance.



Diseases of green peas

Detailed descriptions on many of the diseases mentioned are located in the appendix section of the manual.

Crop growth stages (for peas and beans)



Germination to
five leaf

Early flowering to
pod set

Pod fill to
maturity

Figure 3.42 Growth stages of green pea crops.

The following diseases that affect green peas are discussed:

- ascochyta complex
- black root rot
- damping-off
- downy mildew
- fusarium rot
- fusarium wilt
- powdery mildew
- septoria

Ascochyta complex (*Ascochyta*)

- Round, dark coloured lesions, accompanied by thinning and blackening of lower stems to ground level and poor root development.
- 'Growth rings' may appear around the lesion ('target spot').
- Small, black, fruiting bodies producing spores may also appear in the centre of the lesions.
- Pod spot or rotting with pale tan flecking appearing on the tops of leaves and on pods.
- See Figure 3.42 and 3.43.



Figure 3.42 Round dark lesions caused by *Ascochyta* (QLD/DPI)



Figure 3.43 Pod rotting can be caused by *Ascochyta* complex (QLD/DPI)



Black root rot (*Aphanomyces*)

- Root system and the lower stem gradually turn light brown to a dark, brown-black colour and soften.
- The plant will lose vigour and wilt from the base up if it is restricted of moisture due to the disease.
- Symptoms are difficult to determine in healthy, vigorous plants that are well watered.
- Symptoms do not usually appear until the plant is well established.



Figure 3.44 Typical symptoms of damping off (QLD/DPI)

Damping-off (*Pythium* or *Rhizoctonia spp.*)

- Poor seedling emergence.
- Young seedling will collapse or die.
- Small rot will usually develop on the lower stem near the soil.
- See Figures 3.44 and 3.45.



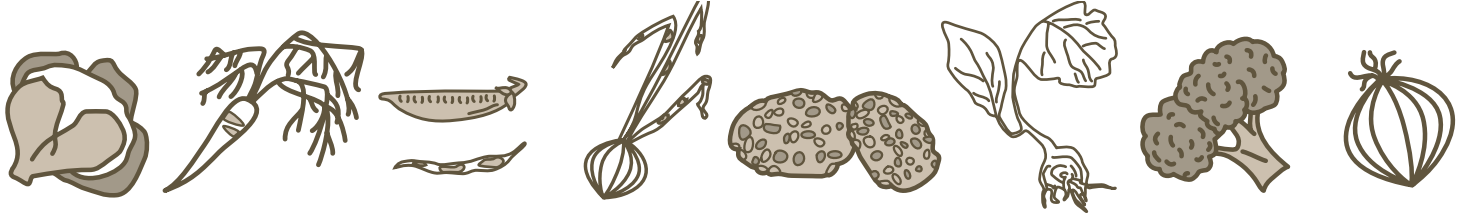
Figure 3.45 Typical symptoms of damping off (QLD/DPI)

Downy mildew (*Peronospora viciae*)

- Infection may appear on the entire plant or just the pods or leaves.
- Infection areas will usually appear as yellow or brown spots.
- A thick, greyish mould covering will also be present on the underside of leaves and on the pods.
- The plant will become stunted.
- See Figure 3.46.



Figure 3.46 Greyish mould covering leaves and pods (QLD/DPI)



Fusarium rot (*Fusarium solani*)

- Symptoms of root rot appear as red-brown discolouration, which cover the root and stem below the soil line.
- Plants become stunted and in warm conditions the foliage will often turn yellow and fall off.

Fusarium wilt (*Fusarium crysporum*)

- Yellowing and wilting, often on one side of the plant.
- May occur in patches.
- May be signs of red-brown streaks in the stems of affected plants.

Phoma root rot (*Ascochyta* complex)

- Brown-black rot of the stem at the stem/seed junction.

Powdery mildew (*Oidium spp.*)

- Infection will usually first appear on the leaves where a whitish powdery mould will develop.
- See Figure 3.49.



Figure 3.49 Whitish powdery substances cover the leaves and pods (QLD/DPI)

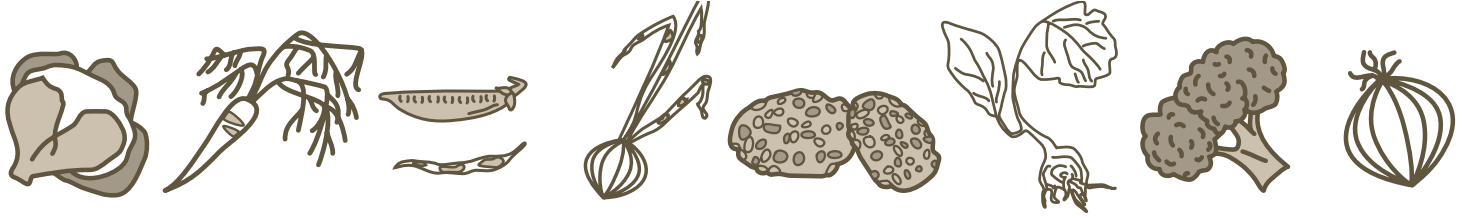
Septoria (*Septoria spp.*)

- Small, yellow flecks or spots appear on the lower leaves and will gradually increase in size and move up the plant.
- Spots will gradually darken to a brown colour, surrounded by a lighter, yellow, halo-like ring.
- Leaves may wilt and die if infection is severe.



Management options for green pea diseases

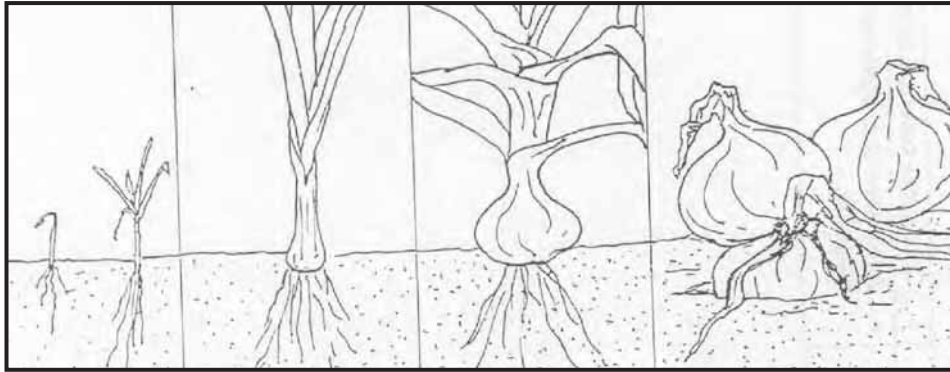
Disease	Cultural/Mechanical	Chemical
Aphano - myces root rot	<ul style="list-style-type: none"> • Use clean and disease free seed. • Improve crop ventilation by increasing row spacing or by planting the rows parallel to prevailing winds. • Avoid over watering. • Proper rotation and drainage is required as seed dressing is not always effective. • Avoid cold wet paddocks with a history of this disease. 	<ul style="list-style-type: none"> • Seed dressing is not always effective.
Ascochyta complex (collar, leaf, stem and pod rots)	<ul style="list-style-type: none"> • Clovers and lucerne can share some diseases with field and green peas, so green manure crops and legume pastures in rotation with peas should be used cautiously and the 3-4 year break observed where practical. • Soils that are over-cropped, compacted or prepared under wet conditions are at more risk of disease than well-prepared and structured soils. • Over and under watering, nutrition out of balance and weed competition increase plant susceptibility to <i>Ascochyta</i>. • Use clean seed. 	<ul style="list-style-type: none"> • Treatment of seed with a registered fungicide can prevent early infection and damage to stems at or near ground level. • Foliar applications of fungicides later in the season are rarely effective in managing leaf and pod spotting.
Damping-off	<ul style="list-style-type: none"> • Use clean and disease free seed. • Improve crop ventilation by increasing row spacing or by planting the rows parallel to prevailing winds. • Avoid over watering. • Encourage rapid growth by avoiding planting seed too deep. 	<ul style="list-style-type: none"> • Seed treatment with registered fungicides.
Fusarium /Pythium root rot	<ul style="list-style-type: none"> • Use disease free seed. • Rotate with non-susceptible crops. • Good soil drainage. • Incorporation of organic material (barley, straw) into the soil has been used to increase fungi and bacteria that are antagonistic to Fusarium. 	<ul style="list-style-type: none"> • Combination of fungicide seed dressings may provide early protection from infection.
Fusarium wilt	<ul style="list-style-type: none"> • Use healthy clean seed. • Soil solarisation during the summer has been shown to reduce disease incidence. • Avoid planting in known infected paddocks. 	
Powdery mildew	<ul style="list-style-type: none"> • Use resistant varieties if available. • Avoid planting when the days are warm and dry, and when nights are cool and moist. • Remove crop debris and volunteer plants after harvest. • Yield will be affected if mildew is visible at the flowering stage. 	<ul style="list-style-type: none"> • Spray recommended and registered fungicides. • Apply when the disease first appears. • Good spray coverage is essential.
Septoria	<ul style="list-style-type: none"> • Use disease free seed. • Use a minimum 2-3 year crop rotation. 	<ul style="list-style-type: none"> • Application of a registered copper fungicide.



Diseases of onions

Detailed descriptions on many of the diseases mentioned are located in the appendix section of the manual.

Crop growth stages



Germination
to three leaf

Four to seven
true leaf

Bulbing

Top senescence
to storage

Figure 3.50 Growth stages of onions.

The following diseases that affect onions are discussed:

- aspergillus black mould
- bacterial soft rot
- black leaf mould
- bloat nematode
- botrytis neck/bulb rot
- damping-off
- downy mildew
- fusarium rot
- onion white rot
- penicillium blue mould
- root-knot nematode

Aspergillus black mould (*Aspergillus niger*)

- Superficial, black, powdery mould that looks like soot will appear on the outer scales.
- Can be seed borne.
- Infection occurs in the field and develops in store.
- Normally not a significant problem.
- See Figure 3.51.



Figure 3.51 Black sooty mould from *Aspergillus* (DPIWE)



Figure 3.51 Field symptoms
- rotting of stem (DPIWE)

Bacterial soft rot (*Pseudomonas spp.* & *Erwinia spp.*)

- The bulb will rapidly rot, releasing a foul smell.
- The flesh will become soft and slimy.
- Occurs in the paddock and in storage.
- See Figures 3.51 and 3.52.



Figure 3.52 Storage symptoms
- rotting of bulb (DPIWE)



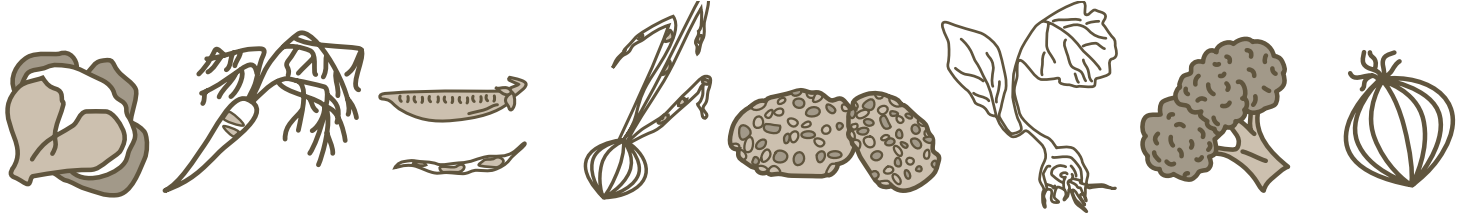
Figure 3.53 Distinct dark smutty
mould (DPIWE)

Black leaf mould (*Stemphylium botryosum*)

- Leaves yellow and shrivel causing the plant to wilt.
- Yellow tips become blackened with a dark smutty mould.
- See Figure 3.53.



Figure 3.54 Knotting and
curling of stem leaves (DPIWE)



Bloat nematode (*Ditylenchus dipsaci*)

- The stem will swell (bloating) and eventually rot.
- The bulb may appear to split.
- Scale tissue becomes dry and mealy.
- See Figures 3.54 (previous page), 3.55 and 3.56.



Figure 3.55 Microscopic slide of soil nematode (magnified) (DPIWE)



Figure 3.56 Splitting and swelling of the bulb (DPIWE)

Botrytis neck / Bulb rot (*Botrytis spp.*)

- Infects leaves of growing plant during the season and usually remains symptomless until bulbs reach storage.
- Bulb infection starts at the neck and spreads.
- Tissue rots, becoming soft and wet.
- Grey mould may also develop on the bulb.
- Small black 'poppy seed like' sclerotes may be present.
- See Figures 3.57 and 3.58.



Figure 3.57 Botrytis on bulb (DPIWE)



Figure 3.58 Advanced symptoms - bulb rots and sclerotes can be seen (DPIWE)



Damping-off (*Pythium* or *Rhizoctonia spp.*)

- Seeds will not germinate (pre-emergent damage).
- Young seedlings may discolour and rot near the base.
- Seedlings may collapse (post-emergent damage).
- See Figure 3.59.

Figure 3.59 Seedling discolouration and root damage(QLD/DPI)



Downy mildew (*Peronospora destructor*)

- Damage occurs on the older leaves at first.
- Pale, green-yellow spots develop on the infected plant, eventually becoming grey-purple and fuzzy as the disease develops.
- Leaves will wither from the top, fall over and die.
- See Figures 3.60 and 3.61.

Figure 3.60 Collapsing of foliage (DPIWE)



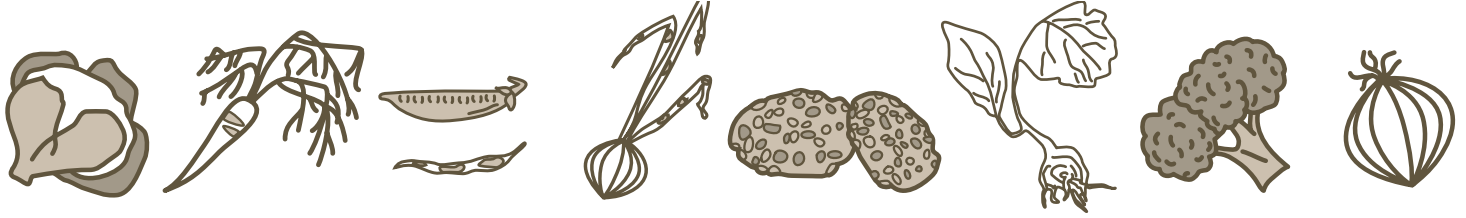
Figure 3.61 Pale green spots on onion stems (DPIWE)



Fusarium rot (*Fusarium spp.*)

- Profuse white-pink mould on base plate of affected onions, usually associated with mechanical damage.
- See Figure 3.62.

Figure 3.62 Infection on the base plate of onion(DPIWE)



Onion white rot (*Sclerotium cepivorum*)

- Plants are stunted and distorted.
- Leaves wilt and collapse, turn yellow and roots will rot.
- White, cottony mass with small black 'poppy seed like' granules (sclerotia) will also appear on the base of the bulb.
- Bulbs easily pulled from the soil because of weak and small roots.
- See Figure 3.63.



Figure 3.63 Small black 'poppy seed like' sclerotia on base of bulb

Penicillium blue mould (*Penicillium spp.*)

- Green to grey-blue coloured dusty mould will appear on the outer scales.
- Not generally associated with bulb breakdown.
- Infection occurs in the field and is common on bulbs windrowed under humid conditions or in close contact with moist soil.
- Develops in storage when humidity is greater than 85% and temperatures are between 20-25° C.
- See Figure 3.64.

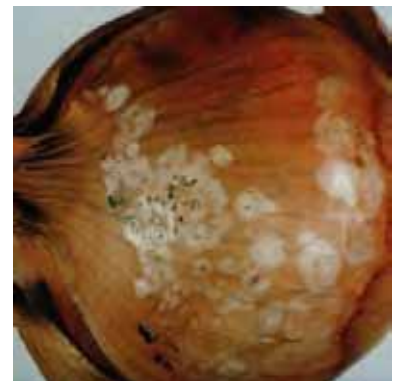


Figure 3.64 Grey-blue dusty mould on the onion bulb (DPIWE)

Root-knot nematode (*Meloidogyne spp.*)

- Roots become beaded and knotted.
- Uneven emergence with seedlings becoming stunted.
- Wilting and death may occur.
- See Figure 3.65.

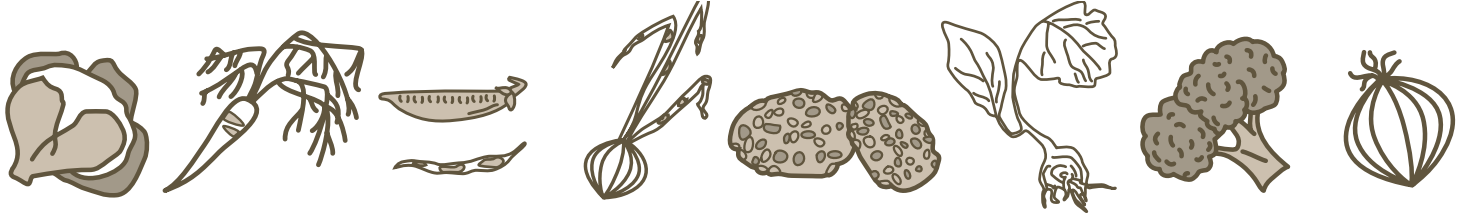


Figure 3.65 Typical symptoms of root-knot nematode (DPIWE)



Management options for onion diseases

Disease	Cultural/Mechanical	Chemical
Aspergillus	<ul style="list-style-type: none"> • Use clean, disease free seed. • Crop rotation. 	
Bacterial soft rot	<ul style="list-style-type: none"> • Improve crop ventilation by increasing plant spacing and row configuration. • Reduce overhead irrigation. • Remove host weeds. • Avoid injury and damage to the crop (eg. mechanical - tractor, hail and herbicide) 	
Bloat nematode	<ul style="list-style-type: none"> • Minimum crop rotation of 3 years. • Plant non-susceptible crops in rotation. • Avoid areas known to be infested. 	<ul style="list-style-type: none"> • Nematicide can be applied before sowing crop.
Botrytis neck rot	<ul style="list-style-type: none"> • Use seed tested to be free of Botrytis. • Control volunteer onions from previous crops. • Destroy cull piles of onions. • Avoid over fertilising with nitrogen. • Promote rapid curing after lifting or use artificial curing. • Minimum rotation of at least 3 years. 	<ul style="list-style-type: none"> • Treat seeds with registered fungicide.
Damping-off	<ul style="list-style-type: none"> • Wash and clean farm machinery. • Plant in raised seedbeds to improve soil drainage. 	<ul style="list-style-type: none"> • Treat seeds with a recommended fungicide.
Downy mildew	<ul style="list-style-type: none"> • Minimum of 3-4 year crop rotation. • Reduce humidity level in crop by reducing overhead irrigation and increasing plant spacing. • Increase crop ventilation by planting beds parallel to prevailing winds. • Reduce overhead irrigation. • Avoid irrigating in evenings and overnight. • Remove host weeds. 	<ul style="list-style-type: none"> • When conditions are favourable for disease infection, apply protective fungicides before symptoms show. • Fungicides should be applied from the earliest stage of infection.
Fusarium rot	<ul style="list-style-type: none"> • Not a significant problem. Occurs as a secondary invader of damaged tissue. • Minimise insect attack and mechanical damage, especially base plate damage following lifting. 	
Onion white rot	<ul style="list-style-type: none"> • Delay sowing until August/September in ground that has previously been infected. • Avoid planting in areas known to be infected. 	<ul style="list-style-type: none"> • Seeds can be dressed with fungicide in infested areas (follow label recommendations).
Penicillium	<ul style="list-style-type: none"> • Good ventilation and airflow in storage prevent spore formation and spread. 	
Root-knot nematode	<ul style="list-style-type: none"> • Rarely causes economic loss. • No control is recommended. 	
Stem-phyllium	<ul style="list-style-type: none"> • Occurs as a secondary invader of injured tissue caused by downy mildew, frost, wind and herbicide damage. • Control through treatment of the primary cause by controlling downy mildew and avoiding herbicide burn. 	



Diseases of potatoes

Detailed descriptions on many of the diseases mentioned are located in the appendix section of the manual.

Crop growth stages

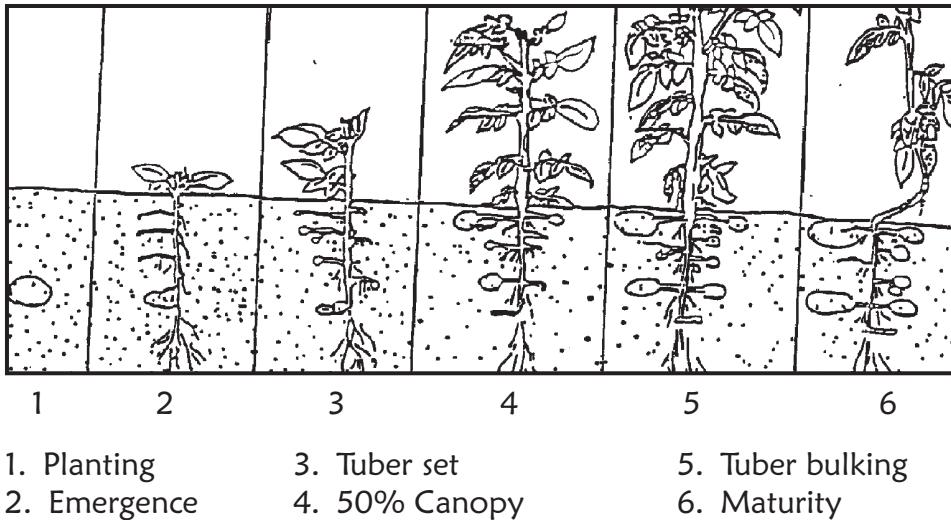


Figure 3.66 Growth stages of potatoes.

The following diseases that affect potatoes are discussed:

- bacterial decay/set decay
- bacterial rot
- black leg
- common scab
- fusarium/phoma
- Irish blight/late blight
- pink rot
- powdery scab
- rhizoctonia
- target spot/early blight
- verticillium

Important potato viruses also discussed:

- potato leaf roll virus
- potato virus S
- potato virus X
- potato virus Y

Bacterial decay/set decay

- Tuber breakdown, with wet rot secreting an unpleasant odour.
- Set decay is usually wet and squishy, not dry.
- See Figure 3.67.



Figure 3.67 Symptoms of bacterial decay (©Denis Crawford – Graphic Science)



Figure 3.68 Bacterial rot
(©Denis Crawford – Graphic Science)

Bacterial rot

- Decaying set, with damping off of shoots and roots if sets planted in cold, wet conditions.
- See Figure 3.68.



Figure 3.69 Blackleg (©Denis Crawford – Graphic Science)

Black leg (*Erwinia spp.*)

- Skins turn black in colour and wilting may occur.
- Mature leaves cure and become brown and dry on the edge.
- Tubers may rot with small black circular lesions appearing.
- Infection is favoured by wet conditions.
- See Figure 3.69.



Figure 3.70 Common scab causes lesions on the tuber (DPIWE)

Common scab (*Streptomyces spp.*)

- Small, reddish-brown lesions appear on the young tubers.
- As the infection develops, lesions may change to one of the following forms:
 - superficial 5 mm circular rusty coloured lesions
 - brown, star shaped crater like lesions (5-15 mm)
 - larger raised lesions (1-2 mm)
 - deep, pitted lesions.

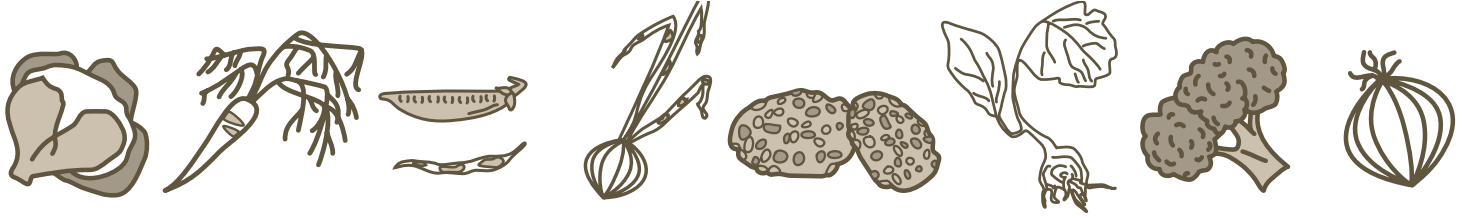


Figure 3.71 Dry rot and lesions on tuber (©Denis Crawford – Graphic Science)

- Early detection may occur in lenticels (breathing pores) of tubers.
- See Figure 3.70.

Fusarium/Phoma

- Tuber breakdown, with dry rot and thumbprint lesions appearing on the tuber.
- See Figure 3.71.



Irish blight/Late blight (*Phytophthora infestans*)

- Small, circular or irregular shaped water soaked lesions appear on the tips of the lower leaves.
- Lesions gradually enlarge (3-5 mm) and become brown.
- Leaves become furry on the underside when humid.
- Following wet conditions, white cottony growth (mycelium) may appear around the lesions.
- Infected tubers will have darkened blotches. When cut open, the infected areas appear dark and extend deep onto the fleshy part of the tuber.
- See Figure 3.72.



Figure 3.72 Blight symptoms on leaves (©Denis Crawford – Graphic Science)

Pink rot (*Phytophthora erythroseptica*)

- The stem may show signs of soft watery rotting near the soil line.
- The plant may then wilt and eventually die.
- The tubers become light-brown and creamy inside and leak water when squeezed.
- Tuber lenticels (breathing pores) turn black.
- See Figures 3.73, 3.74 and 3.75.



Figure 3.73



Figure 3.74



Figure 3.75

Figures 3.73 - 3.75 Tuber symptoms of pink rot (DPIWE)



Figure 3.76 Wart like lesions on tuber surface (DPIWE)

Powdery scab (*Spongospora subterranea*)

- Small, light coloured galls about 1-10 mm long appear on the roots.
- Infected tubers have light coloured pimples or warts (1-10 mm in diameter), that erupt through the skin.
- Warts become powdery and brown when exposed to air.
- See Figure 3.76.



Figure 3.77 *Rhizoctonia* can be on stems and roots (DPIWE)

Rhizoctonia

- Ginger-brown lesions on stems and roots with the set usually remaining firm.
- See Figure 3.77.



Figure 3.78 Target spot (©Denis Crawford – Graphic Science)

Target spot/Early blight (*Alternaria solani*)

- Symptoms don't develop until foliage matures or the plant is under stress.
- Small, dark-brown to black concentric, ring-like lesions appear on leaves.
- Leaves surrounding the lesions may appear to be yellow and withered.
- See Figure 3.78.

Verticillium

- Common symptom is 'early dying' or early senescence of the crop.
- Tops wilt and yellow. Lower stems and tubers can have light brown internal ring.
- Early dying often worse where verticillium and the nematode *Pratylenchus spp* occur together.

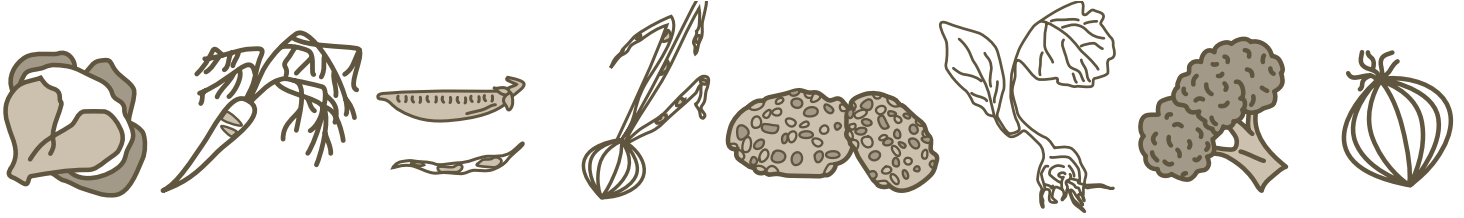


Figure 3.79 PLRV causes the leaves to roll inwards. The plant becomes stunted and eventually dies.

Important potato viruses

Potato leaf roll virus (PLRV)

- PLRV is spread by aphids and carried in infected tubers.
- Current season infection starts when the aphids infect the plant causing yellowing and upward curling of young leaves towards the top of the plant.
- On plants grown from seed tubers infected with leafroll virus, the lower leaves of the plant roll up, turn pale and become dry and leathery.
- Plants become stunted with leaf yellowing, with older leaves wilting and dying.
- See Figure 3.79.

Potato virus S

- The virus is carried in tubers and is transmitted mechanically on machinery and seed-cutting equipment.
- Some strains are also transmitted inefficiently by some aphid species.
- Infected plants are usually symptomless with slight reduction in yield.

Potato Virus X (PVX)

- The virus is carried in tubers and is transmitted mechanically on machinery and seed cutting equipment.
- PVX can be symptomless with loss of yield the only indication of its presence although plants can appear stunted.
- When visible symptoms are present, they take the form of leaf mottling with small, light-green spots appearing over the leaf surface.

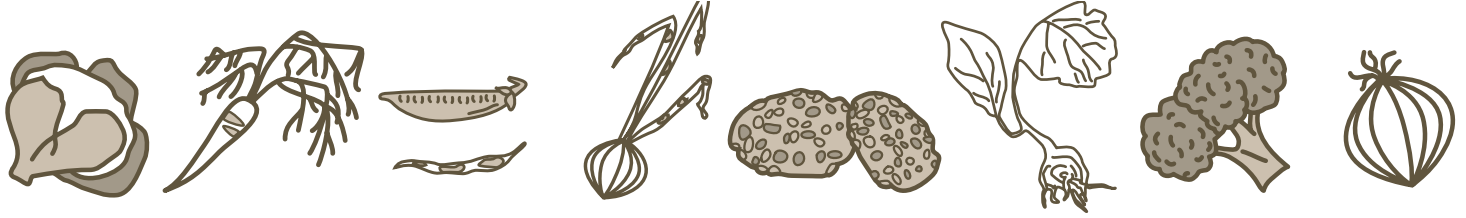
Potato virus Y

- One of the most severe of the potato viruses with two distinct symptoms developing.
- Plants may show signs of mosaic mottling with some areas yellow and light-green and some areas darker than normal.
- Vein banding develops when dark bands along the main vein lines appear on the underside of the leaves. Lower, older leaves will often die and fall off.
- Some strains produce necrotic ring spots on the tubers.
- Relatively uncommon in Australia.



Management options for potato diseases

Disease	Cultural/Mechanical	Chemical
Bacterial decay	<ul style="list-style-type: none"> • Don't plant decaying sets as they will not grow. • Separate contaminated seed lines from healthy seed lines. • Wash knives and all machinery after handling operations. 	
Black dot	<ul style="list-style-type: none"> • Minimum 3 year crop rotation or longer if previous potato crops have shown signs of the fungus. • Remove potato regrowth. • Harvest once skins have hardened. • Use good quality, clean seed. 	<ul style="list-style-type: none"> • Apply a registered in-furrow fungicide at planting.
Black leg	<ul style="list-style-type: none"> • Use certified, clean, disease free seed. • Don't store tubers with wet skins. • Avoid cutting infected seed as this will greatly multiply the level of infection. • Avoid planting into wet and water logged soil as this will promote the development of the infection. • Remove any infected tubers during or immediately after harvesting to reduce spread during storage. • All harvesting, storing and handling equipment needs to be clean to reduce spread. • Provide good soil drainage and reduce over watering to prevent water logging. • Use good harvesting hygiene in the paddock and in the shed. 	
Black scurf/ Rhizoctonia	<ul style="list-style-type: none"> • Always use clean disease free certified seed. • Minimum 3 year cropping rotation (5 years for seed). • Try not to plant in wet, cold conditions. • Plant the sets shallow to accelerate emergence (or plant deeper and scrape the top off the hill prior to emergence). 	<ul style="list-style-type: none"> • Tubers can be treated with registered fungicides or an in-furrow treatment of a registered fungicide can be applied at planting time.
Common scab	<ul style="list-style-type: none"> • Follow a minimum three-year cropping rotation (5 year for seed crop). • Always use good quality certified seed. • Avoid planting paddocks with a history of common scab. • Avoid adding high levels of organic matter to the soil close to planting time. • Monitor soil moisture to ensure accurate irrigation timing. • Use minimal tillage to reduce soil disturbance. • Apply sufficient irrigation as soon as tubers start to develop. Dig up plants to judge the correct time to commence irrigation. • Do not plant too early into a wet cold seed bed. 	<ul style="list-style-type: none"> • If risk of common scab is high, a range of seed treatments are available.



Management options for potato diseases

Disease	Cultural/Mechanical	Chemical
Fusarium and Phoma	<ul style="list-style-type: none"> • Avoid tuber damage. • Provide adequate conditions for suberisation before cooling for storage. 	<ul style="list-style-type: none"> • Apply registered fungicides on clean seed tubers immediately prior to storage.
Fusarium	<ul style="list-style-type: none"> • Always use clean, disease free, certified seed. • Avoid planting paddocks with a history of vascular wilts. • Minimise tuber damage during harvest and grading operations to minimise wound sites for infection. 	<ul style="list-style-type: none"> • Treat tubers immediately following harvest with a registered fungicide.
Irish/late blight	<ul style="list-style-type: none"> • Monitor the crop and environmental conditions. • Conditions become favourable for disease initiation when temperatures are between 15-20°C, and humidity is >90% for 48 hours. This usually occurs mid to late summer when mornings are humid and warm. • Plant the crop at a wide spacing to reduce crop density and therefore lower canopy humidity. • Orientate rows to enhance airflow through canopy for as long as possible. 	<ul style="list-style-type: none"> • Apply a regular preventative registered fungicide throughout the season. If the symptoms appear, apply a registered curative - need to act early. • Optimise spray coverage (jets, pressure, etc) to penetrate canopy.
Pink rot	<ul style="list-style-type: none"> • Minimum 3 year crop rotation program (5 years for seed). • Provide good soil drainage and reduce over watering. • Remove any sign of volunteer potato plants. • Harvest infected areas last to reduce possible spread. • Diseased potatoes should be stored and dried off quickly and separately from clean plants. • Avoid planting drainage areas or low lying areas in the paddock and in known infected areas. 	<ul style="list-style-type: none"> • Registered fungicide treatments can be applied. They are most effective when applied to the foliage or on the soil in the early growth stages of the crop.
Powdery scab	<ul style="list-style-type: none"> • Always use certified seed. • Plant in soils that are scab free or use a variety that is resistant to scab. • Monitor crops once tubers have developed and look for galling on roots and wart like growths on the skin. • Soil liming can increase powdery scab infection. • Monitor soil moisture and apply water according to soil moisture levels. • Avoid over watering and heavy water applications. • Use lighter applications of irrigation water after tuber development. 	



Management options for potato diseases

Disease	Cultural/Mechanical	Chemical
Rhizoctonia	<ul style="list-style-type: none"> • Follow a three year crop rotation program (5 year for seed). • Use good quality, disease free, certified seed stock. • Ensure the crop is not stressed for water or nutrients. • Avoid planting immediately after ground preparation. 	
Target spot/ early blight	<ul style="list-style-type: none"> • Reduce crop stress by applying adequate fertiliser and water. • Monitor the leaves for signs of infection and to accurately apply fungicides. • Test nutrient levels (use sap or dry ash tests) to ensure adequate nutrient supply. • Tuber skins should be properly set prior to harvest. • Do not use the disease as a management tool to terminate crops as the inoculum will spread to later maturing crops. 	<ul style="list-style-type: none"> • Monitor the crop carefully and regularly for signs of the disease and apply registered fungicides once infection has been detected. • Fungicides need to be applied before the infection becomes extensive throughout the crop. • Apply before canopy closure to protect all foliage.
Verticillium	<ul style="list-style-type: none"> • Rotation, although the fungus can persist for many years. • Control solanaceous weeds such as nightshade which are hosts. • Use certified seed potatoes. • Grow less susceptible varieties 	<ul style="list-style-type: none"> • Fumigation of soil.
Viruses	<ul style="list-style-type: none"> • Plant only certified seed. • Control weeds especially solanaceous weeds and volunteer potatoes. • Avoid overlapping crops and rotate (3-5 years) • Destroy cull piles. • Rogue infected plants. • Date of planting may be manipulated to avoid peak vector activity. • Inspect crop for insect vectors. • For viruses which are borne non-persistently by aphids, eg PVY and PVS, planting border crops that are not hosts for the virus can reduce virus spread into the crop. Aphids land in the border crop and lose virus as they feed. 	<ul style="list-style-type: none"> • Insecticides for vector control.