Disease Identification and Control

Disease management strategy

Disease management in pulses is critical, and relies on an integrated management approach involving variety choice, crop hygiene and fungicide management. The initial source of the disease can be from the seed, the soil, the pulse stubble and self sown seedlings, or in some cases, other plant species (see Pages 7 : 31 and 7 : 32). Once the disease is present, the source is then from within the crop itself.

Determine which diseases are the highest priorities to control in the pulse crop being grown, and sow a variety that is resistant to those diseases if possible. Paddock selection and strategic fungicide use are also part of the overall program to minimize disease impact. Fungicide disease control strategies alone may not be economic in high risk situations, particularly if susceptible varieties are grown.

- **Variety selection:** Growing a resistant variety reduces the need for foliar fungicides *(See Chapter 2)*.
- **Distance** from any of last year's stubble of the pulse will affect the amount of infection for some diseases. Aim for a separation of at least 500m.
- **Paddock history and rotation:** Aim for a break of at least 4 years between the same pulse crop. Having a high frequency of crops like lentils, faba beans, vetch, field peas, chickpeas, lathyrus or clover pasture puts pulses at greater risk to diseases such as phoma, sclerotinia or botrytis grey mould. Ascochyta blight species are more specific to each pulse crop. Canola can also increase the sclerotinia risk *(See Table 7 : C)*.
- **Hygiene:** Take all necessary precautions to prevent the spread of disease. Reduce last years pulse stubble and self sown pulses before the new crop emerges *(See Table 7 : B)*.
- **Seed source:** Use seed from crops where there were low levels of disease, especially at podding. For bacterial blight use seed where this disease was not detected. Avoid using seed with known disease infection, particularly with susceptible varieties *(See page 3 : 1)*.
- **Fungicide seed dressing** are partially effective early in high disease risk situations, particularly for diseases like botrytis grey mould, phoma or ascochyta. They are ineffective on viruses and bacterial diseases *(See page 7 : 34)*.
- **Sowing date:** To minimize foliar disease risk do not sow too early, and so avoid excessive vegetative growth and early canopy closure. Early crop emergence also coincides with greater innoculum pressure from old crop residues nearby. Aim for the optimum sowing window for the pulse and the district *(See Pages 3 : 8 to 3 : 11)*.
- **Sowing rate:** Aim for the optimum plant population (depending on region, sowing time, crop type, variety), as denser canopies can lead to greater disease incidence. Adjust seeding rate according to seed size and germination *(See Pages 3 : 13 to 3 : 16)*.
- **Sowing depth:** If using a variety with known seed infection, sowing deeper than normal may reduce the emergence of infected seedlings.
- **Foliar fungicide applications:** Disease resistant varieties do not require the same regular foliar fungicide program that susceptible varieties need to control foliar diseases. Some pulses may require fungicide treatment for botrytis grey mould if a dense canopy exists. Border fungicide protection may be needed if close to last year's pulse stubble. Successful disease control with fungicides is dependent on timeliness of spraying, the weather conditions that follow, and the susceptibility of the variety grown. Monitoring, for early detection and correct disease identification is essential. Correct fungicide choice is also critical.
- **Mechanical damage** due to excessive traffic, wind erosion, frost, hail, post-emergent rolling or herbicide damage can lead to the increased spread of foliar disease in pulses, particularly bacterial blight in peas.
- **Controlling aphids** may reduce the spread of viruses, but not eliminate them. Protective insecticide treatments are unlikely to be successful if applied strategically, or economic if applied regularly. Usually the virus spread has occurred by the time the aphids are detected *(See Chapter 6)*.
- **Harvest management:** Early harvest will reduce disease infection of seed, and is also important for grain quality and to minimise harvest losses. Crop desiccation enables even earlier harvest. Moisture contents of up to 14% are allowable at delivery. Do not prematurely desiccate as this can affect grain quality *(See Chapter 9)*.

Chickpea Diseases

GREY MOULD

Botrytis cinerea

Symptoms *(See Plates 7 : 1, 7 : 1A)*

Chickpea plants may be attacked at any stage of growth.

The most damaging form of the disease is at the base of the stem and in the collar region. The affected areas develop a soft rot and become covered with a fluffy grey mould. As the disease progresses infected plants wither and die. Infected seeds are white and chalky.

Sclerotes may form on the surface of the affected tissue when the plants dies.

In older plants only a few branches on the plant may be affected while the rest of the plant appears quite normal.

Infestation from seed can lead to damping-off root rot, and thinning of plants throughout the crop but not in patches.

Late season infection associated with heavy spring rain will result in fluffy grey mould on pods and severe pod abortion.

Economic Importance

Grey mould is a serious disease of chickpeas in southern Australia and can cause total crop failure.

Discolored seed may be rejected or heavily discounted when offered for sale. If seed infection levels are higher than 5% then it may be worth grading the seed.

Crop losses are worst in wet seasons, particularly when crops develop very dense canopies.

Disease Cycle

The fungus survives in infected seed, on decaying plant debris and in the soil. The disease is often established by sowing infected seed. Masses of spores are produced on infected plants, these become airborne spreading the disease rapidly.

Once a crop becomes established, the warm, humid conditions under the crop canopy provide ideal conditions for infection and spread of disease.

Control

The disease is best controlled by using disease-free seed. Lower seeding rates and wider row spacings may reduce disease severity because the more open crops dry out quicker following moist conditions. Fungicide seed treatments will control seed-borne infection.

PHYTOPHTHORA ROOT ROT

Phytophthora medicaginis

Symptoms *(See Plate 7 : 2)*

Infected plants are usually in distinct patches corresponding to the most poorly drained parts of the paddock. Leaves turn yellow and die off, starting from the bottom. Plants have few side roots and the lower portion of the tap root is often decayed. The remaining taproot is usually discolored dark brown to black. Sometimes the discoloration can extend to the base of the plant. The advancing margins may also have a reddish-brown discoloration.

The disease affects plants at all growth stages. It usually appears after a period of heavy rainfall. Plants may recover if the soil dries out.

Badly affected seedlings suddenly wither and die with no obvious disease symptoms above ground. *(See Plate 7 : 3)*

Economic Importance

Phytophthora root rot is a serious disease of chickpeas in southern Queensland and northern NSW. *(See Plate 7 : 4)* It is a potential problem in areas with lucerne, medics or heavy textured soils.

The disease appears to be widespread and poses a potential threat to chickpea production in other areas.

Disease Cycle

The fungus survives in soil and on plant roots and multiplies in the roots of other hosts, in particular, lucerne and medics.

In wet soils, spores of the fungus are released and attack the developing roots of susceptible plants. If soils remain wet the disease rapidly spreads to other plants.

Control

It is important to avoid soils prone to waterlogging and land with a history of root-rot in chickpeas, lucerne or medics.

Losses can be minimised by growing resistant varieties such as Barwon and Norwin.

The severity of the disease can sometimes be reduced by fungicidal seed treatment where conditions do not favor a disease increase after the seedling stage.*(See Page 7 : 34)*

Chickpea Diseases

SCLEROTINIA

Sclerotinia sclerotiorum, S.minor & S. trifoliorum

Symptoms *(See Plate 7 : 4A)*

Sclerotinia appears mainly on older plants. At first water-soaked patches (lesions) appear on the stems and leaves and later affected areas develop a soft, slimy rot which exude droplets of brown liquid. The infected tissues dry out and become covered with a fine white web of fungus growth. Small black spots, irregular in size and shape may sometimes be seen just below the surface, mingled with the white fungus growth.

Later on, stem lesions turn grey, the white growth disappears and the branch above the lesion dies. Affected plants wilt and die rapidly, without losing their leaves.

A late infection can affect the pod and seeds. Infected seeds are smaller than normal and discolored.

Economic Importance

Sclerotinia can cause severe damage in chickpeas. This has occurred in Kabuli chickpeas in Victoria.

Disease Cycle

The fungus may be present in the soil or may be introduced with contaminated seed.

The fungus in the soil may invade the plant directly or may produce air-borne spores which attack the above ground parts of the plant. Cool, wet conditions are essential for the progress of the disease. Once established, the fungus can move rapidly to neighboring healthy, tissue. A few days after infection, plants start to wither and die. The fungus is carried over to the next year in the infected plants.

Control

The disease risk can be reduced by using disease-free seed. It is also important to avoid sowing chickpeas on areas where the disease is known to be present. If severe infection occurs, the area should be burnt and ploughed deeply to kill the fungus in the soil.

Crop rotation will reduce the risk of infection. Cereals, which are not a host, should be grown for several seasons before returning to chickpeas or other pulses or canola. Other hosts to sclerotinia are the oilseed crops e.g. canola, pulses and broadleaf weeds such as capeweed.

ASCOCHYTA BLIGHT

Ascochyta rabiei

Symptoms *(See Plates 7 : 64 to 7 : 67)*

Usually this disease becomes obvious around flowering and podding when patches of blighted plants appear throughout the paddock. However initial infection often occurs early in the season. The disease spreads during the winter and spring under cool, cloudy, wet weather from isolated plants to surrounding plants forming these blighted patches.

Initially ascochyta blight appears on the younger leaves as small water-soaked pale spots. These spots rapidly enlarge, under cool and wet conditions, joining with other spots on the leaves and blighting the leaves and buds. Small black spots (pycnidia) can be seen in the affected areas. In severe cases the entire plant dries up suddenly.

Elongated patches form on the stem and may circle the stem. The stem may die and break off. Regrowth may occur from below this point. Affected areas on the pods tend to be round, sunken, with pale centres and dark margins. The fungus can penetrate the pod and infect the seed.

When infected seeds are sown, the emerging seedlings will develop dark brown lesions at the base of the stem. Affected seedlings may collapse and die (damping-off).

Economic Importance

This disease is very serious as it has caused severe damage in chickpeas.

Disease Cycle

The fungus can survive in the soil, on infected seed and on crop residue to infect new crops.

Spores of the fungus produced on crop residue can be carried onto the new crop by wind. Infection can occur at any stage of plant growth, provided conditions are favorable. Moisture is essential for infection to occur.

During wet weather, the disease may spread further, when spores of the fungus are carried onto neighboring plants by wind and rainsplash.

Severe pod infection results in reduced seed set and infected seed.

Control

Growing resistant varieties *(Table 2 : A)* will greatly reduce the impact of this disease. Disease risk can be reduced by using clean seed and crop rotations. This disease is specific to chickpeas only.

Fungicidal seed dressing should control any seed-borne infection. Regular foliar fungicide applications *(Page 7 : 34)* are necessary in susceptible varieties.

Chickpea Diseases

PHOMA BLIGHT

Phoma medicaginis var pinodella

Symptoms

Foot rot is the most common symptom as plants can be infected on the stem below ground level. Infected plants are stressed and leaves turn reddish-purple. Lesions on the stems below soil level are black.

Early symptoms are small, dark tan colored, irregular flecks on leaves, stems and pods. As the flecks enlarge on the leaves the surrounding area yellows. At the same time tiny black fruiting bodies of the fungus develop inside the affected patch. Similar but elongated patches form on the stem. Affected areas on pods are sunken, with pale centres and dark margins.

The patches may also be covered with tiny spots. The fungus can penetrate the pod and infect the developing seeds. Leaves fall off badly infected plants.

Economic Importance

There have been many outbreaks of phoma blight in southern Australia. Severe infection results in stunting and reduced productivity.

Disease Cycle

The fungus can survive in soil, on infected seed and in crop residue to infect new crops.

Soil survival appears to be most important. Soil-borne fungi invade the roots and stem base of young plants, particularly under wet conditions.

Spores of the fungus produced on crop residue can be carried onto the new crop by wind. Infection can occur at any stage of plant growth, provided conditions are favorable. Moisture is essential for infection to occur.

During wet weather, the disease may spread further, when spores of the fungus are carried onto neighboring plants by wind and rainsplash.

Severe pod infection results in reduced seed set and infected seed.

Control

Crop rotation is the most important means of control. As phoma blight has a wide host range, the rotation must include non-host crops such as cereals.

Disease risk can be reduced by using clean seed to prevent disease build up.

Fungicidal seed dressing should control seed-borne infection.

ROOT ROTS, including damping off

Fusarium, Rhizoctonia and Pythium spp.

Symptoms

Affected seedlings gradually turn yellow and leaves droop. The plants usually don't collapse. The tap root may become quite brittle and when plants are pulled from the ground the lower portion of the root snaps off and remains in the soil. The upper portion of the tap root is dark, shows signs of rotting and may lack lateral roots. Distinct dark brown to black lesions may be visible on the tap root.

The leaves and stems of affected plants are usually straw colored, but in some cases may turn brown.

Older plants dry-off prematurely and are often seen scattered across a field.

In some cases, especially with kabulis, seeds may rot before they emerge.

Economic Importance

Root rot can occasionally be a serious disease especially when soils are wet for prolonged periods.

Disease Cycle

All the fungi responsible for root rot are soil dwellers. They can survive from crop to crop in the soil, either on infected plant debris or as resting spores.

In wet soils these fungi can invade plant roots and cause root rot. Wet conditions also encourage the spread of disease within a field. The reduced root development causes the plants to die when they are stressed.

Control

The disease can be reduced by crop rotation. As this disease may also affect other pulses, chickpeas should be sown in rotation with another non-legume crop. Chickpeas should not grown in areas subject to waterlogging.

Damping off in kabuli chickpeas can be controlled using fungicide seed treatment. *(See page 7 : 34)*

Chickpea Diseases

BACTERIAL BLIGHT

Pseudomonas andropogonis (synonym Burkholderia andropogonis)

Symptoms

The first signs are usually small water-soaked spots on leaves and sunken, elongated spots on the stems. In very damp conditions the affected areas may be covered with bacterial ooze or slime.

After one to three days the spots on the leaves develop into circular brown spots, the affected leaflets may look "scorched" and soon dry and drop off. The entire growing tip may be killed by blight.

The first spots on the stems become dry and water-soaked after several days, as the infection progresses the spots move up the stem, finally becoming dry and dead looking.

Infected pods have dark, circular spots, similar to those on the leaves.

Economic Importance

The disease is uncommon in Australia and is of minor economic importance. However, overseas the disease sometimes causes significant crop losses. Once established this disease could be difficult to eradicate as it can affect a wide range of plants, including faba beans, vetch and clover.

Disease Cycle

The disease is most likely to be carried over on infected seed and on plant residues. The bacteria infect plants during wet weather and then spread to other plants by rainsplash and wind-carried water droplets.

A combination of heavy rainfall and strong winds will encourage the development of the disease. The disease will not spread in dry conditions.

Control

Serious outbreaks of the disease may be prevented by using disease free seed and crop rotations.

ROOT LESION NEMATODE

Pratylenchus neglectus & P. thornei

Symptoms

Severely affected plants are stunted and may have some yellowing of their foliage, but often have no obvious foliar symptoms of disease. Diseased plants usually have shorter lateral roots and fewer root hairs.

Where many nematodes invade chickpea roots the affected tissues sometimes turn dark brown to black, giving alternating sections of healthy and discolored root tissue. Often discoloration may appear as brown or black stripes along the roots. In severe cases young roots die.

Microscopic examination of the root system is required to confirm the presence of the nematode.

Economic Importance

In susceptible varieties the yield losses have been up to 50% under heavy nematode numbers. Yield losses in the following wheat crop or pasture may also occur.

Nematode numbers appear to increase where chickpea crops are grown in rotation with wheat.

Disease Cycle

Nematodes are small worm-like organisms less than 1 mm in length and are able to move freely through moist soils and young root tissues. As the females move through plants they feed on the plant roots, causing lesions, and deposit eggs.

There may be several generations of nematodes within a growing season. Nematodes are likely to multiply under a range of host crops such as wheat and chickpeas. Barley is only moderately susceptible. Many grass weeds and legumes can also host the nematode.

The nematode survives over the summer months in dry soil and root residues to become active again when the winter rains start.

Control

Resistant varieties will reduce the impact of pratylenchus infection. Pratylenchus can be controlled by using resistant crops such as faba beans, peas or lupins in the rotation. *(Tables 1 : O and 1 : P)*.

Chickpea / wheat rotations should be avoided where root lesion nematodes numbers are high.

Chickpea Diseases

VIRUSES

Luteoviruses: bean leafroll luteovirus (BLRV), beet western yellows virus (BWYV) *and subterranean clover redleaf luteovirus (SCRLV)*
Shoot tip virus complex: *alfalfa mosaic virus* (AMV), *cucumber mosaic virus* (CMV), other less common viruses *(lettuce necrotic yellows virus, clover yellow vein virus)*

Symptoms *(See Plates 7 : 5 to 7 : 6)*

Luteoviruses

Luteoviruses will kill plants within 3 to 4 weeks of the symptoms showing. The diseased plants have a scattered distribution, usually occurring around the edges of a crop or in areas where plant numbers are low. *(See Plate 7 : 5)*

In desi varieties the leaves and stems become red or brown, whereas kabuli varieties turn yellow. In older plants which are podding, premature death may be the only obvious symptom.

A shallow cut with a knife at the base of the main stem, often reveals that the stem has turned brown, compared with a white or green color in healthy plants.

Shoot tip virus complex

The symptoms of AMV and some other viruses are similar to luteovirus but more pronounced on the shoot tops. The symptoms include a pale coloration, bunching with small leaves, tip death and the shoots are horizontal or even pointing downwards. *(See Plate 7:6)*

Symptoms of CMV include reddening of the leaves and stunted growth. Symptoms are often confused with nutritional deficiency or herbicide damage.

Economic Importance

Whilst viruses occur in all states, they are a major problem in chickpeas in northern NSW and southern Queensland where total crop failures have occasionally occurred.

The damage caused by the viruses varies greatly from season to season and depends on the prevalence of aphids. Studies in WA have found that CMV may reduce yield by up to 45%.

Disease Cycle

Aphids bring the viruses from other legumes, including the pulses and pasture legumes (lucerne, clover and medics) to the chickpea crops. Chickpea seed from infected crops may carry viruses CMV or AMV. Luteoviruses are not transmitted by seed.

Control

Seed may be tested for infection of those viruses that are seed transmitted. Damage can be reduced by following current recommendations on seeding rates and sowing times that produce good

establishment, high plant densities and early canopy formation. Retaining stubbles may also reduce the infection.

Avoid sowing chickpeas near lucerne stands.

There are some varieties with partial tolerance to these virus diseases. *(See Tables 2 : A and 2 : B)*

Faba Bean Diseases

CHOCOLATE SPOT

Botrytis fabae

Symptoms *(See Plates 7 : 7 to 7 : 12A)*

Spots, ranging from small leaf spots to complete blackening of the entire plant are symptoms of chocolate spot. Leaves are the main areas affected but under favorable conditions the disease may also affect stems, flowers and pods.

The disease usually occurs in two phases: first a "passive" phase where reddish-brown spots are "peppered" over the leaves and stem and then an "aggressive" phase, where tissue around the spots is rapidly killed leaving large, black or grey dead blotches on leaves.

Small, black sclerotia can sometimes be found inside the stems of badly diseased plants.

Economic Importance

Chocolate spot occurs in all areas where faba beans are grown. It is the major disease of faba beans in southern Australia. Losses range from minor to complete crop failure depending on the seriousness of infection, the time at which infection occurs and the amount of spring rainfall.

In unprotected crops the disease commonly reduces yields by 30 to 50 percent in a bad year, mainly by preventing pod set. *(See Plate 7 : 10)*

Seed from badly affected plants may have a reddish-brown stain which lowers its market value. *(See Plate 7 : G to 7 : H)*

Disease Cycle

The fungus can survive in crop debris, in infected seed, or on self-sown plants. In following years, the infection usually begins when spores on old bean trash are carried onto new crops by wind. These spores can be carried over long distances. Chocolate spot may also be introduced into new bean-growing districts by sowing infected seed.

Once the disease becomes established it rapidly spreads within the crop. It spreads most aggressively in warm, humid conditions particularly at flowering time.

Control

Varieties with resistance to the disease should be grown in areas where the likelihood of chocolate spot is high. *(See Page 2 : 6)*

The disease risk can be reduced by destroying all bean trash and self-sown plants before sowing, sowing disease-free seed and crop rotation. Delaying sowing also reduces the disease risk.

Fungicides can be used to control the disease *(See Page 7 : 34)*. To ensure that chocolate spot is controlled before it has a significant impact on the yield of the crop, the crop should be checked for disease every seven days while the temperature remains below 15°C. If the weather is mild with day temperatures between 15°C and 20°C and humidity over 70 percent in crop inspections should be made every three days.

Spraying to control chocolate spot could begin at early flowering as a protective spray that is able to penetrate the canopy. Follow up sprays will be necessary where

- chocolate spot lesions are visible within the upper canopy or
- relative humidity in the crop is likely to remain high for at least a week or
- disease is increasing.

(See Table 7 : A Page 7 : 31)

Faba Bean Diseases

ASCOCHYTA BLIGHT

Ascochyta fabae

Symptoms *(See Plates 7 : 13 to 7 : 20)*

Ascochyta blight starts as grey spots. These show through both sides of leaves whereas young chocolate spot lesions do not show through at first. *(See Plate 7 : 14)* Ascochyta spots become irregularly shaped, and may merge to cover most of the leaf surface. *(See Plate 7 : 15)*

Leaf tissue next to the affected patches may become black and die off. Many tiny black fruiting bodies develop within the patches as the disease progresses. The pale centres may fall out, leaving holes in leaves. *(See Plate 7 : 16)*

Patches on the stem tend to be elongated, sunken and darker than leaf lesions and usually covered with scattered fruiting bodies. The stems may split and break at the point of infection causing plants to lodge. *(See Plates 7 : 17, 7 : 18)*

On pods, the infected patches are black and sunken. *(See Plate 7:19)* Well developed patches can penetrate the pod and infect the developing seeds. Infected seeds may be smaller than normal and discolored. Badly infected seeds can have brown or black stains. *(See Plate 7 : 20)*

Economic Importance

The disease is widespread in southern Australia but the severity of the disease varies a great deal from crop to crop and between season. Yield losses of up to 80 percent may occur.

Discolored grains may be rejected or discounted.

Disease Cycle

The ascochyta fungus can survive on crop debris, self-sown plants and on infected seed. During wet weather the disease spreads from infected to healthy plants by rainsplash and windborne water droplets.

Infection can occur at any stage of plant growth following either rain or heavy dew. The disease tends to be most severe early in the season and in wet years.

Control

Growing resistant varieties will reduce the risk of severe disease infestations and the staining of seed. *(See Table 2 : D)* Ascochyta can be controlled by sowing disease-free seed, by crop rotation, by controlling self-sown beans in rotations and by sowing crops away from infected bean trash.

Chemical seed treatments reduce the risk of introducing disease from infected seed. *(See Page 7 : 34)*

Foliar sprays with fungicide *(See Page 7 : 34)* are likely to be economic for susceptible varieties. Fungicides should be applied at about 6 weeks to reduce lodging losses from stem infections. Late sprays can reduce seed infection.

(See Table 7 : A Page 7 : 31)

Faba Bean Diseases

RUST

Uromyces vicia-fabae

Symptoms *(See Plates 7 : 21 to 7 : 24)*

Numerous small, orange-brown pustules, surrounded by a light yellow halo appear on the leaves of plants affected by rust. *(See Plates 7 : 22, 7 : 23)* As the disease develops severely infected leaves wither and drop off. The rust pustules on the stems are similar but often larger, than those on these leaves. Late in the season, stem lesions darken as resting spores of the fungus are produced in pustules.

Isolated rust pustules may also appear on the pods. A severe rust infection may cause premature defoliation, resulting in smaller seeds.

Economic Impact

Rust is most prevalent in all warmer bean-growing areas e.g. northern NSW and may significantly reduce yields. The disease has caused losses of up to 30 percent on its own, and in combination with chocolate spot has reduced yields by up to 50 percent.

Disease Cycle

The fungus survives on stubble trash and infects self-sown bean plants directly without the need for alternate hosts. Rust spores are blown onto new crops by the wind.

Rust pustules form on the first few plants to be infected and the disease spreads from these to other plants. Rainfall or dew is necessary for infection.

Control

Growing resistant varieties will reduce the risk of disease infections. *(See Table 2 : D)* Prevention is difficult because the fungus spores can be carried long distances by wind to infect crops far away from the initial source of infection.

Fungicides may be used to control the disease and prevent a rust epidemic. *(See Page 7 : 34)* In areas where the disease is prevalent e.g. northern NSW several sprays will be necessary for adequate disease control.

The risk of disease can be reduced by burning or burial of old bean stubbles and crop rotation.

SCLEROTINIA STEM ROT

Sclerotinia trifoliorum var. fabae, S. sclerotiorum, S. minor

Symptoms

Plants can be attacked at any stage of growth. In young plants the infection usually begins close to ground level and a slimy-wet rot extends into the stem and down into the roots.

Affected plants are easily pulled from the soil. They usually have a blackened base that is covered with cottony, white fungus growth.

Usually isolated plants rather than patches of plants are affected in crops. Older plants can get the infection on any part of their stems, leaves or pods. Infected plants suddenly wilt and collapse.

Sclerotes (2 to 5 mm in diameter) form on the surface of infected plants and in the central cavity of the stem. These sclerotes are usually white at first then turn black.

Economic Importance

Crop losses in Australia have been small so far, however, the disease poses a potential threat.

Disease Cycle

The fungus can survive in the soil for several years. It has a wide host range (including oilseed crops) and may survive on other plants even if beans are not grown.

Sclerotinia may act as either a leaf or root disease. The foliar form of the disease may be spread by airborne spores. Infection begins when these spores settle on the crop. If conditions are cool and wet, the disease develops rapidly and affected plants soon wilt and die.

While damage to the foliage encourages infection, the fungus can infect uninjured tissue.

Root disease occurs when soil-borne spores directly invade the root tissue. A slimy wet root rot develops and the infected plants suddenly wilt and die.

Control

Crop rotation prevents rapid disease build up, but once established in a crop it is difficult to control. Rotations with other legumes and oilseed crops will not break the disease cycle. Cereal crops are not hosts and so can be used in the rotation.

Lower seeding rates, wider row spacings and good weed control give a more open crop, which remains drier, and is less prone to disease.

Faba Bean Diseases

STEM NEMATODE

Ditylenchus dipsaci

Symptoms *(See Plate 7 : 25)*

Heavy infections will show up as patches of malformed and stunted plants or poor germination. The malformation, curling of leaves and water-soak spots, is often confused with herbicide damage. Sometimes the stem will die back, turning reddish brown from the base and stopping at a leaf.

Economic Impact

A heavy infestation of this nematode can cause large yield losses but this has occurred only rarely.

Disease Cycle

Stem nematode infects bean crops from infested seed, straw or soil.

It infects above-ground parts of plants and can multiply many times during the growing season. Disease build-up is worse in wetter situations and at temperatures less than 15°C.

The nematode can survive for many years in seed, straw or soil without having to infect plants. Hosts of this nematode include peas, vetch, oats, rye, maize, onion, strawberry, some broad leaf weeds, bedstraw but not other cereals.

Control

Do not introduce the nematode onto the farm or into clean paddocks. Check seed for the presence of the nematode *(See Seed Testing - Page 3 : 1)* and do not bring oaten hay or straw from infested areas onto the property.

Rotations with non-host crops will reduce nematode numbers.

High rates of nematicide at sowing are needed to prevent damage - these treatments are uneconomic.

CERCOSPORA LEAF SPOT

Cercospora zonata

Symptoms *(See Plate 7 : 12B)*

Dark irregular lesions which may be difficult to distinguish from chocolate spot or ascochyta, however, lesions of cercospora tend to be darker and their shape is more irregular. Within the spots a concentric ring pattern may be seen. Cercospora lesions do not have pycnidia which distinguishes them from ascochyta. Infection may lead to defoliation of individual leaves. Occasionally stem lesions will also occur but these tend to be superficial.

Economic Importance

This disease is increasing in distribution and severity across the faba bean area of southern Australia. It is favoured by cool, moist conditions but extends well throughout the season. Lesions will reach the top of the plant in wet springs. It is not known to be seed-borne.

Disease Cycle

This disease has not been well studied. Cercospora is thought to survive on old bean trash and its spores are probably spread by rain splash. Disease spread seems to be limited to within a paddock from carryover of the fungus on the trash. Spores do not spread long distances to other paddocks.

Control

Carbendazim sprays for chocolate spot should also control this disease. All current cultivars are susceptible.

Wide rotations (at least 3 years) and good crop hygiene are the best means of control.

Faba Bean Diseases

ALTERNARIA LEAF SPOT

Alternaria alternata

Symptoms *(See Plate 7:26)*

Dark brown leaf spots; which often have a zoned pattern of concentric brown rings with dark margins. Symptoms can be confused with chocolate spot. Infection often follows insect damage or other leaf spots caused by rust or chocolate spot.

Economic Importance

Alternaria occurs late in the season and is a minor disease.

Disease Cycle

Alternaria is a weak pathogen of many hosts and often infects following damage by other fungi or insects. Alternaria leaf spot develops late in the season as the plants start to mature. The fungus probably survives on crop residues and on other hosts.

Control

Control of Alternaria alone is not warranted. Fungicide sprays for chocolate spot should give control.

APHANOMYCES ROOT ROT

Aphanomyces euteiches

Symptoms

Chlorosis and wilting of the plant, associated with necrosis in the roots

Economic Importance

This root rot has been observed in recent years in parts of northern NSW. It is unlikely to be a major pathogen of faba bean at the present. However, the expansion of this crop in regions with heavy soils and high rainfall, or irrigated fields, increases the risk of losses.

Disease Cycle

The fungus is a soil dweller. It can survive from crop to crop in the soil, either on infected plant debris or as resting spores.

In wet soils these fungi can invade plant roots and cause root rot. Wet conditions also encourage the spread of disease within a field. The reduced root development causes the plants to die when they are stressed.

Control

The disease can be reduced by crop rotation.

It is not known if this strain of the disease can also affect other pulses, A pea infecting strain is known to occur in Europe.

VIRUSES

Luteoviruses: *bean leafroll luteovirus (BLRV)*
subterranean clover redleaf luteovirus (SCRLV)
Potyviruses: clover yellow vein virus (CYVV)
bean yellow mosaic virus (BYMV)
Other viruses (including alfalfa mosaic virus, subterranean clover stunt virus and tomato spotted wilt virus)

Symptoms *(See Plates 7 : 26 to 7 : 28)*

Initially diseased plants are scattered but by maturity the luteoviruses may have infected nearly all of the crop.

Luteoviruses cause yellowing and stiffening of the leaves and sometimes an upwards rolling of the leaf margins. *(See Plate 7:27)* If infection occurs at the seedling stage, the whole plant shows symptoms. If infection occurs later, only the tops of shoots show symptoms ('top yellows'). Infected plants become stunted and die prematurely unless infection occurs after podding.

BYMV causes leaves to turn pale green. Usually, there is a mosaic of dark green patches over the pale green leaves. *(See Plate 7:28)* The leaves develop an uneven surface texture and outline compared with healthy leaves. There is little or no stunting.

Other viruses eg Tomato Spotted Wilt Virus (TSWV) have been found to infect faba beans but do not appear to be a major problem as yet. Their symptoms are similar to those of luteoviruses.

Economic Importance

The luteovirus BLRV was detected for the first time in 1993 in northern NSW (in faba bean, narbon beans and a forage legume *Lathyrus ochrus*) By 1995 BLRV had caused major yield losses in faba beans in northern NSW.

Another luteovirus, SCRLV, has been infecting faba beans crops in Australia since the 1970's and does not appear to be a serious problem.

BYMV occurs commonly at a low frequency in faba bean crops and has not caused any serious losses.

Disease Cycle

Aphids bring the viruses into faba bean crops from surrounding legume plants. These may be other pulses or pasture legumes such as lucerne, clovers or medics. Seed does not carry BLRV and SCRLV.

Viruses which can be transmitted in seed (including BYMV) have not caused serious problems.

Control

There are no proven control measures for these viruses.

Lentil Diseases

ASCOCHYTA BLIGHT

Ascochyta lentis

Symptoms *(See Plates 7 : 29, 7 : 30 and 7 : 31)*

Usually appears as tan-colored spots on leaves, stems and pods. These spots may be small, irregular in shape and are usually scattered over the plant. The centres of these spots often fade to a light tan-color and become speckled with the small black fruiting bodies of the fungus. Young leaf spots are usually surrounded by a light yellow halo. The disease is often inconspicuous and only found by close inspection of the crop.

Sometimes the yellowing may extend to the whole leaf. As the disease develops many of the heavily infected leaflets wither and fall from the plant.

Seed infected with ascochyta may be shrunken and have purplish-brown patches on the seed coat. *(See Plate 7:31)*

Economic Importance

Ascochyta blight is the major disease of lentils in southern Australia. It can reduce crop yields and affects seed quality and marketability. As the disease is favoured by moist, humid conditions it is most likely to be a problem in wet seasons and high rainfall areas.

Disease Cycle

The fungus can be carried on seed or in infected stubble from diseased lentil crops.

Sometimes the disease may appear to have been established by sowing infected seed but it may also become established when spores of the fungus, produced on infected stubble, are carried onto the new crop by wind. The disease can occur at any stage of plant growth, however, moisture is essential for the spread during wet weather, when spores produced on diseased plants are spread onto neighboring plants by rainsplash. Heavy rainfall late in the season provides ideal conditions for pod and seed infection.

Control

Growing resistant varieties will reduce the risk of severe disease and the staining on seed. *(See Table 2 : F)*

The disease can be prevented by using disease-free seed and sowing crops into areas free of infected lentil stubble. Fungicide seed treatments *(Page 7 : 34)* should give good control of any infection on seed. Burning or ploughing diseased lentil stubble should reduce the risk of infected stubble causing ascochyta blight in lentil crops sown nearby.

Late foliar sprays can reduce seed infection and staining.

Lentil Diseases

GREY MOULD

Botrytis fabae and B. cinerea

Symptoms *(See Plates 7 : 32A to 7 : 32D)*

Plants may be attacked at any stage of growth. The disease usually first appears in patches as a soft rot at the base of the stem. The affected areas become covered with a fluffy grey mould. As the disease progresses either a few branches or the entire plant may wither and die. Large areas of the crop may become infected and collapse. Sometimes the disease spreads to the top of the plant and attacks the upper leaves. The infected leaves turn yellow and often become covered with grey mould. Small black sclerotes may form on the surface of the infected tissue.

Economic Importance

Grey mould is a very serious disease in areas where lentils are grown in wet, humid conditions, particularly in crops with dense canopies. The disease is predominant in seasons with wet springs, and warm night temperatures over 10°C. High yield losses have been recorded and seed quality may be affected.

Disease Cycle

The fungus can be carried on seeds and also survive on plant debris or in the soil. Sowing infected seed will introduce the disease into clean areas. Masses of spores are produced on infected plants and are then spread onto other plants by wind and rainsplash to begin new infections.

The warm, humid conditions created by the crop canopy are ideal for the disease to begin and spread. Grey mould often begins on dead leaves and then spreads to growing plants. The same fungi cause chocolate spot in faba beans and botrytis grey mould in vetch and can spread between these crops.

Control

Foliar fungicides and seed dressings are an important component of controlling BGM in lentils *(Pages 7 : 31, 7 : 34)* . Spraying to control botrytis grey mould should begin immediately prior to canopy closure as a protective spray that is able to penetrate the canopy. Follow up sprays will be necessary where

- the disease is visible in the crop or
- relative humidity in the crop is likely to remain high for at least a week or
- disease is increasing.

Chemical seed dressings may be used to ensure that seed is free of seed-borne infection. The disease is reduced by using disease-free seed and crop rotation.

Crops should be managed to avoid heavy canopies in spring ie. sowing rates not more than 100-120 plants per square metre, row spacing approx 23cm (>23cm increases lodging) and later sowing dates.

Lentils should not be grown in infested paddocks, nor in close rotation to faba beans or vetch that were infected with chocolate spot or botrytis grey mould. Nor should lentils be planted adjacent to early sown crops of faba beans, vetch or lathyrus as these may act as a reservoir for the fungi.

Varieties with moderate levels of resistance are available *(Table 2 : F)* but these will still need some fungicide protection in conditions that promote botrytis grey mould.

Lentil Diseases

SCLEROTINIA

Sclerotinia sp.

Symptoms *(See Plates 7 : 32)*

Sclerotinia appears mainly on older plants. At first water-soaked patches (lesions) appear on the stems and leaves and later affected areas develop a soft, slimy rot which exude droplets of brown liquid. The infected tissues dry out and become covered with a fine white web of fungus growth. Sclerotes, which develop on stems and mingled with the white fungal growth, are larger than the sclerotes associated with botyrtis grey mould. Sclerotinia in lentils is often found in association with botrytis grey mould.

Affected plants wilt and die rapidly, without losing their leaves.

A late infection can affect the pod and seeds. Infected seeds are smaller than normal and discolored.

Economic Importance

Sclerotinia can cause severe damage in lentils in a wet season, often in association with botrytis grey mould.

Disease Cycle

The fungus may be present in the soil or may be introduced with contaminated seed.

The fungus in the soil may invade the plant directly or may produce air-borne spores which attack the above ground parts of the plant. Cool, wet conditions are essential for the progress of the disease. Once established, the fungus can move rapidly to neighboring healthy tissue. A few days after infection, plants start to wither and die. The fungus is carried over to the next year in the infected plants.

Control

The disease risk can be reduced by using disease-free seed. It is also important to avoid sowing lentils on areas where the disease is known to be present. If severe infection occurs, the area should be burnt and ploughed deeply to kill the fungus in the soil.

Crop rotation will reduce the risk of infection. Cereals, which are not a host, should be grown for several seasons before returning to lentils or other pulses or canola. Other hosts to sclerotinia are the oilseed crops e.g. canola, pulses and broadleaf weeds such as capeweed.

VIRUSES

Cucumber mosaic virus (CMV)
Alfalfa mosaic virus (AMV), Bean Yellow Mosaic Virus (BYMV), Clover Yellow Vein Virus (CYVV)
Luteoviruses : Bean Leaf Roll Virus (BLRV), Subterranean clover red leaf virus (SCRLV)

Symptoms

Viruses cause stunted growth, small leaves, yellowing, browning or reddening of leaves and sometimes premature death. These symptoms are usually pronounced at the tops of plants. Luteoviruses may cause twisting and distortion of the young leaves, in combination with mosaic yellowing. Viruses occur in patches of plants, 30 cm or wider in diameter, the centres of which show the most severe symptoms. This is the initial point of infection by the aphid. At a distance, the disease looks similar to a root disease or damage by herbicide residues.

Economic Importance

The viruses have not been seen as major problems in lentil crops although CMV and AMV have caused considerable damage in lentil trials in northern NSW. The extent of yield loss will vary between seasons and localities and is related to aphid activity.

Disease Cycle

Neighboring pasture legumes and pulses are the sources from which aphids carry the viruses into lentil crops. AMV, CMV and

Control

BYMV can also be transmitted on seed. Plants which germinate from infected seed act as centres of infection from which the viruses are spread by aphid.

Use virus tested seed *(See Page 3 : 1)* or seed from a known virus free crop.

Lupin Diseases

PHOMOPSIS STEM BLIGHT

Phomopsis leptostromiformis

Symptoms *(See Plate 7 : 33 to 7 : 36)*

The fungus can infect the stems, leaves, pods and seed of lupins. Infected seedlings develop deep-yellow to brown, irregular shaped lesions below the cotyledons. Severe lesions can girdle the stem and eventually kill the plant.

Sometimes yellow to brown blotches may be visible on the leaves and stems of older plants, but most infected plants show no disease symptoms until late in the season. *(See Plates 7 : 34, 7 : 35)*

On pods, large, irregular reddish tan lesions appear, often covered with powdery grey mould appear. Infected seeds either appear normal or are discolored light yellow to reddish-tan. *(See Plate 7:36)* Web-like grey mould may be seen on the seed coat and inside the seed pod. Small black fungal spots on lupin trash may give the stems a flecked appearance.

Economic Importance

Phomopsis infection usually does not cause large crop losses. However the fungus is far more important because it produces toxins which cause lupinosis in animals that graze infected lupin stubbles or eat infected seed. This causes illthrift and may eventually kill these animals.

Disease Cycle

The fungus may survive on lupin trash and seed. The fungus can survive on the trash for several years. The disease usually becomes established when spores produced on old lupin stubbles are carried onto new crops by wind and rain. Infection can occur at any stage of plant growth if conditions are favorable.

Infected seed may produce infected seedlings. These sometimes develop severe stem lesions and die. Plants that do survive often lack vigor and may lodge.

Heavy rains in late spring favor disease buildup.

The amount of toxin produced depends on the amount of fungal growth in stems and the occurrence of rainfall or dew after crop maturity.

Control

The disease risk can be reduced by sowing resistant varieties *(See Table 2 : I)*, using crop rotation, disease-free seed, and by avoiding cropping close to old infected lupin stubbles.

Lupins should not be sown in the paddock before the infected lupin stubble has rotted away.

Using clean seed will only be useful if seed is sown into clean areas. It will not prevent the disease developing if there are other sources such as diseased trash from lupins up to several kilometres away. This trash can be a source of infection for up to three years.

Lupin Diseases

BROWN LEAF SPOT

Pleiochaeta setosa

Symptoms *(See Plates 7 : 36B,C,D and 7 : 38)*

The fungus can cause both root rot and leaf spotting. Affected roots develop dark brown spots, and in severe infections the root may become completely girdled by the fungus and rot off. Plants losing tap roots wilt and eventually die. Plants with less severe infections, have smaller root lesions and may survive, however they tend to nodulate poorly and lack vigor. Lateral roots may also be affected and rot off.

On the leaves, irregularly shaped, dark-brown to purple spots and streaks develop. Heavily infected leaflets drop prematurely, partially defoliating affected plants. Dark-brown flecks on the stems may develop into cankers which can kill the plant.

Economic Importance

Brown leaf spot is one of the more important lupin diseases in Australia and is widespread. Severe outbreaks can cause total crop failure but are generally rare.

Disease Cycle

The fungus can survive in the soil, on seed, and on old lupin stubbles. On land which has been previously cropped to lupins, spores in the soil may infect the roots of lupin plants. These spores can also be splashed onto the leaves and stems of lupin plants to begin new infections. In wet conditions spores produced on old lupin stubble may be carried into new lupin crops by the wind and may cause stem and leaf infections.

Control

The disease may be prevented by using disease free seed, chemical seed dressing *(See Page 7 : 34)* and crop rotation. Stubble retained on the soil surface reduces the spread by rain splash. Sowing lupins on lupin stubble and sowing lupins close to old lupin stubble will increase disease severity.

SCLEROTINIA STEM ROT

Sclerotinia sclerotiorum, S. minor

Symptoms *(See Plates 7 : 36A, 7 : 39 and 7 : 40)*

The disease usually first shows up as a wilt. On closer inspection a white cottony fungus can be seen at the base of the plant. The stem base may be partly or completely girdled by fungal growth. As the disease develops plants may lose their leaves and scattered patches of defoliated plants may be seen throughout the crop. Infected stems contain black fungal sclerotes (up to 5 mm long).

Economic Importance

This disease is widespread. Crop losses are rarely severe as usually only isolated plants are affected. Affected plants usually die before setting seed.

Disease Cycle

The infection begins when spores in trash germinate and invade plants. The disease attacks other plants, including canola, capeweed, sunflowers and peas. Fungal spores produced on these crops may be carried over to infect the lupin crop.

The infection can be aggravated by close plant spacings and damp conditions.

Control

Sow seed free of fungal sclerotes. As sclerotinia does not attack cereals or pasture grasses rotation with these crops will help control the disease. Weeds such as capeweed in lupin crops should be controlled as they can be a source of infection. Where the disease is a problem lupins should not be resown for at least four years.

Lupin Diseases

CUCUMBER MOSAIC VIRUS (CMV)

Symptoms *(See Plate 7 : 41)*

CMV infected seedlings are stunted and have downward curled leaflets *(See Plate 7 : 42)* and may not survive in adverse conditions but provide a source from which infection can spread to adjacent plants. Plants which are infected later in the season have bunched growth confined to the tops of the plants with normal plant growth at the base *(See Plate 7 : 43)*.

Severe strains of CMV, known to occur in NSW, can cause tip wilting symptoms like those of BYMV.

Infected crops may appear healthy and so a seed test needs to be done *(See Page 3 : 1)* to check whether or not seed is infected.

Economic Importance

This disease occurs in all lupin growing areas and when infected seed is sown, causes large yield losses.

Disease Cycle

Infected seed is the most important source of infection in the lupin crop. It is from here that the disease spreads.

Control

Sow disease-free seed from healthy crops. As the symptoms of CMV are not always obvious in a crop, test all lupin seed. As levels of infection can buildup rapidly in one season it is advisable to test seed each year. When harvesting lupins it is worth keeping seed from areas free from CMV. Harvesting the whole paddock and then keeping seed will contaminate all the seed if CMV is present.

In the case of an early break to the season and high aphid numbers a border spray of the paddock with insecticide as soon as aphid attack becomes obvious may give some control.

Planting a cereal border at least 15 metres around the lupin crop will reduce the risk of aphid spreading the disease into the lupin crop.

BEAN YELLOW MOSAIC VIRUS (BYMV)

Symptoms

BYMV causes wilting and death of shoot tips ('shepherd's crook'), followed by death of the plants. Islands of dark green color (mosaic) may be present on leaves of white lupins before they deteriorate. *(See Plate 7 : 44)*

Economic Importance

BYMV occurs in all lupin growing areas and causes minor yield losses in narrow leaf lupins. In albus lupins major yield losses from BYMV infection can occur. Losses are greater when aphid numbers are high or seasonal conditions favor early flights.

Disease Cycle

Legumes, including the pulses and pasture legumes (lucerne, clover and medics) are sources from which the aphid can carry the virus into the lupin crop. There is no seed transmission of BYMV in narrow leaf lupins however seed transmission is a source in albus lupins and yellow lupins *(L. luteus)*.

Control

Planting a cereal border at least 15 metres around the lupin crop will reduce the risk of aphid spreading the disease into the lupin crop.

Use virus tested seed when planting albus lupins.

ALFALFA MOSAIC VIRUS (AMV)

Symptoms

The initial symptoms of AMV are yellowing of upper leaves and tip necrosis. Then the leaves become dry and drop off and the whole stem becomes dry followed by plant death. Bean leaf roll virus (BLRV) causes nearly the same symptoms and it is hard to differentiate between the two just using symptoms.

Economic Importance

Once a lupin plant is infected with AMV or BLRV it will die without producing any pods or seeds.

Disease Cycle

Neighboring pasture legumes and pulses are the source from which aphids carry the virus into crops.

Control

AMV can also be transmitted on seed. Plants which germinate from infected seed act as centres of infection from which the virus is spread by aphids.

Use virus tested seed *(See Page 3 : 1)* or seed from a known virus free crop.

Lupin Diseases

ROOT ROTS

Fusarium, Rhizoctonia, Pythium and Macrophomina spp.

Symptoms *(See Plates 7 : 45, 7 : 46 and 7 : 47)*

Infected plants often seem normal early in the season, but suddenly wither and die when stressed. Affected plants will have poorly developed root systems when compared with healthy plants.

Distinct dark brown to black spots may be visible on taproots of infected plants and they may have few side roots. The taproot may become quite brittle and when plants are uprooted the lower portion of their root may snap off and remain in the soil.

Economic Importance

The root rots have become a serious problem in southern NSW and north eastern Victoria. Major crop losses have occurred during the 1990's in both narrow leaf and albus type lupins. Root rots cause the most damage in seasons where the above average winter rainfall is followed by a dry spring. Rhizoctonia is most damaging to lupins grown in sandy soils. *(See Plate 7 : 47)*

Disease Cycle

The fungi which cause root rot live in the soil between crops. Under wet conditions they attack the roots of young plants, often soon after emergence, and invade the plant's root system. If conditions remain wet the disease may spread to the neighboring plant. Affected plants lack vigor because of damage to their root system and either die early or yield poorly. The disease level may build up in paddocks that are continuously cropped to legumes.

Control

Root diseases are unlikely to become problems where lupins are grown in rotation with cereals. The exception is rhizoctonia which affects many different types of plants including cereals and so is not well controlled by rotation with non-legumes. Rhizoctonia damage is reduced by cultivating the soil a few weeks before sowing.

GREY LEAF SPOT

Stemphylium botryosum

Symptoms

Leaves, stems and pods of plants may be attacked at any stage of growth. On leaves the typical symptoms are semi-circular to circular dark brown spots. The centres of these spots gradually turn light grey as they become older.

Similar spots develop on infected pods. Stem lesions are usually more elongated and lighter in color than leaf lesions. Following warm, wet conditions, heavily infected plants may become completely defoliated.

Grey leaf spot often causes widespread early leaf drop on self sown stands of lupins.

Economic Importance

Overseas, the disease has been known to cause serious losses in warm, wet conditions. Fortunately, most commercial lupin varieties in Australia are resistant to grey leaf spot, and even though the disease is widespread, it seldom causes significant crop losses.

Disease Cycle

The fungus survives from year to year on infected seed, on infected lupin stubbles and possibly on alternative host plants.

Under warm, wet conditions spores produced on the old stubbles may be carried onto the crop by wind to infect plants. Disease symptoms appear first on the cotyledons and lower leaves. Once established, spores produced on infected plants rapidly spread the disease through the crop.

Control

Grey leaf spot can be avoided by growing varieties with resistance to the disease *(See Table 2 : I)*. Crop rotation and destruction of infected lupin trash should prevent any carry-over of the disease.

Lupin Diseases

ANTHRACNOSE

(Colletotrichum lupini formerly C. gloeosporoides)

Symptoms *(See Plates 7 : 68 to 7 : 71)*

The bending and twisting of stems with a lesion in the crook of the bend is the distinctive symptom of anthracnose. This is very noticeable when the crop is flowering. Stem lesions are usually dark brown and elongated (0.5 to 2.0 cm long) with a pale pink to orange spore mass in the centre. The stem can be completely girdled by lesions so that it is weakened or breaks. The main stem, lateral branches and petioles can be affected. Leaf lesions are fewer, and are seen as beige spots with a dark brown border. Pod lesions are similar to stem lesions, and are often associated with twisting and distortion. Infected seeds are often malformed and may show brown lesions with an occasional pink spore mass.

Economic Importance

Anthracnose is a serious disease of lupins worldwide. This species of anthracnose is specific to lupins, but affects all lupin species, including ornamentals. Albus lupins are the most susceptible.

Disease Cycle

Infection comes from fungal spores or mycelium carried on or in the seed. Seed can carry anthracnose without any visible symptoms. One infected seed in 10,000 seeds can result in severe epidemics. The fungus can survive two or more years on the seed. Seedlings which emerge from infected seed can develop lesions on the root, hypocotyl *(See Page 7 : 33)* or cotyledons. Spores are produced from these lesions within days, and are spread in the crop by raindrops. Most spores spread only a few metres, but in gusting winds the rain drops take the spores further. Spores are spread over much longer distances by farm machinery, animals and insects.

Anthracnose can survive over summer on infected stubble, and spores can be splashed to reinfect seedling lupins. The fungus viability on stubble is decreased by summer and autumn rains. It is poorly adapted to survive on stubble and in soil through wet winter and spring conditions.

Control

In areas without anthracnose, prevention is the best defence, and eradication is possible if isolated infection occurs. In areas where anthracnose is present, the disease can be managed to minimise yield loss and disease spread.

Prevention

- do not introduce the disease on seed, trash or machinery
- treat seed with a fungicide as a precaution *(See Page 7 : 34)*
- monitor lupin crops closely for the disease
- have at least a two year break between lupin crops in the same paddock
- control volunteer lupins
- control sandplain lupins, blue lupins and ornamentals, especially if they border potential lupin paddocks.

Control

- Use clean seed
- Grow resistant cultivars *(See Tables 2 : I, 2 : K, 2 : M)*
- treat seed with a fungicide to minimise effects *(See Page 7 : 34)*
- have at least a two year break between lupin crops in the same paddock
- control volunteer lupins
- minimise the spread in crop and between crops by machinery, animals and insects
- manage seed paddocks to minimise disease introduction or spread.

Eradication

- do not use any of the infected grain on farm
- have at least three years in the infected paddock and surrounds with no lupins
- do not graze the stubble
- disinfect all machinery before leaving the infected paddock
- remove any possible source of the disease.

Lupin Diseases

PHYTOPHTHORA ROOT ROT

Phytophthora species

Symptoms

Plants suddenly wilt and die during pod filling. Leaves turn yellow and drop, often within a 24 hour period. A dark sunken lesion may extend from the base and often up one side of the stem. Infected plants have a rotted taproot, which is woody in appearance with little outer tissue remaining, and with few, if any, side roots.

The pattern of distribution of the disease within a paddock can vary from single scattered plants to large areas of crop, often in low lying areas of paddocks.

Economic Importance

This newly recognised disease was first observed in 1993, when large areas of apparently healthy looking lupin crops suddenly died. Patches of plants within crops turned yellow and failed to produce any seed. Since then this condition has been seen each year in wetter regions of south eastern Australia with varying degrees of crop damage, ranging from scattered plants to very large areas.

Disease Cycle

There appear to be several essential prerequisites for this disease. Firstly, soil temperatures in excess of 15°C. This is why the disease is not seen early in the season during the cooler winter months. Once temperatures rise, infection occurs, the taproot is subsequently rotted, and the plants suddenly wilt and die. This usually occurs around early pod fill when plants may need soil water from deeper in the profile.

The other requirement is a period of flooding or waterlogging. This is often directly linked to the presence of hardpans or ploughpans. These are compacted layers within the soil profile which can form as a result of many years of cultivation. If hardpans are present perched watertables can occur during and following periods of heavy rainfall. This waterlogging is ideal for infection by Phytophthora.

Control

This disease is yet to be studied in detail and so strategies have not been worked out.

The most effective practice that can be recommended is to avoid or rectify paddocks that have a hardpan and can be waterlogged. Hardpans can be identified by simply pushing a spade into the soil - a layer of resistance is felt where a hardpan is present. Alternatively, dig up some plants and observe the root growth - taproots shaped like a 'L' indicates a hardpan.

Also, because the species and host range of Phytophthora is unknown at this stage it is not possible to recommend suitable rotations to minimise disease impact.

There is no known resistance in lupins at present.

Fungicide treatments have not been tested sufficiently to see if they are effective. Because the disease occurs late in the season seed treatments are unlikely to be effective.

BLACK ROOT ROT

Thielaviopsis basicola (synonym Chalara elegans)

Symptoms *(See Plate 7 : 47A)*

The fungus infects and rots the taproot, lateral roots and nodules. The tap root may be internally rotted on mature plants. Plants are stunted with general poor growth. Hyphae and black chlamydospores are abundant.

Economic Importance

Black root rot occasionally occurs in lupin crops. In severe cases, individual crops may be destroyed. The disease is favoured by waterlogged soils. Worst cases have occurred where waterlogging was caused by the addition of clay to sandy soils in paddocks with a high frequency of lupin crops.

Disease Cycle

Infected root and stem residues left in the field after harvest are the primary source of inoculum. Spores will survive for several years in the soil. The fungus is highly soil-borne and transported by the movement of soil.

The fungus grows most abundantly at high temperatures (25-28°C) but the disease is generally more severe at lower temperatures (15-20°C).

Control

Rotation is a key control measure. *T. basicola* has a wide host range including most legume crops and pastures, cotton, peanut, beet, carrot, celery, tomato, sweet potato, tobacco, sesame, lettuce, onion and citrus. Cereals are resistant.

Pea Diseases

BLACK SPOT

Mycosphaerella pinodes, Phoma medicaginis var pinodella and Ascochyta pisi

Symptoms *(See Plates 7 : 48 to 7 : 51)*

Purplish black stains and streaking of the lower stems are typical symptoms of black spot. In severe cases the stem infection can lead to stem or footrot which can kill the plant.

Spotting on the leaves and pods are also common symptoms of black spot. The leaf spots can either be small, irregular, dark-brown spots scattered over the leaf, or a few large circular brown spots. The spots on the pods often merge to form large, sunken, purplish black areas. Infected seeds can be stained purplish brown but lightly infected seeds appear normal.

Economic Importance

Black spot is common in all pea-growing areas but its severity varies from crop to crop and between seasons. In wet seasons, which encourage disease development, losses can be severe, especially in wet springs.

Early sowing increases the likelihood of disease. Individual crop losses as high as 45 percent have been recorded.

Disease Cycle

The group of fungi that cause black spot can be carried over on seeds, on pea trash or following a severe epidemic, directly in the soil. The disease usually becomes established when the spores of the fungi, produced on old pea stubble, are carried onto the new crop by wind. Moisture is essential for the development and spread of black spot.

During wet weather, spores produced on the infected plants are transferred onto healthy plants by wind and rainsplash. Sowing infected seed can also cause black spot infection in a new crop.

Control

Delayed sowing is the most important strategy for blackspot control to avoid the exposure to 'showers' of blackspot spores that are released soon after the break of the season. In areas where the season allows late sowing, then the disease effects can be reduced by delaying sowing until mid-late June. Avoid planting in close proximity to pea stubbles, particularly if the new crop would be down wind of pea stubble paddocks

Destroying the infected pea stubble by grazing, burning and cultivation will reduce the disease risk by minimising the number of spores available to infect new crops. Self-sown peas must also be controlled in the rotation to prevent a build up of disease for the next pea crop. At least 4 years of break crops are needed before growing the next pea crop. Following a severe epidemic of blackspot, the soil-borne disease risk can be assessed through the PredictaB Root Disease Test (from Bayer Crop Science) before planting a new crop of peas. Kits are available through regional chemical retailers or Bayer Crop Science Area Managers.

Chemical seed treatment *(See Page 7 : 34)* will control seed-borne disease and reduce infection on young plants from air-borne spores. This is most likely to be economic in situations favoring high disease levels such as early sowing.

Peas should be harvested promptly as soon as the crop is mature as seed infection increases as the crop stands in the paddock. Infected seed is not instrumental in starting an epidemic in established pea growing areas, but it will reduce crop establishment. Preferably use disease free seed, or seed with less than 5% infection. *(See Table 9 : C)*

Lower germination due to seed infection can be compensated for by increasing the seeding rate. Avoid sowing heavily infected seed as the infection will severely reduce crop establishment. Seed tests are available to check the infestation levels on seed. *(See Page 3 : 1)*

As with many diseases, adequate and balanced nutrition including the trace elements will reduce the disease severity. Excessive herbicide use will also increase the effects of the disease. Observe the maximum plant back period for sulphonyl urea herbicides.

Pea Diseases

DOWNY MILDEW

Peronospora viciae

Symptoms *(See Plate 7 : 51 and 7 : 63A)*

Plants severely affected by downy mildew are a pale yellowish-green color, stunted and distorted. The undersides of the leaves are frequently covered with a fluffy mouse-grey spore mass. *(See Plate 7 : 52)*

The fungus usually appears on the lower leaves first and then progresses up the plant, *(See Plate 7 : 53)* sometimes infecting the flowers and pods. Infected pods are deformed and covered with yellow to brownish patches and surface blisters.

As the infection develops isolated pale yellow-brown blotches appear on the upper surfaces of the leaves while the masses of mouse-grey mildew develop on the lower surfaces of leaves directly under the blotches.

Economic Importance

Downy mildew is one of the more common fungus disease of peas, often reducing plant numbers substantially in wet, cool seasons. Substantial yield losses can occur in cooler districts. Downy mildew also makes plants very vulnerable to herbicide damage by affecting the formation of the protective wax coating on pea leaves.

Disease Cycle

The downy mildew spores survive in the soil, on pea trash, or in seeds, though transmission of the disease from seed to new plants has not been proven. Infection from soil or trash leads to systemic and leaf infections in young seedlings. These seedlings act as a reservoir of infection from which the disease spreads to adjacent plants. The disease is most severe on young plants but generally slows down during the spring as temperatures rise.

Control

Downy mildew is best controlled by chemical seed treatment *(See Page 7 : 34)* or by using resistant varieties *(See Table 2 : P)*. Seed treatment will also provide protection from some other root rots eg. *Pythium* and so may improve crop establishment, especially in wet areas. Destroying infected pea trash, and using extended crop rotations, will also assist to reduce infection. Foliar fungicides are usually applied too late to be of benefit, since most of the damage is done at emergence or during early seedling growth.

POWDERY MILDEW

Erysiphe pisi (synonym E. polygoni)

Symptoms *(See Plates 7 : 54, 7 : 55 & 7 : 56)*

Infected plants are covered in a white powdery film and severely affected foliage looks blue-white. Tissue below these infected areas may be purplish.

In heavily infected crops clouds of spores can be shaken from the plants.

The leaves, stems and pods may all become infected causing the whole plant to wither. Severe pod infections can result in a grey-brown discoloration of the seeds. These seeds may have an objectionable flavor that reduces the quality of the grain.

Economic Importance

A major disease in peas. Susceptible varieties can have yield losses of up to 70 percent.

Powdery mildew is most common late in the season when warm days and cool nights lead to dew formation.

Disease Cycle

The powdery mildew fungus survives on infected plant debris. Spores of the fungus, produced on the old pea trash, are transferred to the new crop by the wind. Once a few plants are infected the disease spreads rapidly to adjacent areas. Under favorable conditions the disease may infect a whole plant within five or six days.

Control

Losses can be minimised by growing resistant varieties. *(See Table 2 : P)*

Fungicide sprays will provide some control *(See Page 7 : 34)*. If the first signs of disease are seen within the last 4 weeks of the growing season it is unlikely that this disease will affect yield. Fungicides are unlikely to be of benefit in this situation. Rotations will not control powdery mildew because the airborne spores can be blown about between paddocks and farms.

Pea Diseases

ROOT ROT

Fusarium, Rhizoctonia, Macrophomina

Symptoms *(See Plates 7 : 57, 7 : 58)*

Infected plants often look normal early in the season but suddenly wither and die during the later stages of flowering and pod formation. The effects are most noticeable in hot weather when there is stress due to high temperature and lack of moisture.

Root rot affected plants are often stunted with obvious yellowing of the lower leaves. Pods may be few, with a reduced number of seeds, or plants may die before any seed is set.

Affected plants have poorly developed root systems compared to normal plants. The upper taproot is often discolored and may have sunken light brown to black patches, while the lower root may be completely rotted. Rhizoctonia can also rot off the hypocotyls *(See Page 7 : 33)*, preventing emergence. These affected seeds may have several rotted shoots sprouting from the seed.

Economic Importance

Severe outbreaks of root rot are uncommon in Australia.

Disease Cycle

Root rot fungi tend to build up quickly when peas are sown in infested soil and decrease very slowly even if peas are not resown for a number of years. The fungi responsible for root rot survive in root debris and in the soil as dormant spores. In wet soils, the fungi infect young seedlings soon after emergence and invade the plant's root tissue.

The disease may then spread to adjacent plants. Affected plants lack vigor and either die or yield poorly. Damage may be obvious as yellowing patches in a crop or may have an effect on growth and yield which is only noticed at harvest. The degree of yield loss depends to a large extent on the degree of water stress the diseased plants suffer during grain formation.

Control

The disease risk can be minimised by crop rotation. It is also important to avoid soils prone to waterlogging and to maintain good soil fertility. Seed treatment with fungicides *(See Page 7 : 34)* will improve seedling establishment in wet areas where root rot can be a problem.

WILT

Fusarium oxysporum f.sp.pisi and F.oxysporum var. redolens

Symptoms

When the disease first appears it usually affects only individual plants, but in the following crop patches of affected plants become obvious. Early infection leads to death of the plant, whereas late infection may allow survival but causes early maturation and poor seed set.

The first signs of wilt include a characteristic greying of foliage followed by downward curling of the leaves and progressive yellowing of the leaves from the bottom to the top of the plant. Sometimes there is a degree of stunting with the stems getting quite brittle and swollen at the base.

The root system of plants affected by wilt appears normal, however, when the tap root is split the inner tissues are stained light orange to brick red. This discoloration may spread well up the plant into the stem.

Economic Importance

The disease is of minor importance in Australia. In other countries, wilt has caused considerable losses in yield and quality.

Disease Cycle

The fungi that cause wilt survive in the soil for long periods as resting or dormant spores. When the field is sown to peas the spores move out of their resting phase and attack the roots of susceptible young plants.

Affected plants suffer moisture stress, particularly in hot weather and usually die prematurely. Infected seed can also be a source of disease.

Control

Losses can be reduced by the use of crop rotation.

Seed from infected crops should not be kept because the disease can be carried by seed.

BACTERIAL BLIGHT

Pseudomonas syringae pv. pisi and P.syringae pv. syringae

Symptoms *(See Plate 7 : 59)*

Bacterial blight first appears as small, dark green, water-soaked spots on leaves and stipules. The spots enlarge and merge but are always limited by the veins. The spots on the leaves turn yellowish and later brown and papery, while those on the pods are sunken and olive brown. Spots can also develop on the stems close to ground level, these begin as water-soaked areas which later turn olive-green to dark brown. These spots can merge together causing the stem to shrivel and die. Stem infections can spread upwards to the stipules and leaflets. In these cases, a fan-like area forms on the stipule. Affected veins become brown-black and leaf tissue yellowish to brown with a papery texture when dry. Pre-emergent and post-emergent damping-off can occur and even advanced plants can be killed by bacterial blight.

Heavily infected seed may be stained but light infections have no visible symptoms on the seed.

Economic Importance

Bacterial blight is common in some pea growing areas. Severe outbreaks of the disease occur occasionally, especially in very wet years or in association with frost. Affected crops appear to be more susceptible to frost and herbicide damage.

Disease Cycle

The bacteria that causes blight can be carried on seed from diseased crops, infected stubble or other hosts. The disease is often introduced to a field by sowing infected seed. During wet weather the disease is spread from infected plants to healthy plants by rain-splash and wind-borne water droplets.

Infection can occur at any stage of plant growth following either rain or heavy dew. As the disease needs wet conditions to spread, blight is most severe in wet seasons. A combination of heavy rainfall and strong winds provides ideal conditions for spreading the disease within the crop.

Plants damaged by frost or heavy rain tend to be more susceptible to the disease.

Control

Bacterial blight can be reduced by planting disease-free seed and crop rotation. Seed tests for bacterial blight are available that will minimise the chances of using infected seed but the tests to do not ensure immunity. The use of disease-free seed will reduce the possibility of disease, provided the land has not been cropped to peas for several years. Avoid planting in close proximity to infected stubbles. Weeds or pastures that may be harbouring the bacterium should be destroyed prior to crop emergence. If the disease occurs in the crop, avoid driving into the paddock as the bacteria will be spread further via the vehicle wheels.

Pea Diseases

DAMPING-OFF
Pythium spp

Symptoms

Damping-off usually affects crops very early, often before seedlings emerge. Damping-off causes seeds to rot rapidly, giving them a slimy, tan colored appearance.

Plants may recover partially but lack vigor and yield poorly.

Infected plants have a poorly developed root system (caused by rotting of root hairs) and are often stunted and yellowed. The infected roots are usually a tan to light brown color and have a characteristic watery-soft rotted texture.

Economic Importance

Damping-off is the major cause of emergence failure.

Damping-off tends to be more prevalent and severe when soils are very wet.

The severity of the disease can vary from season to season with the greatest damage occurring when heavy rains fall immediately after sowing. Rhizoctonia may also blight off seedlings before crop emergence. *(See Page 7 : 23)*

Disease Cycle

Damping-off fungi are common in soil, surviving in root debris. They survive on many plant species and can colonize and invade the seeds and roots of many different plants.

The fungus infects developing roots during or immediately after germination. If soils stay wet the disease spreads quickly to other plants.

Control

Treating the seed with fungicide *(See Page 7 : 34)* is the best way of controlling damping-off.

GREY MOULD
Botrytis cinerea

Symptoms

Leaves and stems affected by grey mould initially become covered with fluffy blue-grey mould, later these areas die off. In humid conditions the disease causes stem, leaf and pod rot of peas.

Grey mould often appears first on dead tissue, in particular, old flowers, then spreads to other plant parts.

Economic Importance

The disease is more important in wet seasons. Pod damage is the main cause of economic loss. Crop losses are greatest in dense crops following wet, humid conditions at flowering.

Disease Cycle

The fungus survives either on decaying plant debris, or on a wide range of plants, or in soil.

In dry conditions, grey mould develops first on the stems, then on the leaves. If conditions remain moist the disease may move further up the plant and infect pods. When the damp petals of withering flowers stick to the young pods they create ideal conditions for infection. Infected pods are often completely destroyed by the mould.

Grey mould spores and bits of infected plant matter spread easily - they can be transported by wind, splashing water, and on farm machinery. The disease can also be spread by infected seed.

Control

Using clean seed will minimise the disease risk. Purple flowering peas are generally less prone to grey mould than the white flowering peas.

At present there are no practical control measures for grey mould. In areas prone to outbreaks of grey mould, lower seeding rates may produce a more open crop, thereby increasing air circulation and reducing humidity.

Pea Diseases

SCLEROTINIA ROT

Sclerotinia sclerotiorum

Symptoms

Sclerotinia rot is usually seen late in the season even though young plants may be attacked. Affected plants have water-soaked spots and patches of slimy rotting tissue on leaves and stems. Droplets of brown liquid may be exuded by the infected tissues.

When the infected tissue dies out it may become covered by the fluffy white fruiting bodies of the fungus, which spreads over the surface of the plant.

Small black patches of hardened tissue, called sclerotes, may sometimes be found on the surface and in the tissues of infected plants. These sclerotes may be irregular in size (2 - 5 mm in diameter) and shape.

Economic Importance

Sclerotinia rot is uncommon but can be very destructive, particularly in irrigated crops. The occurrence of the disease is likely to increase where peas are grown in rotation with very susceptible crops such as canola.

Disease Cycle

Sclerotinia spores living in and on the soil surface can directly invade the lower stem and roots of nearby plants.

In wet conditions the spore capsules may germinate and release airborne spores which can also cause infection. The airborne spores can be blown into neighboring paddocks.

Damp conditions are needed for extended periods before infection will take place. Once the plant has been infected the fungus moves through the entire plant within a few days causing the stems to rot completely killing the plant. Sclerotes formed on the infected plants remain after harvest to carry over the disease.

Other sclerotes may be harvested along with the seed and may then introduce sclerotinia rot to new areas in contaminated seed batches *(See Plate 7 : 40)*.

Control

Sow seed that is not contaminated with sclerotes of sclerotinia and avoid cropping areas recently sown to oilseeds.

Although the fungus has a very wide host range, cereals are not a host and so can be grown in rotation with peas to control this disease.

Paddocks affected by sclerotinia rot should be ploughed deeply and not cropped to peas or other susceptible crops for several years.

SEPTORIA BLOTCH

Septoria pisi

Symptoms *(See Plate 7 : 60, 7 : 61)*

Septoria blotch causes yellow to straw colored blotches on the lower, older parts of the plant and the pods. The blotches vary in size and have no sharp margin. Several blotches may join together to cover the entire leaf. The tiny fruiting bodies of the fungus may be seen inside the blotches. Diseased areas may dry off prematurely.

Economic Importance

Septoria blotch is wide spread but appears to have little effect on the yield of peas. The disease has caused severe losses in canning pea crops in the United States.

Disease Cycle

The fungus oversummers on infected pea trash and seed. Spores of the fungus are carried from the infected trash onto the new crop by wind.

The disease usually begins on the lower foliage where the humidity is high following rain or heavy dews.

Extended periods of high humidity and warm temperatures encourage the development of septoria blotch.

Water splash helps to spread the disease within a paddock.

Seed transmission of septoria blotch can occur and may be an important source of infection.

Control

The disease only affects peas and can be avoided by crop rotation. Control measures are usually not warranted because the disease appears to have little impact on yields.

Pea Diseases

STEM NEMATODE

Ditylenchus dipsaci

Symptoms *(See Plate 7 : 62)*

Heavy infections cause patches of stunted malformed plants or poor germination. Peas will often turn yellow-green. In many instances the symptoms, leaves curling and showing water-soaked areas, are confused with herbicide damage. Sometimes the stem will die back but this occurs more frequently in beans, than in pea crops.

Economic Importance

This nematode can have a significant effect on pea yields, but seriously affected crops are rare.

Disease Cycle

Stem nematode infects pea crops from infested seed, straw or soil.

It infects above ground parts of the plants and can multiply many times during the growing season. Disease build-up is worse in wetter situations.

The nematode can survive for many years in seed, straw or soil without having to infect plants. Hosts of this nematode include beans, vetch, oats, wild oats, rye, maize, onion, strawberry, some broad leaf weeds, bedstraw but not other cereals.

Control

Do not introduce the nematode onto the farm or into clean paddocks. Check seed for the presence of the nematode *(See Seed Testing - Page 3 : 1)* and do not bring straw or soil from infested areas onto the property.

Rotations with non-host crops will reduce nematode numbers.

High rates of nematicide at sowing are needed to prevent damage - these treatments are uneconomic.

VIRUSES

Luteoviruses: bean leafroll luteovirus (BLRV), subterranean clover redleaf luteovirus (SCRLV) and subterranean clover stunt virus (SCSV) Cucumber mosaic virus (CMV), Alfalfa Mosaic Virus (AMV) Pea Seedborne Mosaic Virus (PSbMV)

Symptoms *(See Plate 7 : 63, 7 : 63B and 7 : 63C)*

Luteoviruses cause yellowing (sometimes reddening) of leaves, stunting of growth and premature death. Plants infected at the seedling stage show uniform discoloration and stunting. When plants are infected at a later stage the topmost leaves turn yellow before the whole plant starts to deteriorate. In New Zealand and elsewhere, luteovirus diseases of peas are called 'top yellows'.

Other viruses may cause similar symptoms to those of luteoviruses or may show as flecking, a mosaic, or vein yellowing and distortion of the leaves.

CMV causes yellowing, wilting and curling of growing points. Brown streaks develop on leaves and stems, pods flatten and turn purple.

PSbMV symptoms include downward rolling of leaves and plant malformation, mild chlorosis and vein clearing, mosaic and general stunting. Symptoms are most severe on plants emerging from infected seeds. A mosaic pattern is evident on infected seeds. *(Plate 7 : 63C)*

Economic Importance

Severe luteovirus disease can occur, particularly in northern NSW, following the first detection of BLRV in 1993. In the southern cropping regions, viruses are of minor importance.

Disease Cycle

Lucerne, other pasture pulses, and weeds are sources of the virus for pea crops. Aphids carry the viruses from these into pea crops. Seed transmission is not a concern with luteoviruses, but is for CMV, AMV and PSbMV.

Control

For luteoviruses, tolerant varieties are the most effective control option. *(See Table 2 : P)*

Pea seed for export to some countries requires a phytosanitary certificate documenting that the seed has been tested and found to be free from PSbMV. Commercial testing services *(See Page 3 : 1)* can provide this test.

Grain Vetch Diseases

RUST

Uromyces vicia-fabae

Symptoms *(See Plate 7 : 75)*

Symptoms are similar to rust in faba beans, although it is a different strain to the rust that occurs on faba beans. Numerous small, orange-brown pustules, appear on the leaves of plants affected by rust. As the disease develops severely infected leaves wither and drop off. The rust pustules on the stems are similar but often larger than those on these leaves.

Rust pustules may also appear on the pods. A severe rust infection may cause premature leaf fall, resulting in smaller seeds.

Economic Impact

Rust is most prevalent in all warmer vetch-growing areas e.g. northern NSW and in wetter seasons in southern Australia. The disease has caused losses of up to 30 percent on its own, and in combination with chocolate spot has reduced yields by up to 50 percent.

Disease Cycle

The fungus survives on stubble trash and self-sown vetch plants. Rust spores are blown onto new crops by the wind. Faba beans are not a source of infection but volunteer vetch plants are.

Rust pustules form on the first few plants to be infected and the disease spreads from these to other plants. Rainfall or dew is necessary for infection.

Control

Prevention is difficult because the fungus spores can be carried long distances by wind to infect crops far away from the initial source of infection.

The risk of disease can be reduced by burning or burial of old vetch stubbles and crop rotation. Controlling volunteer vetch plants germinating with an early break to the season will reduce the carryover of rust.

Fungicides may be used to control the disease and prevent a rust epidemic. *(See Page 7 : 34)* In areas where the disease is prevalent e.g. northern NSW several sprays will be necessary for adequate disease control.

ASCOCHYTA BLIGHT

Ascochyta pisi f.sp. viciae

Symptoms *(See Plate 7 : 72)*

Ascochyta blight in vetch starts as grey spots on leaves. These show through both sides of leaves whereas young chocolate spot lesions do not show through at first. Ascochyta spots become irregularly shaped, and may merge to cover most of the leaf surface.

Leaf tissue next to the affected patches may become black and die off. Many tiny black fruiting bodies develop within the patches as the disease progresses.

Economic Importance

The disease is mostly in high rainfall areas (above 450 mm) in southern Australia but the severity of the disease varies a great deal from crop to crop and between seasons. Yield losses are not as severe as ascochyta blight in faba beans.

Disease Cycle

The ascochyta fungus can survive on crop debris, self-sown plants and on infected seed. During wet weather the disease spreads from infected to healthy plants by rainsplash and windborne water droplets.

Infection can occur at any stage of plant growth following either rain or heavy dew. The disease tends to be most severe early in the season and in wet years.

Control

Resistant varieties such as Morava *(Table 2 : R)* will reduce the impact of this disease. Ascochyta can be controlled by sowing disease-free seed, by crop rotation, by controlling self-sown vetch plants, (including wild tares) in rotations and by sowing crops away from infected vetch trash.

Chemical seed treatments reduce the risk of introducing disease from infected seed. *(See Page 7 : 34)*

Foliar sprays with fungicide *(See Page 7 : 34)* may be economic when the disease is likely to be severe. Late sprays can reduce seed infection.

Grain Vetch Diseases

CHOCOLATE SPOT

Botrytis fabae

Symptoms *(See Plates 7 : 73 and 7 : 74)*

Spots, ranging from small dark brown spots on leaves and stems to complete blackening of the entire plant are symptoms of chocolate spot in vetch. Leaves are the main areas affected but under favorable conditions the disease may also affect stems, flowers and pods.

Economic Importance

Chocolate spot occurs in all areas where vetch is grown. It is a major disease of vetches in southern Australia. Losses range from minor to complete crop failure depending in the seriousness of infection, the time at which infection occurs and the amount of spring rainfall.

In unprotected crops the disease commonly reduces yields by 30 to 50 percent in a bad year, through loss of leaves and collapse of stands.

Disease Cycle

The fungus can survive in crop debris, in infected seed, or on self-sown plants. In following years the infection usually begins when spores on old vetch trash are carried onto new crops by wind. These spores can be carried over long distances. Chocolate spot may also be introduced into new vetch-growing districts by sowing infected seed.

Once the disease becomes established it rapidly spreads within the crop. It spreads most aggressively in humid conditions particularly at flowering time.

Control

The disease risk can be reduced by destroying all vetch trash and self-sown plants before sowing, sowing disease free seed and crop rotation. Delaying sowing also reduces the disease risk. The fungus is the same one that causes chocolate spot in faba beans, so vetch should not be grown in or near infected bean stubble.

Fungicides can be used to control the disease *(See Page 7 : 34)*. To ensure that chocolate spot is controlled before it has a significant impact on the yield of the crop, the crop should be checked for disease every seven days while the temperature remains below 15°C. If the weather is mild with day temperatures between 15°C and 20°C and humidity over 70 percent in crops, inspections should be made every three days.

Spraying to control chocolate spot should be considered immediately prior to canopy closure as a protective spray that is able to penetrate the canopy.

Follow up sprays will be necessary where:

- the disease is visible in the crop or
- relative humidity in the crop is likely to remain high for at least a week or
- the disease is increasing.

Grain Vetch Diseases

STEM NEMATODE

Ditylenchus dipsaci

Symptoms

Heavy infections will show up as patches of malformed and stunted plants, or poor germination. The malformation, curling of leaves and water-soak spots, is often confused with herbicide damage. Sometimes the stem will die back, turning reddish brown from the base and stopping at a leaf.

Economic Impact

A heavy infestation of this nematode can cause large yield losses but this has occurred only rarely.

Disease Cycle

Stem nematode infects vetch crops from infested seed, straw or soil.

It infects above-ground parts of plants and can multiply many times during the growing season. Disease build-up is worse in wetter situations and at temperatures less than 15°C.

The nematode can survive for many years in seed, straw or soil without having to infect plants. Hosts of this nematode include beans, peas, oats, wild oats, rye, maize, onion, strawberry and some weeds including bedstraw, but not other cereals.

Control

Do not introduce the nematode onto the farm or into clean paddocks. Check seed for the presence of the nematode *(See Seed Testing - Page 3 : 1)* and do not bring straw from infested areas onto the property.

Rotations with non-host crops will reduce nematode numbers.

High rates of nematicide at sowing are needed to prevent damage - these treatments are uneconomic.

Fungal Disease Control -

When to spray

Sprays will control fungal disease, but when and how often to spray will depend on the varietal resistance, amount of infection, the impending weather conditions and the potential yield of the pulse crop.

Fungal disease control is geared around protection rather than curing. The first fungicide spray must be applied as early as necessary to minimise the spread of the disease. Additional sprays are required if the weather conditions favour the disease.

Principles of spraying

A fungicide spray at the commencement of flowering protects early pod set. Additional protection may be needed in longer growing seasons until the end of flowering. Fungicides last around 2 to 3 weeks. Remember all new growth after spraying is unprotected.

In periods of rapid growth and intense rain (50mm over several days) the protection period will reduce to around 10 days.

Timing of fungicide sprays is critical. As chocolate spot can spread rapidly, DO NOT DELAY spraying. A spray in advance of a rainy period is most desirable. Despite some fungicide washing off, the disease will be controlled. Delaying until after a rainy period will decrease the effectiveness of the fungicide as the disease has started to spread.

Repeat fungicide sprays depend on:

- the amount of unprotected growth
- rainfall since spraying
- likelihood of further extended rainy periods.

Unprotected crops can lose over 50% in yield. In severe cases the crop may drop all its leaves.

TABLE 7 : A **Principles of when to spray faba beans for fungal disease control.**

Disease	Occurrence	When to Spray
Ascochyta blight	First appears under wet conditions, often before flowering	At 6-8 weeks after sowing, during seedling stage. Again during flowering if ascochyta blight is detected and rain is likely. Again at end of flowering when pods are filling, if ascochyta blight is detected and rain is likely. Disease is spread by rainfall.
Chocolate spot	Develops during warm (15-20°C) humid (>70%) conditions, usually at flowering	During early to mid flowering as a protective spray. Additional sprays may be necessary through flowering and pod filling if disease progresses. Disease is favoured by warm weather (15-20°C) and high humidity (>70%RH).
Cercospora leaf spot	On lowest leaves early in season, 3-4 weeks after emergence	Shortly after emergence prior to establishment of disease. Approximately 5-7 weeks after sowing.
Rust	Late in the season, during hot (20 - 30°C) humid conditions through grain filling.	At first sign of disease during flowering or pod filling. Disease is favoured by hot (20-30°C) and humid conditions.

TABLE 7 : B **Carryover of major pulse diseases showing their relative importance as sources of infection**

Crop	Disease	Stubble	Seed	Soil
Chickpeas	Botrytis grey mould	★★★	★★★	★
	Phoma	★★	★	★
	Sclerotinia	★	★	★★★
	Ascochyta blight	★★★	★★	★
Faba Beans	Chocolate spot	★★★	★	★
	Cercospora	★★	–	★★★
	Rust	★	–	–
	Ascochyta blight	★★★	★★	★
Lentils	Ascochyta blight	★★★	★★★	★
	Botrytis grey mould	★★★	★★	★
Lupins	Anthracnose	★★	★★★	–
	Sclerotinia	★	★	★★★
	Brown leaf spot	★★★	★	★★★
	Phomopsis	★★★	★★	–
	CMV	–	★★★	–
Peas	Black spot	★★★	★★	★★
	Bacterial blight	★★	★★★	–
	Septoria	★★★	★★	–
	Foot rot	★★	★	★★★
	Downy mildew	★★	★	★★★
	Powdery mildew	★	★	-
Vetch	Chocolate spot	★★★	★	★
	Ascochyta blight	★★★	★	★
	Rust	★	–	–

– none ★ minor ★★★ major

TABLE 7 : C

Diseases occurring on pulses with potential for cross infection.

	Chickpea	Faba Bean	Lentils	Lupins	Peas	Vetch
Botrytis Grey Mould						
Botrytis cinerea	★★	★★	★★	★	★★	★★
Chocolate Spot						
Botrytis fabae	★★	★★	★★			★★
Cercospora Leaf Spot						
Cercospora zonta		★★				
Sclerotinia						
Sclerotinia sclerotiorium	★★		★★	★★	★★	
Sclerotinia trifoliorium	★★	★★		★★		
Bacterial Blight						
Pseudomonas andropogonis	★					
Pseudomonas syringae pvv syringae		★★	★		★★	
Pseudomonas syringae pvv pisi					★★	
Ascochyta Blight						
Ascochyta fabae		★★				★
Ascochyta lentis			★★			
Ascochyta pisi	★				★	★
Ascochyta rabiei	★★					
Phoma Blight						
Phoma medicaginis var pinodella	★★	★★	★★	★	★★	★★
Black Spot (see also Phoma & Ascochyta)						
Mycosphaerella pinodes	★★	★	★		★★	★
Anthracnose						
Colletotrichum gloeosporoides				★★		
Brown Leaf Spot						
Pleiochaeta setosa				★★		
Grey Leaf Spot						
Stemphylium botryosum	★		★★	★★		
Downy Mildew						
Peronospora viciae					★★	★
Powdery Mildew						
Erysiphe polygoni					★★	
Septoria						
Septoria pisi					★★	
Phomopsis						
Phomopsis leptostromiformis				★★		
Rust						
*Uromyces vicia - fabae***		★★			★	★★
Root Lesion Nematode						
Pratylenchus neglectus	★					
Pratylenchus thornei	★★					★★
Stem Nematode						
Ditylenchus dipsaci	★	★★			★★	★
Virus						
Bean yellow mosaic virus		★		★★		
Cucumber mosaic virus		★	★★	★★		
Luteo viruses complex (eg BLRV & BWYV)	★★	★★	★		★★	★★
Pea seedborne mosaic virus					★★	
Alfalfa mosaic virus	★★	★	★★			★
Wilt						
*Fusarium oxysporum***				★★	★★	
Root Rots						
Fusarium	★	★	★	★	★	★
Macrophomina	★				★★	
Phytophthora medicaginis	★★					
Pleiochaeta setosa				★★		
Pythium *	★		★	★	★	
Rhizoctonia	★	★★	★★	★★	★★	★★
Sclerotinia *	★		★	★	★	

★★ = This disease has caused major damage to this crop.

★ = This disease occurs on this crop but has not caused major damage.

* Sclerotinia (root rot) is worse (★★) in Kabuli than Desi (★) Pythium and Grey Mould is worse (★★) in white peas than Duns (★)

** Strain differences between crops.

For details of the disease refer to the text in section 7.

Fungicides

Suggested Fungicide Treatments for Control of Pulse Diseases in South Australia, 2008

Crop & Disease	Seed Treatments: Thiraflo® (L/t)	Seed Treatments: P-Pickel T (L/t)	Seed Treatments: Apron® XL (ml/t)	Seed Treatments: Mantle®, Rampart® (g/t)	Seed Treatments: Iprodione (various) (L/t)	Seed Treatments: Fortress 500SD Sumisclex® (L/t)	Foliar Sprays: Carbendazim (various) (ml/ha)	Foliar Sprays: Barrack® Betterstick Bravo® Weatherstik Unite 720 (L/ha)	Foliar Sprays: Kocide® Coppit-oh®, Blue Shield® (kg/ha)	Foliar Sprays: Mancozeb (various) (kg/ha)	Foliar Sprays: Dithane® Rainshield (kg/ha)	Foliar Sprays: Procymidone (various) (ml/ha)	Foliar Sprays: Tebuconazole (various) (ml/ha)	Foliar Sprays: Accord® Triadimefon (ml/ha)	Foliar Sprays: Penncozeb 420SC (L/ha)
Peas															
Blackspot	–	2.0	–	–	–	–	–	2.5G	2.2	2.5G	1-2.2	–	–	–	•
Downy mildew	–	–	750	1.5	–	–	–	1.1-1.8G	–	--	–	–	–	–	–
Powdery mildew	–	–	–	–	–	–	–	•	•	-	–	•	145	500	–
Bacterial blight	–	–	–	–	–	–	–	–	2.2	–	–	–	–	–	–
Fusarium root rot	–	2.0	–	–	-	–	–	–	–	–	–	–	–	–	–
Damping-off	2.0G	2.0	750	1.5	–	–	–	–	–	–	–	–	–	–	
Faba Beans															
Cercospora leaf spot	–	–	–	–	–	–	500G	2.0G	•	–	–	–	145-290	•	–
Chocolate spot	2.0G	–	–	–	–	–	500	1.4-2.3	2.2	1.7-2.5	1-2.2	500	–	–	3.5
Ascochyta blight	2.0G	2.0G	–	–	–	–	-	1.0-2.3G	2.2G	1.7-2.5	1-2.2	–	–	–	3.5
Rust	–	–	–	–	–	–	-	1.3-2.3	2.2	1.7-2.5	1-2.2	–	–	–	3.5
Fusarium root rot	-	2.0	–	–	–	–	-	-	-	-	–	-	-	–	–
Damping -off	1.5G	2.0	750G	1.5G	–	–	-	-	-	-	–	–	-	–	–
Lupins															
Anthracnose	1.7-2.0	–	–	–	–	1 or 2G	–	–	–	1.0-2.2	1-2.2	–	–	–	–
Brown leaf spot	–	–	–	–	1-5	1 or 2	•	2.5G	•	•	•	•	–	–	•
Phomopsis	–	–	–	–	–	–	•	•	•	•	•	•	–	–	•
Chickpeas															
Ascochyta blight	2.0	2.0	–	–	–	–	–	1.0-2.0P	–	1.0-2.2P	1.2.2	–	–	–	1.8-3.9P
Phoma root rot	2.0	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–
Phytopthora root rot	–	•	750	1.5	–	–	–	–	–	–	–	–	–	–	–
Botrytis grey mould	2.0	2.0	–	–	–	–	500	1.0-2.3G	•	1.0-2.2P	1-2.2	•	–	–	1.8-3.9P
Damping off (kabulis)	2.0	2.0	750G	1.5G	–	–	–	–	–	–	–	–	–	–	–
Lentils															
Ascochyta blight	–	2.0	–	–	–	–	–	1.0-2.0P	•	1.0-2.2P	1-2.2	–	–	–	1.8-3.9P
Botrytis grey mould	–	2.0	–	–	–	–	500	1.0-2.0P	•	1.0-2.2P	1-2.2	500	–	–	1.8-3.9P
Fusarium root rot	–	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–
Damping-off	2.0G	2.0	750G	1.5G	–	–	–	–	–	–	–	–	–	–	–
Vetch															
Rust	–	–	–	–	–	–	–	1.0-2.3G	2.2G	1.0-2.2	1-2.2	–	–	–	•
Chocolate spot	–	–	–	–	–	–	500	1.0-2.3G	2.2G	1.0-2.2	1-2.2	500G	–	–	•
Ascochyta blight	–	2.0G	–	–	–	–	–	1.0-2.3G	2.2G	1.0-2.2	1-2.2	–	–	–	•
	Mix 2L with 3L water.	Mix 2L with up to 8L water.	Apply diluted with water.	Apply as a dust or slurry.	Apply as slurry. May be antagonistic to rhizobia.	Use higher rate if severe disease expected.	Add wetting agent.	Use lower rate if crop less than 20cm high or before flowering.	Do not spray crops affected by frost, in hot weather, or if poor drying conditions persist.	Add wetting agent at 0.1 to 0.2%.	Add wetting agent at 0.1 to 0.2%.	Apply in 30L water/ha by aircraft. Add wetting agent.	Apply in at least 50L of water by ground.	Repeat 14 days later if disease pressure high.	
Registration or permit South Australia	Chickpeas Lupins	Peas Chickpeas Lentils	Chickpeas, Peas	Chickpeas Peas	Lupins	Lupins	Beans Chickpeas Lentils	Beans Chickpeas Lentils	Peas Beans	Beans Chickpeas Lentils	Beans Chickpeas Lentils, Lupins Peas, Vetch	Beans Lentils	PA	Peas	Beans Chickpeas Lentils

– = No control or not recommended. • = No or insufficient information.
NR = Not registered on any crop. RP = Registration pending.
P = Permit PA = Permit applied. G = Not registered for that specific crop or disease.

See page 7 : 34 for notes on fungicides.

Charts have been compiled from PIRSA Spraying Charts and in consultation with chemical companies.

These suggestions are based upon only limited trial work/or farmer experience and, hence, do not necessarily apply to all situations.

Comments on Fungicides

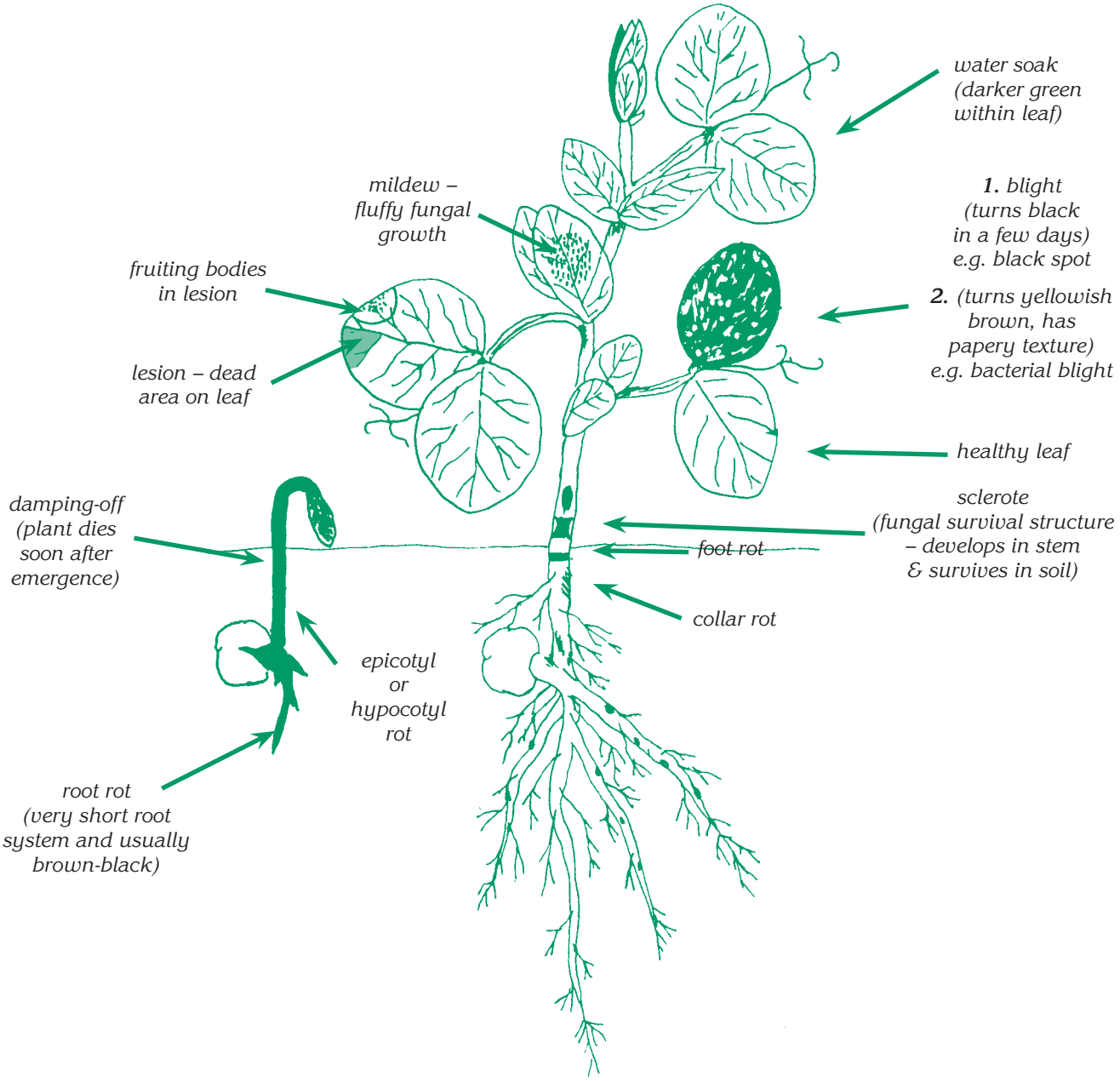
NOTE: These recommendations are for South Australia. Registrations may differ in other states.

For more details check the label, including grazing withholding periods

SEED TREATMENTS	REMARKS
THIRAFLO® (600g/L thiram)	Effective against damping off root rots that kill seedlings before or soon after emergence. Can also prevent seedborne transmission of some diseases. Do not mix in a slurry with chickpea or lupin rhizobial inoculant.
P-PICKEL TSC (200g/L thiabendazole and +360g/L thiram)	Broad-spectrum liquid fungicide seed treatment. Controls black spot for up to eight weeks after sowing. May also give some control of botrytis grey mould of chickpeas lentils. Mix 2L of product with up to 8L of water for each 1 tonne of seed.
APRON XL® 350 ES (350g/L metalaxyl-M) MANTLE®, RAMPART® (350g/kg metalaxyl)	Activity limited to control of downy mildew at early stages of crop infection and several root diseases. Apply rhizobium separately. DO NOT store treated seed for more than 6 months before sowing.
CIVET®, ROVRAL®, PROSHIELD, VANQUISH, XLFLO (250g/L iprodione)	Apply at 100 to 500ml plus water to make up to 600ml / 100kg seed. Use higher rate where disease pressure higher, eg. close rotations with lupins.
FORTRESS® SD SUMISCLEX® BROADACRE (500g/L procymidone)	100ml rate - mix with 300ml water per 100kg seed. 200ml rate - mix with 200ml water. Agitate during application to stop settling.

FOLIAR SPRAYS	
BAVISTIN®, SPINFLO®, CARBEND®, HOWZAT®, GOLDAZIM®, BOOMER®, (500g/L carbendazim)	Broad-spectrum systemic fungicide. However, movement of fungicide to new growth developing after spraying is negligible.
BARRACK® BETTERSTICK, BRAVO® WEATHERSTIK, UNITE 720 (chlorothalonil)	Broad-spectrum protectant fungicide. For best results spray at an early stage of disease development. Note these are the only chlorothalonil products with a permit for use in pulses. Check label for grazing restrictions and withholding periods.
KOCIDE® 101, COPPIT-OH®, BLUE SHIELD® (540g/kg cupric hydroxide)	Broad-spectrum protectant fungicide. For best results spray at an early stage of disease development. A fine powder formulation suitable for application from aircraft.
DITHANE® RAINSHIELD, DITHANE® M-45, MANCOZEB, MANZATE® or PENNCOZEB® 750 DF (750 or 800g/kg mancozeb) PENNCOZEB 420SC (420 g/L mancozeb)	Broad-spectrum protectant fungicide. For best results spray at an early stage of disease development. Dithane Rainshield has improved rainfastness.
FORTRESS® 500, SPIRAL®, SUMISCLEX® BROADACRE (500g/L procymidone)	Locally systemic fungicide with protectant and eradicant activity on chocolate spot of faba beans. Apply in 30L water/ha by aircraft. Use wetting agent at 0.1% of 600g/L product.
FOLICUR® 430 SC, TEBUCONAZOLE (430g/L tebuconazole)	Eradicant fungicide giving good control of powdery mildew. Wetting agent not required.
ACCORD®, TRIAD® 125, TRIADIMEFON, TURRET® (125g/L triadimefon)	Apply first spray at flowering. This is a preventative spray and should be applied at very first sign of disease or just before disease appears. Apply a second spray 14 days later (about flat pod stage). DO NOT mix with post emergent broadleaf herbicide.

Drawing explaining some of the disease terms
(See also page 3:17 for plant part terms)



Chickpea diseases

Plate 7.1

Botrytis (grey mould) infection on lower stem of chickpeas.

Plate 7.1A

Botrytis (grey mould) on pods of chickpeas.

Plate 7.2

Root systems can be severely affected by phytophthora root rot.

Plate 7.3

Phytophthora root rot can kill chickpeas.

Chickpea diseases

Plate 7.4

Successive crops of chickpeas can be devastated by root rots such as phytophthora. Crop on left had chickpeas in the previous year. Crop on right did not.

Plate 7.4A

Sclerotinia causing pod abortion of chickpeas.

Plate 7.5

Luteovirus in Amethyst chickpeas.

Plate 7.6

Early symptoms of alfalfa mosaic virus, showing affected shoot tips.

Faba bean diseases - chocolate spot

Plate 7.7

Infections of chocolate spot in beans start as small brown spots.

Plate 7.8

Grey, dead areas of chocolate spot spread out from brown spots. Flowers are also blighted, stopping any pod set.

Plate 7.9

Chocolate spot causes a brown speckle on pods and stems.

Plate 7.10

Chocolate spot can cause thick parts of crop (e.g. headlands) to lodge.

Faba bean diseases - chocolate spot and cercospora

Plate 7.11
Seed infected with chocolate spot (left) has a brown stain. Healthy seed on the right.

Plate 7.12
Chocolate spot on leaves.

Plate 7.12A
Chocolate spot on stems.

Plate 7.12B
Cercospora leaf lesions on beans.

Faba bean diseases - Ascochyta blight

Plate 7.13

Comparison of ascochyta (large grey spot) with chocolate spot (small brown infection).

Plate 7.14

Infections start as small grey spots and may spread to the leaf edge.
Inset - Ascochyta lesion.

Plate 7.15

Pale centres of ascochyta may fall out leaving holes in leaves.

Plate 7.16

Older infections turn pale with black specks.

Faba bean diseases - Ascochyta blight

Plate 7.17

Stem infections are sunken with pale centres.

Plate 7.18

Severe stem infections can cause complete blight of stems (on left).

Plate 7.19

Pod infections are black and sunken. They range from small isolated spots to the large multiple infection shown here.

Plate 7.20

Left Ascochyta on bean stems cause stem breakage and lodging. Right Staining resulting from Ascochyta infection. Disease is transferred by seed to new crop.

Faba bean diseases - Rust

Plate 7.21
Leaves can be heavily infected with rust.

Plate 7.22
Young rust infections have a pale green ring, compared with no ring around chocolate spot infection (at pencil; tip).

Plate 7.23
Rust shows as orange bumps on leaves.

Plate 7.24
Rust on faba bean stem.

Faba bean diseases

Plate 7.25
Stem nematode causes stunting and twisting of leaves. Black streaks down stems are also a symptom.

Plate 7.26
Clover yellow vein virus.

Plate 7.27
Bean leaf roll virus.

Plate 7.28
Leaf symptoms of bean yellow mosaic virus.

Lentil diseases

Plate 7.29
Ascochyta on lentils.

Plate 7.30
Ascochyta lesions on pods.

Plate 7.31
Ascochyta staining on seeds.

Plate 7.32
Sclerotinia white hyphae in lentils.

Lentil diseases - Botrytis grey mould

Plate 7.32A
Early leaf lesions of botrytis grey mould.

Plate 7.32B
Botrytis grey mould on lentil pods.

Plate 7.32C
Botrytis grey mould patch in lentils.

Plate 7.32D
Botrytis grey mould sclerotes on lentil stems.

Lupin diseases - Phomopsis

Plate 7.33

Fully developed infection of phomopsis on old lupin stem.

Plate 7.34

Stem lesion, early stage on growing plant.

Plate 7.35

Stem lesions, developed, showing tan coloring and black fruiting bodies.

Plate 7.36

Phomopsis on lupin seed. Note yellow to reddish-tan staining.

Lupin diseases

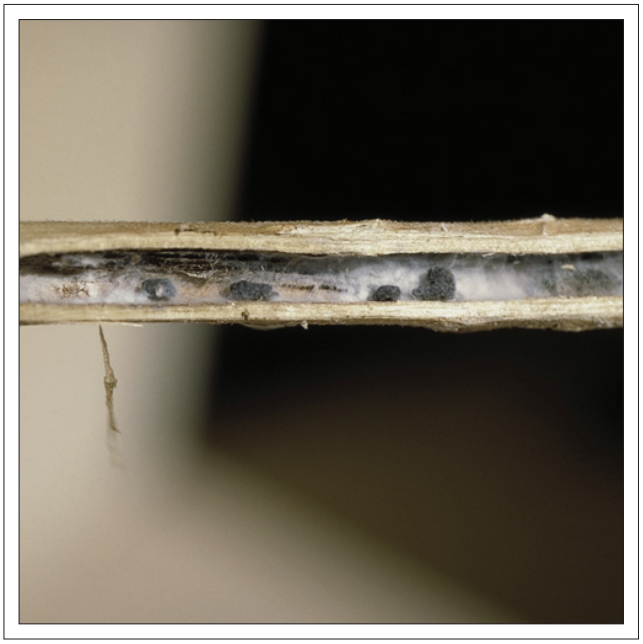


Plate 7.36A
Sclerotinia hyphae and sclerotes in cut stem.

Plate 7.36B
Brown leaf spot on stems.

Plate 7.36C
Brown leaf spot on pods.

Plate 7.36D
Brown leaf spot on leaves.

Lupin diseases

Plate 7.37
Brown leaf spot on lupins.

Plate 7.38
Pleiochaeta root rot on lupins (caused by the brown leaf spot fungus).

Plate 7.39
Stem lesion caused by sclerotinia. Note white fungal growth (fungal sclerotes develop in this area).

Plate 7.40
Sclerotes of sclerotinia contamination of a seed sample can be a future source of infection.
Left: contaminated sample.
Top: sclerotes.
Right: clean sample.

Lupin diseases - viruses

Plate 7.41
Cucumber mosaic virus in lupins, causes bunching of the plant tops.

Plate 7.42
Cucumber mosaic virus occurred early.

Plate 7.43
Cucumber mosaic virus occurred late.

Plate 7.44
Bean yellow mosaic virus in lupins.

Lupin Diseases

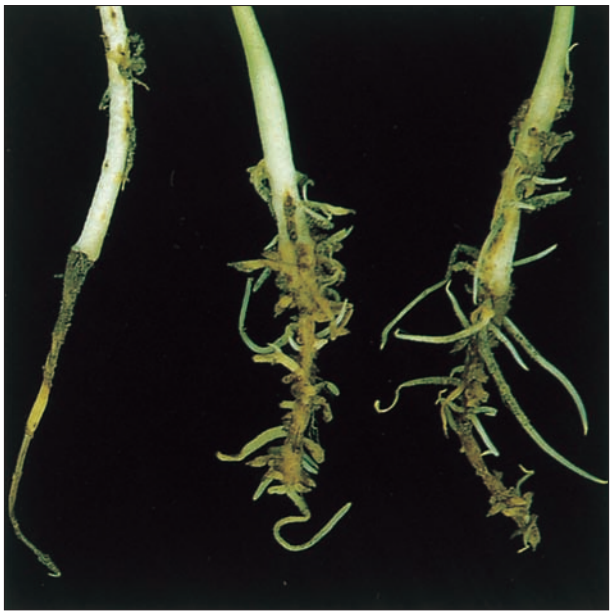


Plate 7.45

Varying degrees of infection by rhizoctonia. Note the most severely affected have no lateral roots.

Plate 7.46

Rhizoctonia infection on hypocotyl of lupins. Note red lesions on the hypocotyl.

Plate 7.47

Patches of stunted plants in a lupin crop caused by rhizoctonia.

Plate 7.47A

Black root rot in lupins.

Pea diseases - Black spot

Plate 7.48
Black spot on leaves of peas.

Plate 7.49
Black spot on leaves and stems.

Plate 7.50
Black spot on lower stems.

Plate 7.51
Black spot on pods.

Pea diseases

Plate 7.52

Downy mildew can be identified by the pale grey fungus on underneath the leaves.

Plate 7.53

Downy mildew on peas. Note the grey fungal growth on the under side of the leaves.

Plate 7.54

Powdery mildew on pea leaves is characterised by white fungus initially on the topside of leaves.

Plate 7.55

Severe powdery mildew on leaves and pods.

Pea diseases

Plate 7.56

Severe powdery mildew on pea pod. Grey fungal spores cover the pod.

Plate 7.57

Fusarium root rot of peas. Most severely affected on left. Unaffected root system on right.

Plate 7.58

Rhizoctonia on peas. The root system can be severely retarded. Note the rotted "spear" tips of roots.

Plate 7.59

Bacterial blight on pea stipules. Note the fan like pattern of the blight.

Pea diseases

Plate 7.60
Septoria of peas - left on petiole and right on leaf.

Plate 7.61
Septoria on pea leaves.

Plate 7.62
Stem nematode in peas. Plants become severely stunted and distorted.

Plate 7.63
Early infection symptoms of luteovirus in peas (3 plants on right).

Pea diseases

Plate 7.63A
Downy mildew on pea seedlings.

Plate 7.63B
Clover yellow vein virus.

Plate 7.63C
Pea seedborne mosaic virus on seeds.

Chickpea diseases - Ascochyta blight

Plate 7.64
Ascochyta blight: Initial infection with Ascochyta from seed occurs in patches. Spores are splash borne to neighbouring plants.

Plate 7.65
Ascochyta blight: Lesions on branches and stems are brown and cause stems to break. Fungal fruiting bodies are visible in freshly killed tissue.

Plate 7.66
Ascochyta blight: Lesions on leaves showing fungal fruiting bodies.

Plate 7.67
Ascochyta blight: Late rains can cause infection of pods. Seed are also infected at this time.

Lupin diseases

Plate 7.68

Anthracnose: Seed-borne infection of young seedlings in regrowth.

Plate 7.69

Anthracnose: Stem lesions form masses of pink spores in the centre. Lesions constrict the stems causing distortion and death of the foliage.

Plate 7.70

Anthracnose: Distortion of growing points caused by stem infection.

Plate 7.71

Anthracnose: Infection occurs initially in patches due to localised spread of splash-borne spores.

Vetch diseases

Plate 7.72
Ascochyta leaf lesion.

Plate 7.73
Chocolate spot on leaves.

Plate 7.74
Chocolate spot on pods.

Plate 7.75
Rust on leaves.