SOUTHERN
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GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

LENTIL

SECTION 10

DISEASES

KEY POINTS | IMPACT AND COST OF DISEASES | INTEGRATED PEST MANAGEMENT (IPM) STRATEGIES | SELECT A RESISTANT VARIETY | PADDOCK SELECTION | GOOD HYGIENE | USE CLEAN SEED | SOWING | RISK ASSESSMENT | SYMPTOM SORTER | FREE ALERT SERVICES FOR DISEASES | CORRECTLY IDENTIFYING DISEASES | BOTRYTIS GREY MOULD (BGM) | ASCOCHYTA BLIGHT | SCLEROTINIA STEM ROT | ALTERNARIA | ROOT ROTS AND DAMPING OFF | STEMPHYLIUM BLIGHT | STEM NEMATODE | ROOT-LESION NEMATODES (RLN) | VIRUSES | EXOTIC DISEASES WITH POTENTIAL TO IMPACT ON AUSTRALIAN CROPS

Diseases

Key points

- Lentil need good disease management to ensure a quality, blemish-free seed product.
- The key diseases in the southern region are Botrytis grey mould (BGM) and Ascochyta blight.
- Avoid growing susceptible varieties and use good agronomic management to minimise the risk of disease. Use a three-year break between lentil crops and sow at least 250 m from other lentil, faba bean, chickpea, vetch or lathyrus crops or stubble.
- Crop monitoring for disease is essential. There are three critical periods for fungicide application. Accurately identify disease to choose the appropriate fungicide.
- Disease pathogens can mutate and overcome resistance. Monitor all varieties regardless of resistance rating.

The major fungal diseases affecting lentil grown in the Southern Region are Botrytis grey mould (BGM) and Ascochyta blight.[1]

The Pulse Breeding Australia lentil program aims to breed varieties that have resistance to BGM and Ascochyta blight and to investigate options for resistance to viruses.[2]

These diseases can be effectively controlled to prevent them from causing yield loss. Management decisions and seasonal conditions play a significant role in disease outbreaks and grain yield. Lentil growers need to take an integrated approach to disease management in most years to produce a profitable crop.

10.1 Impact and cost of diseases

A 2012 GRDC study reported that disease cost the Australian pulse industry an average of $74 million per year or 14.8% of the gross value of pulse production.[3] Losses would be far higher without the current range of controls, which include the use of resistant varieties, rotation, paddock management and the use of pesticides.

In the Australian lentil industry, disease causes an estimated current average annual loss of $2.7 million, or $21.76 per hectare. This is 4.3% of the average annual value of the crop. Most lentil crops (97%) are treated with foliar fungicides at a cost of $114.15/ha per year. These figures are the same for the southern region as the area of lentil grown elsewhere in Australia is minimal.

In the southern region the most important lentil diseases, with a yearly incidence of 25% or more, are Ascochyta blight, BGM caused by *Botrytis cinerea* and/or *B. fabae*, Alfalfa mosaic virus (AMV), Cucumber mosaic virus (CMV) and Turnip yellows virus (TuYV, formerly Beet western yellows virus (BWYV)).[4]

Based on the value of estimated yield losses, the most important diseases are Ascochyta blight ($133/ha) and BGM (>$131/ha). Cucumber mosaic virus ($54/ha) is less of an issue.

While diseases are not going to be an issue every year, when conditions are right such as in 2016, disease can have devastating results.

10.2 Integrated pest management (IPM) strategies

Disease management in pulses is critical, and relies on an integrated management approach to variety choice, crop hygiene and strategic use of fungicides. 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. Once the disease is present, the source is then from within the crop itself.

A plant disease may be devastating at certain times and yet, under other conditions, it may have little impact. The interaction of host, pathogen and environment are all critical in disease development and can be represented by the two disease triangles.

1 W Hawthorne, M Materne, J Davidson, K Lindbeck, L McMurray, J Brand (2015) Lentil: Integrated disease management, Pulse Australia website, http://pulseaus.com.au/growing-pulses/bmp/lentil/idm-strategies

2 GRDC (2016) Pulse Breeding Australia (PBA). GRDC website, https://grdc.com.au/Research-and-Development/Major-Initiatives/PBA

3 GM Murray, JP Brennan (2012) The current and potential costs from diseases of pulse crops in Australia. GRDC Report, https://grdc.com.au/resources-and-publications/all-publications/publications/2012/06/the-current-and-potential-costs-from-diseases-of-pulse-crops-in-australia

4 GM Murray, JP Brennan (2012) The current and potential costs from diseases of pulse crops in Australia. GRDC Report, https://grdc.com.au/Resources/Publications/2012/06/The-Current-and-Potential-Costs-from-Diseases-of-Pulse-Crops-in-Australia

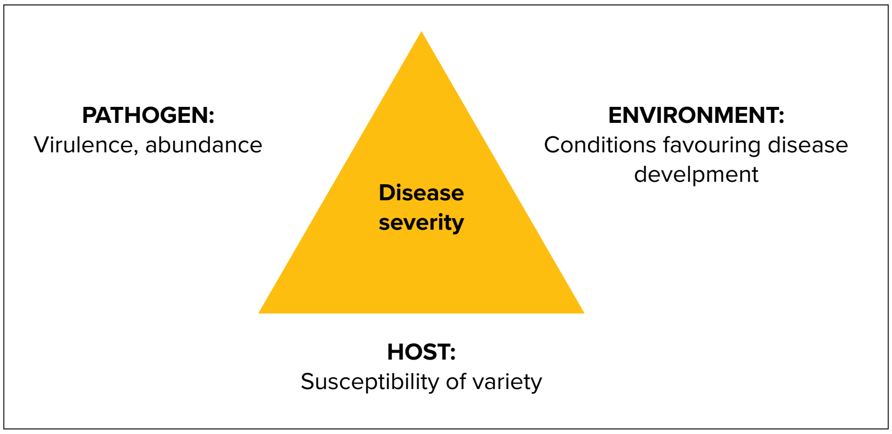

Figure 1: *Fungal disease triangle.*

Source: GN Agrios (1988) Plant Pathology (3rd edition). Academic Press, New York.

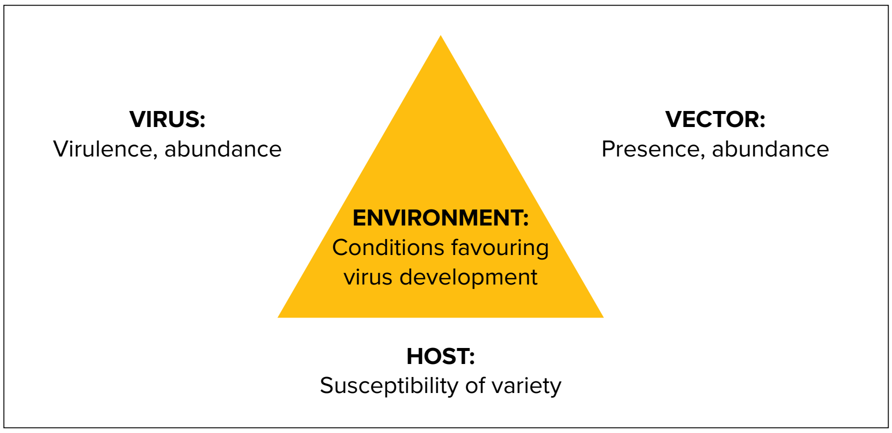

Figure 2: *Viral (and some bacterial) disease triangle.*

Source: RAC Jones, MJ Barbetti (2012) Influence of climate change on plant disease infections and epidemics caused by viruses and bacteria. CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources 7, 1-31.

Where possible choose a pulse variety that is resistant to the most important diseases in your area. Choose a paddock with low disease risk based on rotation and proximity to other pulse crops. Strategic fungicide application is necessary to minimise disease impact. In high-risk situations fungicide disease-control strategies alone may not be sufficient, particularly if susceptible varieties are grown.

The key aspects to managing diseases in pulses are detailed in Sections 10.3 to 10.12. In summary:

- **Varietal resistance** – Select a resistant variety. Spread risk by sowing more than one variety.
- **Distance** – Separate by at least 250 m from stubble of the same pulse from the previous year. This reduces infection for some diseases.
- **Rotation** – Aim for at least a three-year rotation between planting the same pulse crop. A high frequency of crops like lentil, faba bean, vetch, field pea, chickpea, lathyrus or clover pasture puts pulses at greater risk to multi-host diseases such as BGM, Phoma and Sclerotinia; and canola in the rotation can increase the risk of Sclerotinia.
- **Hygiene** – Practice hygiene by reducing last year's pulse stubble, if erosion is not a risk, and removing self-sown pulses before the new crop emerges.
- **Clean seed** – Sow seed from crops with no disease or a low level of infection, especially at podding. Avoid using seed where there was a known disease infection, particularly for susceptible varieties. Have seed tested for disease.

MORE INFORMATION

For more information see Section 9.2 Identifying pests

MORE INFORMATION

Visit the Pulse Australia webpage for information lentil integrated disease management: http://www.pulseaus.com.au/growing-pulses/bmp/lentil/idm-strategies

- **Fungicide seed dressing** - In high-risk situations seed dressings provide partial early suppression of diseases like BGM and Ascochyta blight. They are not effective against viruses and bacterial diseases.
- **Sowing date** - Aim for the optimum sowing window for the pulse variety and your district.
- **Sowing rate** - Aim for a plant population of 100–120 plants per square metre.
- **Wider row spacing** - Wide rows (23–42 cm) delay canopy closure, and may reduce disease if lodging does not occur. Standing cereal stubbles help to keep lentil erect.
- **Sowing depth** - The normal sowing depth is 2–6 cm. When a seed lot is infected with disease deeper sowing will help reduce the emergence of infected seedlings. The seeding rate must be adjusted upwards to account for the potential of a lower emergence and establishment percentage.
- **Foliar fungicide applications** – Susceptible varieties require a more intense fungicide program. Success depends on timing, 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** - Physical damage from excessive traffic, wind erosion, frost, hail, post-emergent rolling or herbicide damage can increase the spread of foliar disease in pulses.
- **Control aphids** – Integrated pest management to reduce the incidence of aphids can reduce the spread of viruses. Spraying insecticide may assist, but is not always effective or and rarely economic. Usually the virus spread has occurred by the time the aphids are detected.
- **Harvest** - Harvest early to minimise disease infection of seed. Consider desiccation as a tool to enable earlier harvesting.

10.3 Select a resistant variety

Selecting a resistant variety is the most effective method of disease control. Other management practices are not always effective and can be expensive and highly dependent on seasonal conditions. Resistant varieties reduce the reliance on foliar fungicides.

The variety resistance ratings are defined as follows:

- Resistant (R) varieties – no economic yield loss is expected under average conditions. Control measures are unlikely to be profitable. Resistant varieties are not immune when conditions are conducive to disease.
- Moderately resistant (MR) varieties are expected to sustain low to moderate yield loss and control measures are likely to be cost effective.
- Moderately resistant to moderately susceptible (MR-MS) varieties are expected to sustain moderate to high losses and control measures are necessary to ensure a profitable crop.
- Moderately susceptible (MS) or susceptible (S) will sustain very high to total yield loss and control measures are essential to produce a harvestable crop.

Most new lentil varieties released across the southern region are resistant to Ascochyta blight at the time of their release.

Variety resistance status may change over time. This can result from disease incursions from overseas or a high population pressure through frequent planting of varieties all relying on the same resistance gene. For instance, a strain with increased virulence to PBA Flash$^{\phi}$, Nipper$^{\phi}$ and Northfield has increased in prevalence and these varieties are now more susceptible to Ascochyta blight.

FEEDBACK

Under extreme disease pressure Ascochyta blight can still develop in a moderately resistant (MR) variety. Growing lentil in a three-year rotation and away from previous crop stubbles is essential to preserve the resistance genes.[5]

Varieties are now rated for Ascochyta blight on both foliage and pods/seed because there are differences. This may influence control strategies and fungicide timings during podding to preserve seed quality and marketability.

Under high disease pressure, all varieties will require fungicide protection to control disease epidemics. In wet seasons, such as 2016 when repeated cycles of infection occurred, even MR varieties can have yield-reducing levels of disease.

The disease ratings in Table 1 were current in early 2016. Always check the updated disease ratings each year in the current crop variety guides for each state or in the National Variety Trials (NVT) Crop Disease Au app.

Table 1: Lentil disease ratings

Variety	Ascochyta blight foliar	Ascochyta blight seed/pod	Botrytis grey mould (BGM)
Small red seed			
Nipper⑪	MR-MS	MR	R/MR
Northfield	MR-MS	MR	S
PBA Bounty⑪	MR-MS	MS	MS
PBA Herald XT⑪	R	R	R/MR
PBA Hurricane XT⑪	MR	R/MR	MR-MS
Medium red seed			
Nugget	MR-MS	MR-MS	MR-MS
PBA Ace⑪	R	R	MR-MS
PBA Blitz⑪	MR	MR-MS	MR
PBA Bolt⑪	MR	R/MR	S
PBA Flash⑪	MS	MS	MR-MS
Large red seed			
Aldinga	MR-MS	MS	MS
PBA Jumbo⑪	MR-MS	S	MS
PBA Jumbo2⑪	R	R	R/MR
Medium green lentil			
PBA Greenfield⑪	MR-MS	MR-MS	MR
Large green lentil			
Boomer⑪	MR	MR-MS	MR-MS
PBA Giant⑪	MR	MS	MS
Tiara	–	–	S

Resistance order from best to worst: R > R-MR > MR > MR-MS > MS > S.
R = resistant, M = moderately, S = susceptible.

Disease ratings from Pulse Breeding Australia. Varieties with a disease rating up to R-MR may require fungicide application under severe disease pressure.

Source: W Hawthorne, M Materne, J Davidson, K Lindbeck, L McMurray, J Brand (2015) Lentil: Integrated disease management, Pulse Australia, http://pulseaus.com.au/growing-pulses/bmp/lentil/idm-strategies

MORE INFORMATION

Crop variety guides https://grdc.com.au/Research-and-Development/National-Variety-Trials/Crop-Variety-Guides

Natinoal Variety Trials (NVT) Crop Disease Au app: http://www.nvtonline.com.au/interactive-tools/apps/

MORE INFORMATION

For more information see Section 9.3 Key pests of lentil

5 A Lawson (2016) Disease pressure builds with intensive lentil production. GRDC Media Release, 14 April 2016, https://grdc.com.au/Media-Centre/Media-News/South/2016/04/Disease-pressure-builds-with-intensive-lentil-production

MORE INFORMATION

See GRDC Media release: Disease pressure builds with intensive lentil production https://grdc.com.au/Media-Centre/Media-News/South/2016/04/Disease-pressure-builds-with-intensive-lentil-production

10.4 Paddock selection

Sow lentil into standing stubble of previous cereal stubble to protect against rain-splash of soilborne spores, protect against erosion and reduce attractiveness of the crop to aphids that can spread viruses.

Rotational crops

Allow three years between growing lentil crops in the same paddock. Do not sow adjacent to lentil stubble, particularly downwind. If possible, aim to separate this year's lentil crop from last year's lentil stubble by a distance of at least 250 m to minimise the inoculum for BGM and Ascochyta blight.

Some diseases have potential for cross infection across more than one pulse crop (Table 2). Reduce disease risk by not sowing adjacent or into faba bean, chickpea, vetch or lathyrus stubble. If this is not possible, manage the lentil crop with a high-BGM-risk management strategy.

In district of high Sclerotinia risk, avoid planting lentil after canola or other broadleaf crops which act as alternative hosts to this disease.

Avoid paddocks with high soil nitrogen, as this can lead to greater vegetative growth in lentil (i.e. heavy canopies), predisposing the crop to disease development, particularly BGM.

Table 2: Diseases occurring on pulses with potential for cross-infection.

	Chickpea	Faba bean	Lentil	Lupin	Pea	Vetch
Botrytis grey mould						
Botrytis cinerea[1]	★★	★★	★★		★★	★★
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 and Ascochyta)						
Mycosphaerella pinodes	★★	★	★		★★	★

FEEDBACK

	Chickpea	Faba bean	Lentil	Lupin	Pea	Vetch
Anthracnose						
Colletotrichum gloeosporoides				★★		
Brown leaf spot						
Pleiochaeta setosa				★★		
Grey leaf spot						
Stemphylium botryosum	★		★★	★★		
Downy mildew						
Peronospora viciae					★★	★
Powdery mildew						
Erysiphe pisi					★★	
Septoria						
Septoria pisi					★★	
Phomopsis						
Phomopsis leptostromiformis				★★		
Rust						
Uromyces viciae-fabae[2]		★★			★	★★
Root-lesion nematode						
Pratylenchus neglectus	★					
Pratylenchus thornei	★★					★★
Stem nematode						
Ditylenchus dipsaci	★	★★			★★	★
Viruses						
Bean yellow mosaic virus		★		★★		
Cucumber mosaic virus	★★	★	★★	★★		
Luteo viruses complex (eg BLRV & BWYV)[3]	★★	★★	★★	★	★★	★★
Pea seedborne mosaic virus (PSbMV)[4]		★★			★★	
Alfalfa mosaic virus	★★	★	★★			★
Wilt						
***Fusarium oxysporum*[2]**				★★	★★	
Root rots						
Aphanomyces root rot *(Aphanomyces euteiches)*[5]		★★			★	
Fusarium	★	★	★	★	★	★
Macrophomina	★				★★	
Phytophthora medicaginis	★★					
Pleiochaeta setosa			★★			
Pythium[1]	★		★	★	★	
Rhizoctonia	★	★★	★★	★★	★★	★★
Sclerotinia[6]	★		★	★	★	

★ This disease occurs in this crop, but does not caused major damage. ★★ This disease has caused major damage to this crop.

1 Pythium and Botrytis grey mould is worse (★★★) in white peas than dun peas (★★) 2 Strain differences between crops. 3 Luteovirus complex on pulse crops consists of Bean leafroll virus (BLRV), Beet western yellows virus (BWYV, syn. Turnip yellows virus, TuYV), Soybean dwarf virus (SbDV) and Phasey bean virus. Each of these viruses can be found on each of the pulse crops, but their impact varies between host species and regions. 4 PSbMV causes seed markings on faba bean that can have a serious impact on price. However, as Australian PSbMV strains are only seed-borne in field pea, faba bean infections only occur if the crop is grown in the vicinity of PSbMV infected field pea crops. 5 Aphanomyces root rot has been identified as a cause of severe root rot on faba bean in commercial fields in NSW. So far it is not reported as a problem in Australian field pea, but it is considered a very serious field pea disease overseas. 6 Sclerotinia (root rot) is worse (★★) in Kabuli than Desi (★).

Source: Pulse Australia (2016) Southern lentil best management practices training course

MORE INFORMATION

For more information on variety cross-contamination, see: http://pulseaus.com.au/growing-pulses/bmp/lentil/variety-cross-contamination

Herbicide interaction

Herbicide residues in soil and crop damage from herbicides are known to increase the risk of disease. This may be by directly damaging the plant, making it easier for the disease to enter, or by reducing the overall health of the plant, making it more vulnerable to disease.

Ensure the maximum plant-back period for all herbicides is adhered to, as herbicide residues may weaken plants' resistance to disease.

When diagnosing damage in the field it can be difficult to determine whether the cause of damage is disease or herbicide or a combination of both.

It is not recommended to grow a pulse again after a failed pulse crop because disease pressure is increased, herbicide residues can be limiting, and there is the potential for cross-contamination of seed, reducing its market value.[6] Please see "Table 3: Minimum re-cropping intervals and guidelines" for more information.

10.5 Good hygiene

Diseases can carry over on stubble, seed or soil (Table 3).

Table 3: Carryover of major lentil diseases.

Disease	Stubble	Seed	Soil
Botrytis grey mould (BGM)	★★★	★	★
Ascochyta blight	★★★	★★	★

The relative importance as sources of infection is indicated by the number of stars, with three starts being the most important.
Source: Pulse Australia (2016) Southern lentil best management practices training course.

The BGM and Ascochyta blight pathogens can carry over from one season to the next on infected lentil seed, stubble and volunteer plants. Purchase disease-free seed or retain seed from the healthiest crop to avoid carryover on infected seed.

Control volunteer lentil during the summer–autumn season and in fallows to avoid carryover of inoculum of BGM and Ascochyta blight.

Some of the viruses affecting lentil have wide host ranges. Weeds, particularly perennial legumes, can host viruses and their aphid and leafhopper vectors (e.g. Cucumber mosaic virus).

Weeds may also host Sclerotinia and should be controlled prior to planting and during crop growth.

BGM can carry over on the stubble of alternate hosts such as faba bean, vetch, chickpea or lathyrus as they may be a potential harbour of the same botrytis species (*Botrytis fabae* and *B. cinerea*) that can attack lentil.

Burn or bury last year's pulse stubble if erosion is not a risk. Grazing over summer may reduce stubble, but be aware that stock can carry infected stubble between paddocks. Adhere to grazing restrictions on stubble from crops treated with fungicides.

Infected stubble may also be carried by wind, water (particularly flooding) or machinery at harvest.

Where practical, clean all machinery, transport equipment and storage bins thoroughly with compressed air before moving to the next paddock. Spray rigs, should also be cleaned to reduce the risk of disease transmission particularly if contractors are used.

Paddock inspections should be carried out using clothing suitable to the task and footwear should ideally be disinfected prior to entering a crop. This is an important point for agronomists who may move through several crops in one day.

Floodwaters may transport disease agents.

6 W Hawthorne (2007) Residual Herbicides and Weed Control. Pulse Australia Southern Pulse Bulletin, PA 2007 #03, http://www.pulseaus.com.au/growing-pulses/publications/residual-herbicides

10.6 Use clean seed

Seed retained on-farm for sowing should be from the cleanest paddocks or section of paddock. Preferably use seed with nil disease infection.

A fungal threshold of <1% is acceptable. Definitely avoid using seed with >5% Botrytis or 5% Ascochyta infection.

Avoid using seed infected with either Cucumber mosaic virus (CMV) or Alfalfa mosaic virus (AMV). A threshold of <0.1% seed infection is recommended for sowing in high-risk areas, and <0.5% seed infection for sowing in low-risk areas.

If seed is more than one year old, frosted, weather damaged or diseased, its germination and vigour may have deteriorated. This may increase its susceptibility to disease attack.

10.6.1 Seed dressings

Fungicide seed dressings are registered in lentil to control seedborne Ascochyta blight and BGM (Table 4).

Table 4: Seed dressings registered for use with lentil.

Active ingredient	Thiram + thiabendazole
Example trade name	**P-Pickel® T**
Ascochyta blight	Registered
Botrytis grey mould (BGM)	NR
Damping off	Registered
Fusarium	Registered
Phoma root rot	NR
Phytopthora root rot	NR
Pythium	Registered
Jurisdiction	**All states**

NR = not registered for use in this crop.
Refer to the current product label for complete 'Direction for Use' prior to application.
Prior to the use of any crop protection product, ensure that it is currently registered or that a current permit exists for its use in lentil.

Source: Southern lentil best management practices training course, (2016), Pulse Australia

Thiabendazole plus thiram (eg P-Pickel T®) is registered in lentil for Ascochyta blight and seedling root rots (*Fusarium* spp. and *Pythium* spp.), but also has efficacy against botrytis seedling blight. Seed dressings are not effective on viruses nor on bacterial diseases.

Seed dressings reduce the establishment of seedborne diseases in crops and protect seed from infection by soilborne fungi including seedling root rots. Some fungicide seed dressings also protect seedlings from external airborne infection for the first few weeks. This is important in reducing the subsequent establishment and spread of disease within crops. Seed treatments provide effective control for a maximum of 4–6 weeks after sowing, but do not provide absolute control.

Sowing untreated seed infected by botrytis can result in the development of botrytis seedling blight, which causes early seedling death and reduced seedling establishment

It is important that seed treatments are evenly distributed on seed to ensure each seed gets an effective dose. This is enhanced for flowable seed treatments by dilution with water (refer to the label). Secondary mixing of treated seed through an auger assists to obtain even seed coverage. Correct calibration of the applicator and a consistent seed flow are critical for the recommended rate of seed treatment to be applied.

Many fungicide seed dressings are toxic to rhizobia so their contact time must be minimised. Read the labels for compatibilities. Ideally, seed should be treated with fungicide and then, in a separate operation, inoculated with rhizobium just before sowing. Sowing should occur immediately after rhizobium has been applied, particularly in acid soils. Granular or liquid injection of inoculum in-furrow eliminates the contact between seed treatments and rhizobia.

10.7 Sowing

10.7.1 Sowing date

Lentil are quick to emerge, but their early growth is slow, and they can take a long time to completely cover the ground, especially if maximum daily temperatures are below 15°C.

Early sowing results in more vegetative growth and crops may be prone to lodging, increasing the risk of disease infection. Frost risk also needs to be considered.

Later sowings reduce disease risk, but can result in lower yields due to the risk of dry conditions, high temperatures at flowering and pod-fill and reduced crop height making harvest difficult.

Disease-resistant varieties may be sown earlier than other varieties since disease risk is reduced.

The optimum sowing time for lentil is dependent on location and disease risk:

- Early sowing is usually beneficial in medium to low rainfall areas or in areas prone to early, quick finishes to the season. This is provided that weeds, BGM and Ascochyta blight are effectively controlled.
- Delayed sowing is required in areas where high biomass production occurs in spring, and lodging occurs pre-flowering making effective BGM control more difficult. The ideal is for the lentil to remain standing until flowering has finished.
- Spring sowing is desirable in some higher rainfall areas, or areas with a long, late growing season.
- In a BGM-prone area, sow at the later end of the recommended window for your district and sow resistant varieties like Nipper⏀ or PBA Jumbo2⏀ before BGM-susceptible varieties like PBA Bolt⏀ or Aldinga.

The optimum sowing times for lentil are in Section 4 "Planting".

10.7.2 Sowing rate and row spacing

Higher plant populations can exacerbate foliar disease development by encouraging a dense canopy and a more humid environment.

Optimum plant populations for most lentil are 100–120 plants per square metre. Calculate actual seeding rates (kg/ha) based on seed size because sizes vary widely with variety and season. These may typically range from 40 to 70 kg/ha.

Sow to minimise overlap, or avoid sowing headlands, as the higher seeding rate can favour the development of a BGM epidemic.

Seeding rates resulting in lower than recommended plant populations can reduce disease but may also reduce potential crop yield.

Wider row spacing can be part of BGM disease management in lentil by keeping the canopy open and drier for longer, provided lodging does not occur.

Inter-row sowing lentil between standing cereal stubble rows allows trellising and keeps the lentil more erect. Without stubble trellising, row spacings greater than 23 cm make the lentil crop susceptible to lodging and increase the risk of disease development. Botrytis can colonise wet cereal straw, but the ability of cereal stubble to act as a multiplier for BGM is still unclear.

10.8 Risk assessment

Risk assessment is about assessing the known risks (e.g. paddock history), deciding what can be changed and weighing these up against the unknowns (e.g. seasonal conditions). While the overall aim is to reduce the level of risk, each grower will have a different level of tolerance to risk.

There are three steps in risk assessment.[7]

1. Identify factors that determine risk

Pathogen: Exotic *v.* endemic, biotypes, pathogenicity, survival and transmission, amenable to chemical management.

Host: Host range, varietal reactions, disease rating, does susceptibility change with growth stage?

Environment: Weather dependency, interactions with nutrition, herbicides, other diseases, agronomic factors, e.g. planting depth, row spacing, no-tillage, soil conditions.

Risk Management: Access to components of management plan, ease of implementing plan, how many options; cost of implementation.

2. Assess level of factors

Pathogen: Level of inoculum, infected seed, aggressiveness of isolate, weed hosts prevalent in paddock or nearby, paddock history.

Host: How susceptible, nutritional status, frost susceptibility, herbicide susceptibility.

Environment: Length of season, likelihood of rain, drought, waterlogging, irrigation; availability of spray gear; paddock characteristics, herbicide history.

Risk management: Has it not yet been considered, a plan is being developed, or is a plan in place?

3. What risk level is acceptable?

High: Grower is prepared to accept substantial yield loss as potential returns are high and financial situation sound, crop failure will not impact on rotation or other components of the farming system.

Low: Grower needs cash flow and cannot afford to spend much or lose the crop, failure impacts seriously on farming system.

10.9 Symptom sorter

This symptom sorter (Table 5) can be used to help diagnose diseases from other crop-damage causes starting from the symptom description.

7 Pulse Australia (2016) Southern lentil best management practices training course – 2016. Pulse Australia.

Table 5: Lentil symptom sorter (diseases shown in bold)

Crop effect	Distribution	Plant symptom	Disorder
Poor emergence	Patches	Seed rotted	**Damping off**
			Botrytis seedling blight
		Plants chewed	Mice
			Snails
	General	Plants distorted	Trifluralin damage
		Plants stunted	Seed sown too deep
		Ungerminated seed	Poor storage
			Insect damage
Wilting	Scattered plants	Reduced growth - yellow	**Fusarium wilt**
		Yellow – red	**Virus**
		Premature death	**Root rots**
	Patches	Stunted	Herbicide damage
		Premature death	**Fusarium wilt**
			Botrytis grey mould (BGM)
			Waterlogging
			Virus
			Salinity
	General	Plants limp	Herbicide damage
Stunted, distorted	Scattered	Reduced growth	Orobanche (broomrape)
		Leaves, stem distorted	**Stem nematode**
			Virus
			Mites
	Patches	Yellow – death of leaves	Iron deficiency
			Manganese deficiency
			Sulfonylurea damage
			Broadstrike® damage
		Yellow/red	**Damping off (Pythium root rot)**
			Virus
			Nodulation failure
		General	Herbicide damage (e.g. ormone)
Leaf and stem spotting and discolouration	Scattered plants	Brown lesion with pepper spots	**Ascochyta blight**
		Yellow leaves, grey mould growth on lower stems	**Botrytis grey mould (BGM)**
		Yellow/red	Diflufenican damage
		Tip death	Triazine damage
		Tip death. Shrunken – purplish brown	Zinc deficiency
		Shrunken – purplish brown	**Ascochyta blight**
Pods discoloured	General	Mainly within canopy, may have small black sclerotia	**Botrytis grey mould (BGM)**
		Tan spots on pods with small, dark fruiting bodies within spots	**Ascochyta blight**

Crop effect	Distribution	Plant symptom	Disorder
White fungal growth	Stems and leaves	May be with soft, slimy rot, may have larger black sclerotia	**Sclerotinia blight**
Physical damage	Patches	Plants chewed	Mouse damage
		Plants chewed	Snail damage
		Pods chewed	Native budworm
		Pods chewed	Lucerne seed web moth
		Stem, leaves and pods damaged	Mouse damage
	General	Stem, leaves and pods damaged	Hail damage
		Stem bent and twisted	Frost

Source: Lentils: The Ute Guide, Southern region, (2008), GRDC and PIRSA

Crop monitoring

The two main diseases where monitoring is necessary are BGM and Ascochyta blight.[8] Monitoring for these diseases also provides the opportunity to look for other diseases, weeds or plant disorders. To be effective, crop monitoring needs to include a range of locations in the paddock, preferably following a 'V' or 'W' pattern.

10.9.1 Botrytis grey mould

BGM is more likely to occur in bulky crops following canopy closure. The critical stage for the first action is just before canopy closure when a protective fungicide needs to be applied to ensure coverage and protection of the lower canopy. Inspect just before the commencement of flowering, as temperatures begin to increase, and then regularly through the flowering and seed-filling period.

Symptoms appear as small dark-green, tan or white spots on leaves. Light brown or blanched stem lesions develop and become covered in grey mould, girdling the stems and leading to dead patches in the crop. Small black sclerotes may form on the stem lesions. Infected flowers lead to flower drop and lesions can also occur on pods, creating seed abortion or shrivelled and discoloured seed.

BGM can infect lentil at any time during the growing season, but epidemics generally develop late, after the crop canopy has closed.

BGM develops quickly when conditions are conducive. It requires high leaf moisture or humidity (>70%) within the crop canopy and optimal temperatures of 15°C–25°C for 4–5 days, particularly at flowering and after canopy closure. When humidity levels decrease or maximum daily temperature exceed approximately 25°C, infection levels decline sharply.

Yield losses due to BGM arise from infection of lower stems and leaves, which will spread and lead to stem and plant death, and the eventual formation of dead patches within crops that produce small seed or no seed at all.

More regular crop monitoring and protection may also be required if high-risk situations exist such as:

- immediately adjacent to last year's crop;
- bulky, dense canopy and sown with narrow row spacing;
- non-optimal paddock selection (e.g. waterlogging);
- high disease pressure experienced last year;
- a susceptible variety is planted; and
- shortened lentil rotation interval.

8 Pulse Australia (2016) Southern lentil best management practices training course – 2016. Pulse Australia

10.9.2 Ascochyta blight

The initial symptoms of Ascochyta blight are lesions on the leaves and stems of young plants. A distinguishing feature is fungal fruiting structures (small black dots) visible within the centre of lesions, although these may not be visible in the first few days of lesion development.

Monitoring should commence 6–10 weeks after emergence, or 10–14 days after a rain event. This allows time for disease expression after an infection event, such as transmission from infected seed or rain-splashed inoculum. Infected seedlings can deteriorate quickly and plant parts above the lesion may also break off, making symptoms difficult to detect.

Timing is critical. After the initial inspection, subsequent inspections should occur every 10–14 days after a rain or heavy dew event. During dry periods, inspections can be less frequent. When monitoring, look for signs of lesions on leaves or, if severe, wilting in upper foliage or small areas of dead or dying plants. If present examine individual affected plants for symptoms of infection. This method will allow more of the crop to be inspected than a plant-by-plant check.

Most new lentil varieties for the southern region are resistant to Ascochyta blight at the time of their release. However, variety resistance status can change over time, for instance PBA Flash⊕, Nipper⊕ and Northfield are now more susceptible to Ascochyta blight than when they were released.

10.10 Free alert services for diseases

MORE INFORMATION

More information about free information services is available at http://extensionaus.com.au/field-crop-diseases/resources/newsletters

IN FOCUS

Growers can subscribe to newsletters that provide local disease updates. The services listed below are all free.

South Australian Research and Development Institute (SARDI):

- Crop Watch disease newsletter by email. Subscribe by emailing DK Communications.
- Follow the Crop Watch Twitter account @CropWatchSA

Agriculture Victoria:

- Crop Alert disease update by email. Subscribe by emailing crop.safe@ecodev.vic.gov.au
- General grains information is available on the Twitter @VicGovGrains

Southern NSW and northern Victoria:

- NSW DPI and GRDC provide the Crop Disease Bulletin for advisers in southern NSW and northern Victoria. To subscribe contact Kurt Lindbeck or Andrew Milgate.

Australia-wide:

- GrowNotes Alert on the latest weed, pest and disease issues in your area delivered via app, SMS, voice, email, social media or web portal (or a combination of preferred methods). Subscribe to this GRDC and Agriculture Victoria service on the GRDC website.
- For disease issues across Australia follow extensionAus on Twitter @AusCropDiseases or Facebook.

10.11 Using fungicides

The legal considerations for using fungicides are the same as for herbicides (see Section 8.4 in weeds)

10.11.1 Registered products

Managing foliar disease in lentil is all about reducing the risk of infection. Fungicides are preventative and need to be sprayed before disease is evident. Fungicides protect against new infection, but do not cure existing infection. Getting the timing right is critical.

Unprotected crops can lose more than 50% in yield and in severe cases the crop may drop all of its leaves.

Foliar fungicides are essential for the management of BGM in all varieties, and are an important tool for the management of Ascochyta blight. Varieties with higher levels of disease resistance do not require as many sprays as susceptible varieties.

Early detection of disease is vital and makes disease monitoring essential. Ensure any disease is correctly identified to make sure the correct fungicide is selected. Controlling disease with fungicides depends on:

- the timeliness of spraying;
- the weather conditions that follow; and
- the susceptibility of the variety grown.

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.

Fungicides give protection for around 2–3 weeks. Any new growth after fungicide is applied is not protected. In periods of rapid growth and intense rain (50 mm over several days) the protection period will reduce to 7–14 days.

Plan ahead to ensure that fungicides can be applied as soon as a decision is made. Do not compromise a fungicide spray to wait until it can be combined with herbicide application. Ideally, spray 1–2 days before significant rain is forecast. Don't delay if rain has already started. Although some fungicide will wash off, the disease will still be controlled.

Foliar fungicides registered for the control of Ascochyta blight and BGM are chlorothalonil, mancozeb and metiram, with carbendazim and procymidone also registered for BGM ("Table 6: Foliar fungicides for the control of foliar diseases in lentil."). Other products may be temporarily available by permit (See Section 10.12.2 Current minor use permits (MUP)). Check pesticide registrations and permits for any changes in use patterns before using fungicides.

Spraying against BGM before canopy closure is essential to ensure fungicide penetrates deep into the crop. BGM can only be controlled if it is not allowed to develop before the crop canopy becomes too dense to allow penetration of the fungicide into the lower canopy.

There is no data on efficacy of fungicides to control Sclerotinia white mould in lentil and none are registered for this use.

Check the efficacy of each fungicide against each disease. Some products are broad-spectrum and are registered against a number of diseases (such as products containing mancozeb and chlorothalonil), while others are specific against single diseases (such as products containing carbendazim and procymidone).[9]

Mancozeb, chlorothalonil and metiram are protectants and have no curative action on existing infections. Newly grown, untreated foliage will not be protected.

9 K Lindbeck (2016) Pulse diseases the watch outs for 2016. GRDC Update Papers, 16 February 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Pulse-diseases-the-watch-outs-for-2016

Carbendazim and procymidone have protectant and limited curative action and work best when applied before an infection event. These fungicides are not translocated from sprayed leaves so foliage that grows after spraying is not protected.

Label regulations limit carbendazim and procymidone each to a maximum of two consecutive sprays at 14-day intervals. These are systemic fungicides with single-site specificities so the probability of resistance developing increases with regular use. It is best to alternate these with each other or with either chlorothalonil or mancozeb. Observe the withholding period for grain prior to harvest for all fungicides.

Take note of grain and grazing withholding periods (WHPs). For crops that are desiccated or windrowed, the WHP is to that date, not the actual harvest date. For chlorothalonil the grazing withholding period (14 days) and the export slaughter interval (ESI) restriction (63 days).

Table 6: Foliar fungicides for the control of foliar diseases in lentil.

Active ingredient	Carbendazim	Procymidone	Chlorothalonil	Mancozeb	Tebuconazole
Example trade name	**Spin Flo®**	**Sumisclex®**	**Barrack®/Unite®**	**Dithane® Rainshield**	**Folicur®**
Botrytis grey mould (BGM)	Registered	Registered	Registered	Registered	-
Ascochyta blight	-	-	Registered	Registered	-
Jurisdiction	All states	All states	QLD, NSW, Vic, SA, WA	All states	All states

Refer to the current product label for complete 'Directions for Use' prior to application. Prior to the use of any crop protection product, ensure that it is currently registered or that a current permit exists for its use in lentil.
Source: Southern Lentil Best Management Practices Training Course Manual (2016), Pulse Australia

Good leaf coverage with lots of fine droplets will maximise the benefit. Use high water rates. For ground application use 100 L water/ha unless a different minimum rate is specified on the label. For air application use 30 L/ha. Spray early in the morning when dew is present to assist fungicide spread.

A fungicide spray at the commencement of flowering minimises infection and so also protects early podset (Table 6 When to spray for fungal disease control in lentil). Additional protection may be needed in longer growing seasons until the end of flowering. Fungicides last around 2–3 weeks in winter, but as the weather warms in spring they may need to be reapplied to protect new growth every 7–14 days.

Table 7: When to spray for fungal disease control in lentil.

Disease	Occurrence	When to spray
Botrytis grey mould (BGM)	Develops late winter and spring (15–25°C) in humid (>70%) conditions, usually at flowering	Spray just before canopy closure. Subsequent applications may be required during early to mid flowering to maintain protection, depending on the varietal susceptibility, growth and seasonal conditions. These additional sprays become necessary through pod filling if seasonal conditions enable disease progression.
Ascochyta blight	First appears in cool and wet conditions before flowering, but also affects pods and seeds.	Spraying in a moderately susceptible (MS) variety may be required at 10–14 weeks after sowing. Monitor for disease presence in other varieties. Spraying may be required during podding if Ascochyta blight is detected and rain is likely.

Source: Southern Lentil Best Management Practices Training Course Manual (2016), Pulse Australia

Disease-resistant varieties require a much less intensive foliar fungicide program than susceptible varieties.

Photo 1: *Varieties with resistance or managed with fungicide show less disease.*

The BGM-susceptible variety Northfield (front, centre) showing BGM compared with the same variety (immediately behind) treated with fungicide and other varieties (left and right) that have resistance to BGM.

Photo: Lentil: Integrated disease management, (2015), Pulse Australia, http://pulseaus.com.au/growing-pulses/bmp/lentil/idm-strategies

10.11.2 Current minor-use permits (MUP)

Some products may be available under permit, with conditions attached, until enough data is generated for full registration. In other cases, a temporary permit may be granted when there is a particular seasonal issue.

Pulse Australia holds several minor-use permits on behalf of the pulse industry and is actively involved in the pursuit of new permits and label registrations to meet industry needs.[10]

The current minor-use permits for fungicides are:

- PER81533
  Custodia® for use in lentil to control Ascochyta blight and BGM.
  Current to 30-Sep-2017
- PER81406
  Captan® for use in lentil to control Ascochyta blight, chocolate spot and BGM.
  Current to 30-Sep-2018

MORE INFORMATION

For more information visit:
Pulse Australia webpage: Crop protection products – minor-use permits http://www.pulseaus.com.au/growing-pulses/crop-protection-products

10.11.3 The critical periods for fungicide use

During the critical periods, monitor crops at least once every week and react by spraying ahead of rain events. Fungicide sprays for BGM are likely to be required depending on variety, rainfall and canopy.[11]

Fungicide application during the critical periods is a standard practice in high disease risk situations, e.g. high rainfall regions, in a wet year or in known disease risk zones. A crop is considered to be at high risk if susceptible varieties are grown, crop rotation is tight, planting is adjacent to lentil stubble, where all preventative management strategies cannot be followed, or any combination of factors put the crop at risk.

10 Pulse Australia (2016) Crop protection products, http://pulseaus.com.au/growing-pulses/crop-protection-products

11 W Hawthorne, M Materne, J Davidson, K Lindbeck, L McMurray, J Brand (2015) Lentil: Integrated disease management, Pulse Australia website, http://pulseaus.com.au/growing-pulses/bmp/lentil/idm-strategies

Additional fungicide applications may be required, particularly if conditions are conducive to disease.

The timing based on the resistance status of varieties is detailed in Figure 3.

Ascochyta blight (AB) Use registered fungicide e.g. chlorothalonil, mancozeb

	R & **MR** varieties – spray 2–3 days ahead of rain fronts		Mid-Sept if ascochyta blight is present	Extra podding spray if it rains	
Plant mid-May with thiram seed dressing	**S** & **MS** varieties – spray 3 weeks ahead of rain fronts	During August if ascochyta blight is present	Mid-Sept if ascochyta blight is present	Extra podding spray if it rains	Last spray 4 weeks before harvest
seeding	**seedling & vegetative growth**	**canopy closure**	**flowering & podding**		**dry-down & harvest**

Botrytis grey mould (BGM) Use registered fungicide e.g. chlorothalonil, cabendazim, procymidone

Plant mid-May with thiram seed dressing	**S** & **MS** varieties	Spray at canopy closure if high risk. Mix or rotate with ascochyta spray	Spray ahead of major rain front. Spray every 2–3 weeks if high risk continues (i.e. high humidity and temperatures 18–25°C. Mix or rotate with ascochyta spray.
	R & **MR** varieties	Spray at canopy closure if high risk. Mix or rotate with ascochyta spray	If extreme risk continues, spray ahead of major rain front. Mix or rotate with ascochyta spray.

Figure 3: *Fungicide timing for lentil disease control.*

The specific times are based on variety Resistance (R) or Susceptibility (S) to that specific disease.
Source: Jenny Davidson, SARDI via W Hawthorne, M Materne, J Davidson, K Lindbeck, L McMurray, J Brand (2015), Lentil: Integrated disease management, Pulse Australia website, http://pulseaus.com.au/growing-pulses/bmp/lentil/idm-strategies

First critical period

This is 10–14 weeks after emergence, shortly prior to canopy closure.

Early application of fungicide is critical to restrict the early development and spread of BGM. In susceptible varieties, or all varieties in districts prone to BGM epidemics, apply a fungicide, irrespective of BGM being present. An application at this stage is the final chance for spray penetration deep into the crop canopy to protect stems.

The presence of Ascochyta blight at this stage is unlikely to cause significant yield losses in varieties that have moderate resistance to foliar infection by Ascochyta blight. Varieties like PBA Flash⁽ᵇ⁾ and Tiara that are more susceptible may require Ascochyta blight protection at this early stage depending on level of infection.

Second critical period

This is at mid-flowering/early pod fill, 14–16 weeks after emergence.

If either BGM or Ascochyta blight is present, or weather is conducive to disease, apply a fungicide. The type of fungicide used will be dependent on the disease susceptibility of the variety. Mixtures of foliar fungicides may be required to give control for both diseases in some susceptible lentil varieties.

Continued infection by BGM at this stage will impact on yield by causing stem infection under the canopy and subsequent plant death. Infection of pods by Ascochyta blight or BGM at this stage will impact on seed quality and yield if seed is aborted.

Third critical period

This is at the end of flowering/mid-pod-fill, 16–18 weeks after emergence.

This is the final growth stage where all pods are formed and protection against Ascochyta blight infection ensures good seed quality is achieved.

If Ascochyta blight is present during pod formation and filling, seed staining can occur in many older varieties. Varieties with seed resistance (Table 1) to ascochyta infection and subsequent staining are the exception. However, in a wet spring even these may require a spray during podding to prevent seed staining. Severe disease pressure from Ascochyta blight can result in yield loss in some varieties due to seed abortion.

BGM control may be required if that disease is severe and weather is conducive to spread.

MORE INFORMATION

For more information visit:

NVT online: Disease app for android and ios http://www.nvtonline.com.au/interactive-tools/apps/

GRDC app: GRDC Lentils ute guide https://itunes.apple.com/au/app/grdc-lentils-ute-guide/id1061505797?mt=8

10.12 Correctly identifying diseases

Correct disease identification is important as this will determine the choice of product.

Symptoms of Ascochyta blight can be easy to confuse with BGM or Stemphylium blight until the pycnidia (fruiting bodies) are formed. In addition, symptoms may be similar to damage on leaves from herbicides or physical events, which then allow minor diseases such as Alternaria to infect the plant tissue. Correct disease identification is important to avoid unnecessary spraying or incorrect fungicide use.

10.12.1 Diagnostic skills

Accurate diagnosis is essential to effectively manage disease.[12] An incorrect diagnosis can be more costly than inaction.

Not all plant disorders are cause by plant pathogens; consider genetic, insect, animal, environmental and agronomic causes.

Some problems involve more than one cause, although usually there will be only one major cause.

Looking at the problem in the paddock is more likely to lead to a correct diagnosis than examining specimens in the office.

Take notes and photographs as well as recording historical information (e.g. sowing date, variety, herbicide history, previous crop, etc) because describing the distribution and symptoms in writing forces us to see what we're looking at. Include this information when sending a sample away for diagnosis.

Follow these steps for an accurate diagnosis:

What is the distribution of the disorder across the district?

- Regional distribution of a problem can eliminate many causes and may identify likely ones.
- If only one crop or one grower in the district has the problem, the cause is unlikely to be environmental (but it could be lightning), or an airborne disease e.g. BGM.
- Isolated problems often reflect some agronomic problem e.g. wrong type or rate of herbicide, poor quality seed, inadequate nutrition, nodulation failure, deep seeding or a soilborne pest or disease.

What is the distribution of the disorder across the paddock? Is the pattern linked with a farming operation (past or present)?

- For example, cultivation, old fence line, sheep camp, sowing, varieties, spraying, harvesting?
- Does it follow drainage lines or is it confined to low or high parts of the paddock?
- Does it affect individual plants throughout the paddock; individual plants at the edge of the crop or in thin areas?
- Does it occur in patches?

12 Pulse Australia (2016) Southern lentil best management practices training course – 2016. Pulse Australia

What's the weather been like?

- Could it be frost, heat stress, drought, waterlogging?

What's the insect activity been like?

- Aphids on the windscreen, moths in the crop?

Determine the progression of symptoms. Look at plants showing the range of symptoms from apparently healthy to just starting to show the problem to just about the die.

- Are plants easy to pull up?
- Do they break off at ground level?
- Look for evidence of feeding by insects, birds or rodents.

Dig up plants:

- Is soil clinging loosely to their roots (evidence of fungal hyphae)?
- Wash soil from roots in bucket and examine against a light-coloured background.
- Make progressive tangential slices into the root, collar and stem looking for vascular discolouration.

Finally, if you suspect a plant disease, remember the disease triangles (Figure 3 and Figure 2). A crop can only have a serious disease problem if three conditions are met:

- susceptible host;
- prevalent causal agent; and
- favourable environment.

10.12.2 Sending samples for disease diagnosis

For accurate diagnoses it is imperative that specimens are carefully selected, well presented and submitted with adequate information.[13]

Selection of specimens

Select plants that show the range of symptoms from slightly to severely affected. Include several healthy plants for comparison. Collect whole plants if practicable, including the roots. For root diseases, include roots and some soil from the root zone (i.e. roots contained in a soil plug).

Preservation

Fresh plant specimens are preferred. If delays in transit are likely and plant material is likely to break down and/or become mouldy, dry specimens are recommended.

DO NOT FREEZE samples.

Fresh specimens are best stored in aerated conditions at high humidity and cool temperatures, preferably not on the back seat of a ute in the sun. Use an esky with fridge bricks to keep samples cool. Diagnosis of viruses requires very fresh specimens. Plants should be wrapped in dry paper and placed in a plastic bag. The paper should not be wet. If dead tissue is present on the sample, damp paper should be avoided as moulds may develop.

Dried specimens are best when dried rapidly, but again not in the back of the ute. Place plant parts between sheets of newspaper (with some pressure), and change paper daily for one week.

13 Queensland Department of Agriculture and Fisheries (2016) How to collect, prepare and package samples for analysis. Queensland Department of Agriculture and Fisheries, https://www.daf.qld.gov.au/plants/health-pests-diseases/plant-pest-diagnostic-services/grow-help/collecting-samples

Packaging

Fresh specimens: specimens likely to decompose e.g. pods should be wrapped in paper and placed in a suitable container. Other plant parts can be placed in partially inflated plastic bags and tied-off (fairly loosely to allow aeration but not desiccation). Soil samples should be packed in a sealed plastic bag or airtight container.

Dry specimens: should be supported between 2 firm surfaces e.g. cardboard, before dispatch.

Note that diagnoses for suspect virus diseases can only be made with fresh specimens.

Labelling

Use waterproof ink. All containers should be clearly marked. If labels are placed inside bags use plastic as paper can become mush.

Dispatch

Specimens should be sent ASAP after collection. Send early in the week to avoid delays over the weekend. Label the item 'Plant Specimens – Perishable' or 'Soil Samples'.

Before sending check whether the relevant authority has a submission form.

The information usually required includes:

- Name and address of grower and location of crop
- Host and variety (if not obvious)
- Area of injury e.g. leaves, roots, pods
- Nature of injury e.g. leaf scorch, root rot, leaf spot
- Prevalence/distribution e.g. localised, entire field, scattered
- Severity
- Soil type, moisture and drainage
- Previous cropping history
- Other useful details such as chemical usage, fertiliser applications, irrigations, growing conditions, frost, weather conditions.

Relevant contacts

South Australia
SARDI Plant Diagnostic Centre
Ph: (08) 8303 9400
Seed and crop testing: http://pir.sa.gov.au/research/services/crop_diagnostics/seed_and_crop_testing

Post to:
SARDI Crop Pathology
Locked Bag 100,
Glen Osmond, SA, 5064

Courier to:
Plant Research Centre, Waite Institute
Gate 2B, Hartley Grove,
Urrbrae, SA 5064

South Australia
SARDI Molecular Diagnostics Group
Ph: (08) 8303 9400
PreDicta B nematode testing: http://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b

Post to:
C/- SARDI RDTS
Locked Bag 100,
Glen Osmond, SA, 5064

Courier to:
SARDI Molecular Diagnostics Group
Plant Research Centre
Gate 2B
Hartley Grove
Urrbrae SA 5064

Victoria
DEDJTR Pulse Pathology,
Ph: (03) 5362 2111

Post to:
Private Bag, Natimuk Rd,
Horsham, VIC 3401

Courier to:
110 Natimuk Rd
Horsham, VIC 3401

Victorian samples may also be submitted via agronomists through the CropSafe program. The program aims to provide the early detection of exotic diseases. http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/cropsafe-program

Tasmania
Ph: 1300 368 550
Email: biosecurity.planthealth@dpipwe.tas.gov.au

Prices:
http://dpipwe.tas.gov.au/biosecurity-tasmania/plant-biosecurity/plant-health-laboratories

New South Wales
Submission form: http://www.dpi.nsw.gov.au/about-us/services/laboratory-services/sample-submission

Plant Health Diagnostic Service – Wagga Wagga
Ph: (02) 6938 1608
Post to:
Wagga Wagga Agricultural Institute,
Private Bag, Pine Gully Road,
Wagga Wagga, NSW 2650

Plant Health Diagnostic Service - Tamworth
Ph: (02) 6763 1133
Post to:
Tamworth Agricultural Institute,
RMB 944, 4 Marsden Park Rd,
Calala, NSW 2340

MORE INFORMATION

AgVic webpage: Seed health testing in pulse crops http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/seed-health-testing-in-pulse-crops

ExtensionAUS webpage: Disease testing services around Australia https://extensionhub.com.au/web/field-crop-diseases/-/disease-testing-services-around-australia

10.13 Botrytis grey mould (BGM)

Botrytis cinerea and *B. fabae*

10.13.1 Symptoms

BGM is caused by the fungi *Botrytis cinerea* and *B. cinerea causes* BGM in lentil, chickpea and other crops and *B. fabae* causes BGM in lentil as well as chocolate spot in faba and broad beans and vetch.[14]

Plants may be attacked by *Botrytis* at any stage of growth and all above-ground plant parts can be affected. When infected seed is planted the seedlings can suffer seedling blight and die soon after emergence.

Later in the season BGM may appear as small white or greyish-brown lesions on leaves (Figure 5). The affected areas can become covered with a fluffy grey mould under the canopy (Figure 6).

Stem lesions can be light brown or bleached and covered in grey mould. Dark fungal sclerotia on the stems can survive over the summer on lentil stubble (Figure 7).

The mould has masses of spores (Figure 8). These rise from infected plants if disturbed and can quickly spread to other plants.

Infected leaves, flowers and pods wilt and fall to the ground. Plants may ripen prematurely due to infection on the lower stem. Under continuing wet conditions stems can become girdled and whole plants die, leaving gaps in the crop.

Infected pods may not fill properly or may produce no seed (Figure 9). Botrytis grey mould on lentil pods. Infected seed can be discoloured and shrivelled, downgrading quality.

Photo 2: *Early leaf lesions of Botrytis grey mould (BGM) on lentil leaves.*

Photo: Southern Lentil Best Management Practices Training Course Manual, (2016), Pulse Australia Limited

14 G Hollaway, F Henry, M McLean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Diseases in pulses: lentil. In 'Identification and Management of Field Crop Diseases in Victoria' Department of Economic Development, Jobs, Transport and Resources, CropPro website, http://www.croppro.com.au/crop_disease_manual/ch08.php

Photo 3: *Botrytis grey mould (BGM) patch in lentil.*

Photo: W. Hawthorne, formerly Pulse Australia via Southern lentil best management practices training course, (2016), Pulse Australia.

Photo 4: *Botrytis grey mould (BGM) sclerotia on lentil stems.*

Photo: SARDI via Southern lentil best management practices training course, (2016), Pulse Australia

Photo 5: *Botrytis grey mould (BGM) sporulation on lentil stem.*

Photo: J. Davidson, SARDI via Southern lentil best management practices training course, (2016), Pulse Australia.

Photo 6: *Botrytis grey mould (BGM) on lentil pods.*

Photo: J. Davidson, SARDI via Southern lentil best management practices training course, (2016), Pulse Australia

10.13.2 Economic importance

A 2012 GRDC survey estimated the incidence of BGM is 34% of years and 40% of lentil crops in the southern region.[15]

BGM is a very serious disease in areas where lentil is 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.

Discoloured seed may be rejected or heavily discounted when offered for sale. If seed infection levels are <5% then purchasing new seed is recommended or at least grading the seed to remove small seed, which is more likely to be infected.

10.13.3 Disease cycle

The *Botrytis* fungi survive on alternate hosts: *B. cinerea* on over 138 genera of plants including lentil and chickpea and to a lesser extent lupin, field pea and vetch, and *B. fabae* on lentil, vetch, and faba and broad bean.[16]

Seed that is infected with *Botrytis* can suffer seedling blight soon after emergence and plants die.

15 GM Murray, JP Brennan (2012) The current and potential costs from diseases of pulse crops in Australia. GRDC Report, https://grdc.com.au/resources-and-publications/all-publications/publications/2012/06/the-current-and-potential-costs-from-diseases-of-pulse-crops-in-australia

16 R Ford (2008) UM00015 Epidemiology and control of Botrytis grey mould of lentils 2003-2008. Project Final Report, The University of Melbourne, http://finalreports.grdc.com.au/UM00015

Spores from infected plants spread to other plants by wind or rain-splash.[17] Spores may blow long distances from trash or other crops. Moisture is essential for infection; leaves need to remain wet for at least 12–18 hours. Once the disease becomes established it rapidly spreads within the crop. BGM is favoured by warm (15–25°C), humid conditions (>70%) that extend for 4–5 days, particularly at flowering time and after canopy closure when the crop environment is most humid. Early sown crops or those with high sowing rates where crop canopy closure is earlier are usually more affected. Occurrence is worse in wet seasons

Yield loss due to BGM results from stem collapse and plant damage, flower loss and reduced seedset, as well as pod abortion. The disease starts in the leaves and stem and progresses to the pods under prolonged wet conditions.

The disease cycle is shown in Figure 4.

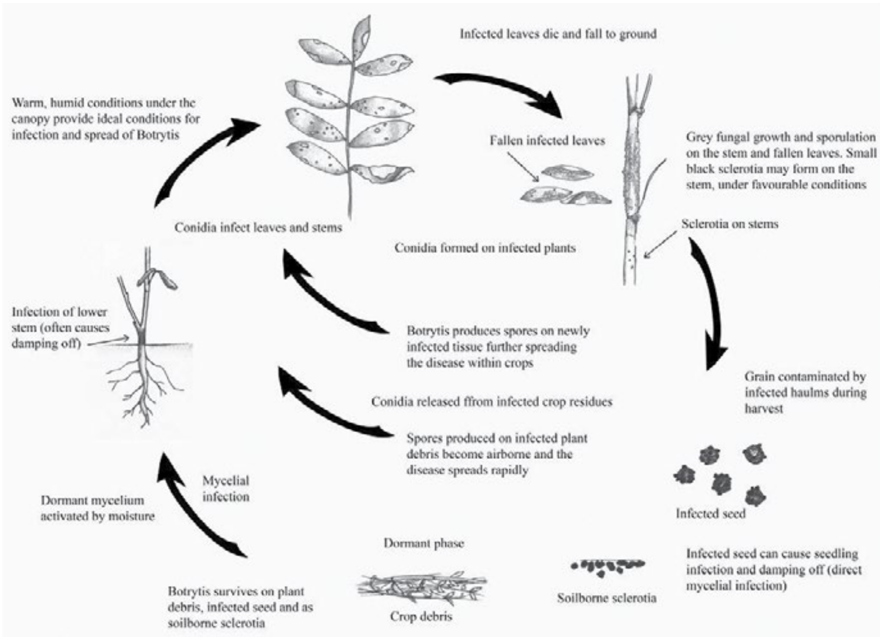

Figure 4: *Disease cycle of Botrytis grey mould (BGM) on lentil*

Illustration by Kylie Fowler.
Source: Diseases in pulses: lentil. In 'Identification and Management of Field Crop Diseases in Victoria', (2015), Department of Economic Development, Jobs, Transport and Resources, http://www.croppro.com.au/crop_disease_manual/ch08.php

Source: G Hollaway, F Henry, M McLean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Diseases in pulses: lentil. In 'Identification and Management of Field Crop Diseases in Victoria' Department of Economic Development, Jobs, Transport and Resources, CropPro website, http://www.croppro.com.au/crop_disease_manual/ch08.php

17 G Hollaway, F Henry, M McLean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Diseases in pulses: lentil. In 'Identification and Management of Field Crop Diseases in Victoria' Department of Economic Development, Jobs, Transport and Resources, CropPro website, http://www.croppro.com.au/crop_disease_manual/ch08.php

10.13.4 Management options

Growers should always assume that BGM inoculum is present, even at low levels. BGM is more dependent on suitable conditions for infection, unlike Ascochyta blight which is more dependent on inoculum, at least in the early phases.

A lentil crop is considered to be at risk of BGM if one or more of the following conditions apply:[18]

- Sown adjacent to lentil, chickpea, faba bean, vetch or lathyrus stubble.
- Is in a high rainfall area.
- Running total of spring rain is >20 mm rain (susceptible variety) or or >45 mm rain (moderately susceptible variety) and more rain is forecast.
- Forecast night temperatures are >8–10°C.
- Was sown early and developed a heavy canopy.
- Sown with a susceptible variety.
- Has a plant population of >120 plants/m2.
- Reached canopy closure by late winter/early spring.
- Has lodged.

Follow the principles of integrated disease management (IDM) which include:

- Use crop rotation and careful paddock selection – allow three years between pulse crops and control self-sown pulses (particularly lentil, faba bean, chickpea, vetch and lathyrus).
- Remove or bury trash (of all pulse crops).
- Select resistant varieties (Table 1 Lentil disease ratings).
- Sow disease-free seed (with no more than five% infection).
- Sow later or at reduced rates to limit crop bulk and delay canopy closure.
- Use fungicide seed dressings (Table 4 Seed dressings registered for use with lentil).
- Canopy management through time of sowing, seeding rate and row spacing.
- Regular crop monitoring.
- Strict hygiene on and off farm.
- Strategic use of foliar fungicides.

While it is important to choose resistant varieties, in areas and years where BGM disease pressure is high all varieties are can become infected.

Crop canopy closure is critical for the development of BGM by providing suitably humid conditions. A more dense canopy is more prone to disease development. Sow at the recommended rate and date for your district. Sowing later or in wider rows can limit disease development, but may also reduce yield. Aim to avoid dense, heavy or lodged canopies in spring.

Always apply fungicides before canopy closure to ensure fungicide penetration of the crop.

Under warm and wet conditions follow-up sprays may be necessary 12–14 days later. Resistant varieties may not need follow-up sprays. Follow-up sprays will be required when:

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

Fungicides for BGM control are those containing carbendazim, procymidone, chlorothalonil or mancozeb.

18 W Hawthorne, M Materne, J Davidson, K Lindbeck, L McMurray, J Brand (2015) Lentil: Integrated disease management, Pulse Australia website, http://pulseaus.com.au/growing-pulses/bmp/lentil/idm-strategies

If BGM pressure or risk is high or the disease is spreading in the crop, then carbendazim or procymidone are more effective than chlorothalonil or mancozeb. Where mancozeb or chlorothalonil is being used primarily for Ascochyta blight control, they have the added benefit of controlling low levels of BGM.

Label regulations limit carbendazim and procymidone to a maximum of two consecutive sprays at 14-day intervals. These are systemic fungicides with single-site specificity so the probability of resistance developing increases with regular use. It is best to alternate carbendazim and procymidone with each other or with either chlorothalonil or mancozeb. Observe the withholding period for grain prior to harvest for all fungicides.

To ensure that BGM 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% in crop inspections should be made every three days.

Fungicide programs depend on varietal resistance. However, in areas and years of high risk all crops may require foliar fungicides.

For resistant (R) and moderately resistant (MR) varieties[19]:

- These varieties require fewer fungicide applications as the disease moves slower. However, disease can be an issue if left unprotected at canopy closure in high and extended disease pressure situations.
- When disease risk is deemed high, or the disease is detected, apply an early foliar fungicide for BGM control just before canopy closure. The amount of growth, row spacing and erectness of the variety will influence canopy size and when it closes over. Timing of the pre-canopy closure application will vary with the variety, farming system and time of sowing.
- In 2016, when continuing wet conditions promoted BGM growth, even resistant varieties required additional fungicide after canopy closure.

For moderately resistant to moderately susceptible (MR-MS) varieties:

- When disease risk is deemed high, or the disease is detected, apply an early foliar fungicide for BGM control just before canopy closure. The amount of growth, row spacing and erectness of the variety will influence canopy size and when it closes over. Timing of the pre-canopy closure application will vary with the variety, farming system and time of sowing.
- Repeat fungicide application may be needed during flowering and podding depending on the canopy size and seasonal conditions.
- An application at late podding may be required to protect grain quality in high risk situations or if the disease is present. These varieties will have minimal Botrytis in the pods and seeds if the leaf canopy is kept clean of the disease.

For moderately susceptible (MS) varieties:

- If the disease is likely to be present, the risk is deemed high, or the disease is detected, apply an early foliar fungicide for BGM control just before canopy closure. The amount of growth, row spacing and erectness of the variety will influence canopy size and when it closes over. Timing of the pre-canopy closure application will vary with the variety, farming system and time of sowing.
- Repeat foliar fungicide will likely need to be applied during flowering and podding to ensure upper leaves are retained and kept clean of lesions.
- Application at late podding may be required to protect grain quality in high risk situations or if the disease is present. These varieties will have minimal Botrytis in the pods and seeds if the leaf canopy is kept clean of the disease.
- Timing of the pre-canopy closure application will vary with the variety, farming system and time of sowing.

19 Pulse Australia (2016) Southern lentil best management practices training course – 2016. Pulse Australia.

- Varieties with moderate susceptibility to BGM may require no fewer and just as many fungicide applications for botrytis control as a susceptible variety. The disease does move slower in these varieties, but can be devastating if left unprotected in medium to high disease pressure situations.

For susceptible (S) varieties:

- The risk is deemed high for BGM in most situations and so control must start by regularly protecting with foliar fungicide that starts before canopy closure.
- Apply an early foliar fungicide for BGM control just before canopy closure. The amount of growth, row spacing and erectness of the variety will influence canopy size and when it closes over. Timing of the pre-canopy closure application will vary with the variety, farming system and time of sowing.
- Repeat foliar fungicide will likely need to be applied during flowering and podding to protect the crop.
- An application at late podding may be required to protect grain quality. Botrytis in the pods and seeds can occur with minimal disease in the canopy.

The South Australian Research and Development Institute (SARDI) have provided a decision-support model for BGM control in lentil (Figure 5).

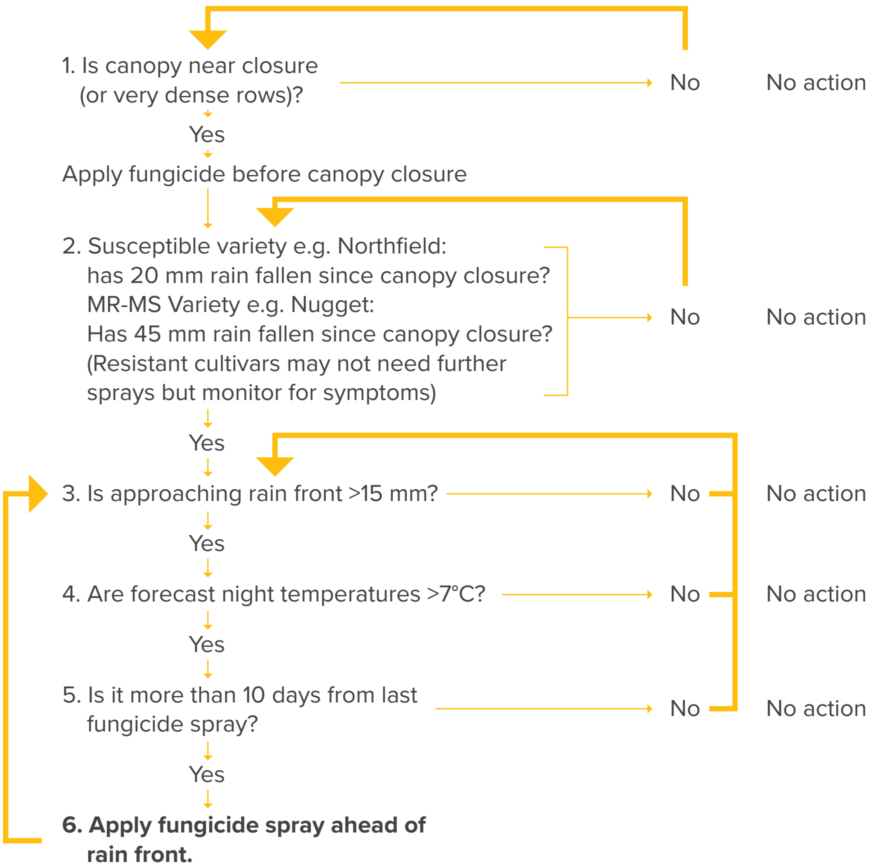

Figure 5: *SARDI decision-support for fungicide applications to control BGM in lentil.*

NB: BGM disease can still develop outside the rainfall and temperature guidelines quoted in the decision model.
Source: J. Davidson, SARDI

10.14 Ascochyta blight

Ascochyta lentis

10.14.1 Symptoms

Ascochyta blight can affect all above-ground plant parts from leaves and stems to flowers and pods (Photo 7).[20] It may appear from seedling to mature stages. Spots start grey but mature to tan, often with a yellow/brown halo. These spots may be small, irregular in shape and are usually scattered over the plant.

The centre of lesions can become speckled with pycnidia, the small black fruiting bodies of the fungus (Photo 8). These pycnidia distinguish Ascochyta blight from other diseases such as BGM or stemphylium blight.

The disease is often inconspicuous and only found by close inspection of the crop (Photo 9).

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. Ascochyta blight spots become irregularly shaped, and may merge to cover most of the leaf surface.

Lesions on the stem tend to be elongated, sunken and darker than leaf lesions and usually covered with scattered fruiting bodies i.e. pycnidia. The stems may split and break at the point of infection causing plants to lodge.

On pods, the infected patches are brown and sunken (Photo 10). Well-developed patches can penetrate the pod and infect the developing seeds. Infected seeds may be smaller than normal, shriveled and have purplish-brown patches on the surface reducing quality. Badly infected seeds can have brown or black stains (Figure 11)..

Photo 7: *Ascochyta lesion on a lentil flower*

Photo: Sam Markell, North Dakota State University via Southern lentil best management practices training course, (2016), Pulse Australia.

20 G Hollaway, F Henry, M McLean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Diseases in pulses: lentil. In 'Identification and Management of Field Crop Diseases in Victoria' Department of Economic Development, Jobs, Transport and Resources, CropPro website, http://www.croppro.com.au/crop_disease_manual/ch08.php

Photo 8: *Typical Ascochyta blight lesion showing the pycnidia.*

Photo: SARDI via via Southern lentil best management practices training course, (2016), Pulse Australia

Photo 9: *Ascochyta lesions and leaf necrosis on lentil leaves.*

Photo: W. Hawthorne, formerly Pulse Australia via via Southern lentil best management practices training course, (2016), Pulse Australia.

Photo 10: *Ascochyta lesions on lentil pods.*

Photo: Agriculture Victoria via Southern lentil best management practices training course, (2016), Pulse Australia

Photo 11: *Ascochyta staining on lentil seeds.*

Photo: SARDI via Southern lentil best management practices training course, (2016), Pulse Australia.

10.14.2 Economic importance

Ascochyta blight is a major disease of lentil. It is widespread in southern Australia. A 2012 GRDC survey estimated the incidence of Ascochyta blight is 92% of years and 50% of lentil crops in the southern region are affected when the disease develops.[21]

Severity varies considerably from crop to crop and between seasons. When seasons are favourable for the disease yield losses range from 10–30% in protected crops. Susceptible varieties can suffer significant yield losses and poor seed quality with losses of up to 80% possible in unprotected crops. Discoloured grains may be rejected or discounted.

As the disease is favoured by moist, rainy conditions it is most likely to be a problem in wet seasons and high rainfall areas, particularly where there is a tight history of lentil in the rotation.

The main impact of Ascochyta blight is on seed quality and marketability as discoloured grains may be rejected or discounted. Heavy infection can reduce crop yield but this is less typical.

A change in ascochyta virulence was observed in 2013 with an increase in virulence observed against Nipper⁽ᵖ⁾ and Northfield.[22] This virulent form of ascochyta is now widespread in the southern region.

In 2016 leaf lesions of Ascochyta blight were observed on PBA Hurricane XT⁽ᵖ⁾ lentils in the Maitland and Mallala regions. Testing in controlled environment conditions at SARDI have shown susceptibility of PBA Hurricane XT⁽ᵖ⁾, PBA Ace⁽ᵖ⁾ and PBA Bolt⁽ᵖ⁾, although field reactions have not been confirmed on the latter two cultivars.[23]

There is natural variability in the ascochyta pathogen and the high intensity cropping of a single variety leads to the selection of resistance breaking isolates. The rapid uptake and dominance of PBA Hurricane XT⁽ᵖ⁾ also threatens the longevity of Ascochyta blight resistance in this and numerous other varieties that share a common resistance. Rotation with varieties that have different sources of esistance, e.g. PBA Jumbo2⁽ᵖ⁾, will help the durability of resistance.

21 GM Murray, JP Brennan (2012) The current and potential costs from diseases of pulse crops in Australia. GRDC Report, https://grdc.com.au/resources-and-publications/all-publications/publications/2012/06/the-current-and-potential-costs-from-diseases-of-pulse-crops-in-australia

22 J Davidson, R Kimber, C Walela, L McMurray, K Hobson, J Brand and J Paull (2016) Pulse diseases in 2015. GRDC Updates Paper, 9 February 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Pulse-diseases-in-2015

23 S Blake, J Davidson, R Kimber, S Day, L McMurray (2017) Pulse diseases 2016. GRDC Updates Paper https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2017/02/Pulse-diseases-2016

10.14.3 Disease cycle

The ascochyta fungus can survive on infested stubble, self-sown plants and on infected seed. The disease spreads short distances during the growing season when spores produced from diseased plants are spread onto neighbouring plants by rain splash. Airborne spores produced on infested stubble travel over longer distances via wind during autumn and early winter.

Moisture is essential for the spread of Ascochyta blight. Infection can occur at any stage of plant growth following either rain or heavy dew. Infection is likely to occur in environments with prolonged wet, cool (5°C–15°C) conditions and plants become infected early in the growing season. Damage from stem infection often results in serious crop lodging in susceptible varieties.

Heavy rainfall late in the season provides ideal conditions for pod and seed infection. Infection at this stage can cause seed staining and the subsequent downgrading of lentil grain (Photo 11).

The disease cycle is shown in Figure 6.

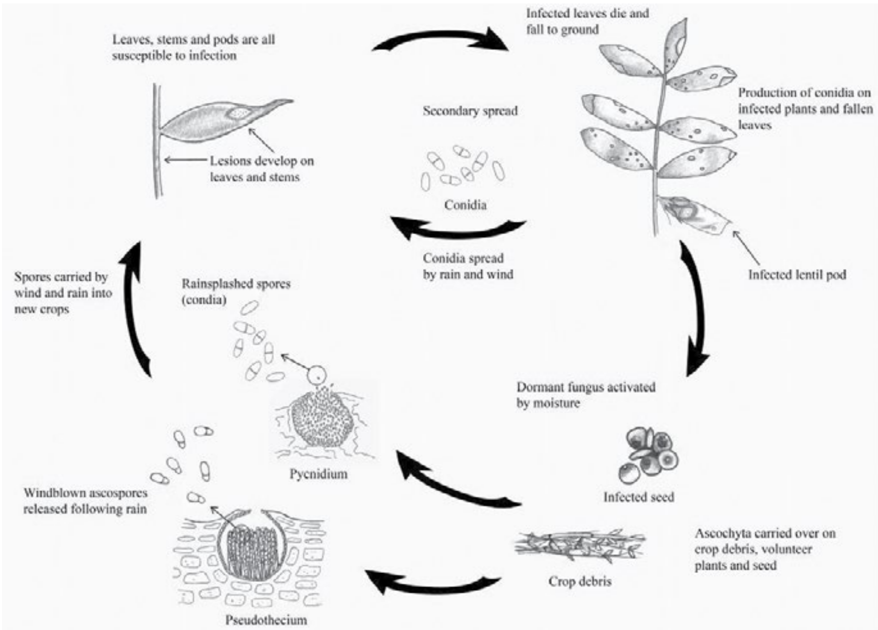

Figure 6: *Disease cycle of Ascochyta blight on lentil.*

Illustration by Kylie Fowler.

Source: Diseases in pulses: lentil. In 'Identification and Management of Field Crop Diseases in Victoria', (2015), Department of Economic Development, Jobs, Transport and Resources, http://www.croppro.com.au/crop_disease_manual/ch08.php

10.14.4 Management options

A lentil crop is considered to be at risk of Ascochyta blight if one or more of the following conditions apply.[24]

- sown adjacent to old lentil stubble
- sown with a susceptible variety
- has been sown early
- history of numerous lentils in the rotation
- ascochyta blight is present at commencement of flowering in a susceptible variety
- Ascochyta blight is present at flowering in a resistant variety during a wet spring

24 W Hawthorne, M Materne, J Davidson, K Lindbeck, L McMurray, J Brand (2015) Lentil: Integrated disease management, Pulse Australia website, http://pulseaus.com.au/growing-pulses/bmp/lentil/idm-strategies

Integrated disease management (IDM) can minimise the presence of inoculum and protect against potential infection as the crop develops:

- Use crop rotation and careful paddock selection – allow three years between lentil crops and control self-sown lentil.
- Select resistant varieties (Table 1).
- Sow disease-free seed (or with no more than five% infection).
- Sow at the optimum time, not early.
- Use fungicide seed dressings (Table 4). S
- Monitor crops regularly.
- Use fungicides strategically.

Chemical seed treatments reduce the risk of transferring disease to seedlings from infected seed. They only protect the emerging seedling from seedborne ascochyta and botrytis. Seed dressings with thiabendazole will provide a small amount of protection to the emerged seedling from rain-splashed ascochyta or windborne botrytis, but this will only last approximately 6–8 weeks.

Fungicides used in lentil are protectants only. They generally have no systemic action, and they will not eradicate an existing infection. To be effective they must be applied before infection, hence before rain. The key to a successful Ascochyta blight spray program is regular monitoring combined with timely application of registered fungicides.

Target Ascochyta blight in all critical periods, particularly in susceptible varieties and when conditions favour disease spread.

If Ascochyta blight is present during pod formation and filling, seed staining can occur in many older varieties. In a wet spring even resistant varieties may require a spray during podding to prevent seed staining. Severe disease pressure from Ascochyta blight can result in yield loss in some varieties due to seed abortion. Monitoring is essential.

If Ascochyta blight risk is high, or it persists and continues to spread in the lentil crop, then chlorothalonil is considered more effective than mancozeb. Beware of the grazing withholding period (14 days) and the export slaughter interval (ESI) restriction (63 days) with chlorothalonil. The withholding period for grain prior to harvest is 28 days for mancozeb and 14 days chlorothalonil.

Most new lentil varieties for the southern region are resistant to Ascochyta blight at the time of their release. However, variety resistance status can change over time. There is natural variability in the the Ascochyta blight pathogen and the high intensity cropping of a single variety leads to the selection of resistance breaking isolates.

In 2013 an increase in virulence was observed against Nipper⟑ and Northfield. This virulent form of Ascochyta blight is now widespread in the southern region. These varieties may require spraying during the vegetative period in disease prone areas and will definitely require a podding spray ahead of rainfall during spring.

In 2016 leaf lesions of Ascochyta blight were observed on PBA Hurricane XT⟑ lentils in the Maitland and Mallala regions of South Australia. Testing in controlled environment conditions at SARDI have shown susceptibility of PBA Hurricane XT⟑, PBA Ace⟑ and PBA Bolt⟑, although field reactions have not been confirmed on the latter two cultivars. In 2017, growers in these regions should manage these cultivars as a potentially higher risk for ascochyta, in particular thiram-based seed dressing should be used and growers should be prepared for a fungicide spray during podding. Crops should also be monitored closely in case an additional spray is required during the season to control Ascochyta blight, especially in a wet season.

Differing spray programs have been developed based on each variety's foliar Ascochyta blight rating. Note though that some varieties with good foliar resistance have less resistance to pod Ascochyta blight and are more vulnerable to seed staining (e.g. PBA Jumbo⟑, PBA Giant⟑).

FEEDBACK

For resistant (R) and moderately resistant (MR foliar) varieties:[25]

- The presence of Ascochyta blight at an early stage on varieties with moderate resistance in the foliage is unlikely to cause significant yield loss.
- A foliar fungicide applied during podding is unlikely to be required to protect grain quality in most situations unless significant Ascochyta blight is present and rainfall is significant.
- Early monitoring and control of BGM is still critical in Ascochyta blight resistant varieties as they require fewer and later fungicide applications for Ascochyta blight control if at all. This may result in the early development of BGM infection which would have normally been controlled as a result of an earlier fungicide application for Ascochyta blight.
- The Ascochyta blight pathogen can mutate to overcome plant resistance and all varieties should be monitored regardless of nominated resistance ratings.

For moderately resistant to moderately susceptible (MR-MS foliar) varieties:

- Foliar fungicides applied during flowering and podding are likely to be required to protect grain quality particularly in higher rainfall situations, and where Ascochyta blight is present.

For moderately susceptible (MS foliar) varieties:

- Foliar fungicide applications for Ascochyta blight control may be necessary 10–14 weeks after emergence, before canopy closure.
- If Ascochyta blight is present fungicides will be necessary through flowering and podding, ahead of rain events.
- Starting early with protective applications is critical, as control is often ineffective if fungicides are applied after the disease spread.

MORE INFORMATION

For more information visit CropPro webpage: Ascochyta of lentils http://www.croppro.com.au/crop_disease_manual/ch08s02.php

10.15 Sclerotinia stem rot

Sclerotinia trifoliorum, S. sclerotiorum, S. minor

10.15.1 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 (Figure 18).

However, Sclerotinia mainly appears on older plants, which can get the infection on any part of their stems, leaves or pods. At first, water-soaked lesions appear on the stems and leaves, and later affected areas develop a soft, slimy rot which exudes droplets of brown liquid. The infected tissues dry out and become covered with a fine white web of fungus growth.

Sclerotia develop on stems alongside the white fungal growth and are larger (usually 2–5 mm in diameter) than the sclerotia associated with BGM. These sclerotia are usually white at first, then turn black. Sclerotinia in lentil is often found in association with BGM.

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 discoloured. Usually isolated plants rather than patches of plants are affected in crops.

25 Pulse Australia (2016) Southern lentil best management practices training course – 2016. Pulse Australia.

FEEDBACK

Photo 12: *Sclerotinia white hyphae in lentil.*

Photo: Unknown, South Australia 2015 via Southern lentil best management practices training course (2016), Pulse Australia

10.15.2 Economic importance

Crop losses in Australia have been small so far. However, the disease poses a potential threat, particularly with canola in the rotation, and is more likely to be severe in wet seasons. A 2012 GRDC survey estimated the incidence of Sclerotinia stem rot is 5% of years and 3% of lentil crops in the southern region are affected when the disease develops.[26]

10.15.3 Disease cycle

The fungus may be present in the soil or may be introduced with contaminated seed. It can survive in the soil for several years. It has a wide host range (including most pulse and oilseed crops) and may survive on other plants even if lentil is not grown.

Sclerotinia may act as either a leaf or root disease. The fungus in the soil may invade the plant directly or may produce airborne 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 neighbouring 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 or as sclerotes directly in the soil.

The foliar form of the disease may be spread by airborne spores. While damage to the foliage encourages infection, the fungus can infect uninjured tissue.

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

10.15.4 Management options

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 can be used in the rotation to reduce the risk of infection. Cereals should be grown for several seasons before returning to lentil, other pulses or canola. Broadleaf weeds such as capeweed also host sclerotinia.

The disease risk can be reduced by using disease-free seed. It is also important to avoid sowing lentil 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.

MORE INFORMATION

GRDC updates on 2017 pulse diseases are at: 'The watch outs for pulse diseases in 2017' https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2017/02/the-watch-outs-for-pulse-diseases-in-2017

26 GM Murray, JP Brennan (2012) The current and potential costs from diseases of pulse crops in Australia. GRDC Report, https://grdc.com.au/resources-and-publications/all-publications/publications/2012/06/the-current-and-potential-costs-from-diseases-of-pulse-crops-in-australia

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

10.16 Alternaria

Alternaria alternata

10.16.1 Symptoms

Alternaria appears as dark brown leaf spots which often have a zoned pattern of concentric brown rings with dark margins. Symptoms can be confused with other diseases as infection often follows insect damage or other leaf spots caused by BGM or Ascochyta blight.

10.16.2 Economic importance

Alternaria alternata is a fungus causes leaf spot and other diseases on over 380 host species of plant. It is an opportunistic pathogen of numerous hosts causing leaf spots, rots and blights on many plant parts.

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

A 2012 GRDC survey on disease incidence did not estimate the incidence of Alternaria.

10.16.3 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.

10.16.4 Management options

Control of alternaria alone is not warranted. Fungicide sprays for other major fungal pathogens should give control.

FEEDBACK

MORE INFORMATION

For more information see GRDC fact sheet: Pythium root rot www.grdc.com.au/GRDC-FS-PythiumRootRot

10.17 Root rots and Damping off

Fusarium, Rhizoctonia, Pythium spp., *Sclerotium rolfsii*

10.17.1 Symptoms

Root rot can be caused by a range of fungal pathogens including Rhizoctonia, Fusarium and Pythium. Lesions on the stems below soil level are black. Infected plants are stressed.

Seedlings affected by root rot gradually turn black and leaves droop. The plants usually don't collapse completely. The taproot may become quite brittle, except in Pythium root rot when it becomes soft. 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 taproot is dark, shows signs of rotting and may lack lateral roots. Distinct dark brown to black lesions may be visible on the taproot.

The leaves and stems of affected plants usually start turning black. Older plants dry-off prematurely and are often seen scattered across a field. In some cases seeds may rot before they emerge.

10.17.2 Economic importance

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

Severe pod infection can result in reduced seedset and infected seed. A 2012 GRDC survey estimated the incidence of root rots is 5% of years and 3% of lentil crops in the Southern Region are affected when the disease develops depending on the causal agent.[27]

10.17.3 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.

Soilborne fungi invade the roots and stem base of young plants, particularly under wet conditions. Wet conditions also encourage the spread of disease within a field. However, recent research has shown that Pythium does not require high rainfall or cold waterlogged soils.[28] The reduced root development causes the plants to die when they are stressed.

10.17.4 Management options

The disease can be reduced by crop rotation. As this disease may also affect other pulses it is recommended to rotate with non-legume crops.

Disease risk can be reduced by using fresh, undamaged and robust seed treated with a seed dressing to prevent disease build-up. Avoid areas subject to waterlogging as these conditions reduce the vigour of lentil and encourage root rot fungi. Damping off can be controlled using fungicide seed treatment.

Pythium root rot can be detected with a SARDI PreDicta B soil test (http://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b) prior to sowing.

27 GM Murray, JP Brennan (2012) The current and potential costs from diseases of pulse crops in Australia. GRDC Report, https://grdc.com.au/resources-and-publications/all-publications/publications/2012/06/the-current-and-potential-costs-from-diseases-of-pulse-crops-in-australia

28 GRDC (2010) Pythium root rot. Root disease fact sheet, GRDC, May 2010, https://grdc.com.au/GRDC-FS-PythiumRootRot

10.18 Stemphylium blight

Stemphylium botryosum

10.18.1 Symptoms

Stemphylium blight is characterised by large, grey-black necrotic lesions restricted to the leaves, often starting from the leaf edge.[29] In North America leaf drop can leave the plant defoliated with only the top-most leaves remaining.[30]

It can be confused with other diseases of lentil such as aschochyta (look for pycnidia). In Canada the disease is increasingly found in seed tests in the lab, but researchers say it can be misdiagnosed in the field, with symptoms mistaken for Sclerotinia (white fluffy mould or black sclerotia) or botrytis (grey fuzzy mould under a magnifying glass).[31]

10.18.2 Economic importance

A 2012 GRDC survey on disease incidence did not estimate the incidence of Stemphylium in lentil. Stemphylium is considered a minor disease of lentil in Australia, although there have been epidemic or sporadic incidences in Bangladesh and Canada.[32]

It is common in lucerne and can cause severe defoliation.[33] In 2016 the mild, wet winter led to an unusually high number of reports of Stemphylium on faba bean in northern NSW.[34]

10.18.3 Disease cycle

Stemphylium botryosum occurs on lucerne, clovers, lupin, beans and tomato.[35] In lucerne, Stemphylium can be carried over on infected plant debris, seed and in soil. The disease is favoured by warm, moist conditions and spores are spread by wind or rain splash.

10.18.4 Management options

As it is a minor disease no control is generally required.

29 S Jeffrey (2016) Mild, wet winter leads to emergence of leaf blight. GRDC media release, 18 August 2016, http://www.dpi.nsw.gov.au/content/agriculture/broadacre/pests-diseases/winter-crops-lupins-chickpeas-other-pulses/stemphylium-blight-in-faba-bean

30 M Wunsch (2013) Management of Stemphylium blight of lentils. North Dakota State University website, https://www.ag.ndsu.edu/carringtonrec/documents/plantpathologyrd/noyeardocs/LENTILStemphyliummgmt.pdf

31 J Isaacs (2014) Lentils with blight can be misdiagnosed. Grainews, 20 May 2014, http://www.grainews.ca/2014/05/20/lentils-with-blight-can-be-misdiagnosed/

32 P Kant (2013) Stemphylium blight. Pulse Breeding Australia newsletter, Issue 12, Summer 13/14, p15, https://grdc.com.au/~/media/Documents/Major-Initiatives/PBA/Newsletters/Issue-12-PBA-Summer-13-14-Newsletter-pdf.pdf?la=en

33 R Clarke (1999) Diseases of lucerne: fungal leaf diseases. AG0727. Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/pastures-diseases/diseases-of-lucerne-2-fungal-leaf-diseases

34 S Jeffrey (2016) Mild, wet winter leads to emergence of leaf blight. GRDC media release, 18 August 2016, http://www.dpi.nsw.gov.au/content/agriculture/broadacre/pests-diseases/winter-crops-lupins-chickpeas-other-pulses/stemphylium-blight-in-faba-bean

35 R Clarke (1999) Diseases of lucerne: fungal leaf diseases. AG0727. Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/pastures-diseases/diseases-of-lucerne-2-fungal-leaf-diseases

FEEDBACK

MORE INFORMATION

For more information see:

Plant Health Australia fact sheet: Stem nematode http://www.planthealthaustralia.com.au/wp-content/uploads/2013/01/Stem-nematode-FS.pdf

APPS fact sheet: Ditylenchus dipsaci http://www.appsnet.org/publications/potm/pdf/Mar11.pdf

10.19 Stem nematode

Ditylenchus dipsaci

10.19.1 Symptoms

Stem nematode damage can be similar to the effects of some herbicides: poor emergence and establishment, stunting and distortion of plants, swollen stem bases, premature plant death, lodging and fewer seed heads. In heavy infections there is poor germination and emergence with patches of malformed and stunted plants (Photo 13).

Symptoms in lentil, faba bean, canola, field pea and chickpea are first seen in seedlings and plants may show signs of recovery later in the season.

Symptoms in oats can persist throughout the season. Lucerne can exhibit 'white flagging' of leaves. Symptoms usually occur in patches, but the entire crop can be affected in severe cases.

The nematodes multiply rapidly on susceptible plants under cold, wet conditions. Sometimes the stem will die back, turning reddish brown from the base and stopping at a leaf.

Photo 13: *Stem nematode causes stunting and twisting of leaves, Black streaks down stems are also a symptom.*

Photo: S. Taylor, formerly SARDI via Southern lentil best management practices training course, (2016), Pulse Australia

10.19.2 Economic importance

Stem nematode is a soilborne pest of oat, pulse and some pasture crops.[36] In South Australia and Victoria there are three different races of the nematode: the oat, lucerne and clover races. The oat race infects the cultivated and wild oat, faba bean and field pea and has been recorded on lentil, chickpea and canola seedlings.

The 2012 GRDC survey on disease incidence did not estimate the incidence of stem nematode in lentil crops.

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

Access to some international and domestic markets requires seed to be tested and found free of stem nematode.

36 Plant Health Australia (2013) Stem nematode fact sheet. Plant Health Australia, http://www.planthealthaustralia.com.au/wp-content/uploads/2013/01/Stem-nematode-FS.pdf

10.19.3 Life cycle

Stem nematode is spread by infested hay, straw, weeds and other plant material, and as a contaminant of seed. It is transferred in soil by machinery, humans and stock. Stem nematode is highly resistant to desiccation, and can survive in a dehydrated state for many years.

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.

It is more common in high rainfall areas on clay soil.

10.19.4 Management options

There are no chemical options for managing nematodes. Hygiene is very important. Do not introduce the nematode onto the farm or into clean paddocks. Test seed for the presence of stem nematode with a SARDI seed test. Do not bring oaten hay or straw from infested areas onto the property.

Rotate with non-host crops such as wheat and barley to reduce nematode numbers.

Soilborne disease risk can be assessed through the SARDI PreDicta B soil test.

10.20 Root-lesion nematodes (RLN)

Pratylenchus neglectus, P. thornei and other *Pratylenchus spp*.

Lentil is grown as a rotational crop to reduce the population of root-lesion nematodes in the soil.

10.20.1 Symptoms

Root-lesion nematode (RLN) can impair root function, limiting water and nutrient uptake by the plant. Affected plants generally do not thrive or show symptoms of nitrogen deficiency. Symptoms are increased when plants are subjected to water and nutrient stress, or when combined with root damage caused by fungi.

Root symptoms are often difficult to diagnose in the field and are usually not seen until plants are older than eight weeks. Root symptoms are generally more obvious in plants grown in sandier soils. Root symptoms include:

- disintegration of outer layers of root tissue;
- reduction in root hairs and/or nodules;
- a lack of/or stunting of side (lateral) roots; and
- brown lesions and discoloration of roots

Diagnosis can be difficult and the presence of RLN in the soil can only be confirmed with a SARDI PreDicta B soil test to identify the particular RLN species.

10.20.2 Economic importance

Most lentil varieties are resistant to RLN and suffer minimal yield loss.

Root-lesion nematodes can cause large grain yield losses in susceptible crops such as wheat and chickpea.[37] At least 20% of cropping paddocks in south-eastern Australia have populations of RLNs high enough to reduce yield. The extent of yield loss is directly related to the nematode population density at sowing.

37 G Hollaway (2013) Cereal Root Diseases. Agnote AG0562, Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/cereal-root-diseases

Worldwide, the genus *Pratylenchus* is the second most important group of plant-parasitic nematodes with more than 90 species of RLN known worldwide. The two main species of RLN in the southern region are *Pratylenchus neglectus* and *P. thornei*.

P. teres and *P. penetrans* are found in the western region.

More than one RLN species can be found in the roots of an individual crop, although one species usually dominates.[38] Identification is important as different crops have different resistance or susceptibility depending on the *Pratylenchus* type. All species of *Pratylenchus* have a wide host range.

The estimated incidence of root-lesion nematode in lentil was not quantified in the 2012 GRDC study on the cost of diseases in Australia. However, SARDI have published results of recent PreDicta®B soil tests for root-lesion nematode.

MORE INFORMATION

For more information see:

GRDC fact sheet: Plant parasitic nematodes http://www.grdc.com.au/GRDC-FS-Plant-Parasitic-Nematodes-SW

Soil Quality fact sheet: Root-lesion nematode http://soilquality.org.au/factsheets/root-lesion-nematode

SARDI webpage: PreDicta B testing http://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b

GRDC Video: Root-lesion nematodes https://youtu.be/Ntf08QGXPI0

GRDC Video: Root-lesion nematodes. Resistant cereal varieties have surprising impact on RLN numbers https://youtu.be/1dt64MfUmOc

DAFWA video: How to diagnose root-lesion nematode https://youtu.be/ttFItE-B4qA

10.20.3 Life cycle

Nematodes are small, worm-like organisms <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 depositing eggs.

There may be three to five 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.

Nematodes will not move great distances unless they are spread by surface water, soil on farm machinery or wind-blown soil in summer.

10.20.4 Management options

There are no chemical options for managing nematodes. Rotation with resistant crops such as lentil, faba bean, field pea or lupin is the most important management tool for RLN.

Resistant crops reduce the population of nematodes in the soil. Tolerant crops do not reduce the population, but are less vulnerable to damage from nematodes.

Resistant crop species can reduce nematode populations by up to 50% per year. A two or more year break from susceptible crops may be necessary to minimise yield loss if nematode numbers are high. Resistant varieties of susceptible crop species should be grown in the following years.

With the exception of chickpea, pulses tend to have good resistance to *P. neglectus* and *P. thornei*, so can reduce nematode populations in cropping rotations (Table 8).

Resistant crops may differ in their capacity to host *P. neglectus* or *P. thornei* so tailor rotations to manage the predominant species. Crops such as field pea and lentil provide some control for *P. thornei*, while faba bean, field pea and lentil provide control for *P. neglectus*.

Controlling volunteer crops and host weeds is also important. Weeds that can host nematodes include wild oat, barley grass, brome grass, wild radish and *Brassica tournefortii*.

Nematode numbers increase where susceptible crops like chickpea and wheat are grown in rotation.

Reducing the nematode population can lead to higher yield in subsequent cereal crops. Yield loss in south-eastern Australia from RLN is lower than in northern Australia.

38 J Isaacs (2014) Lentils with blight can be misdiagnosed. Grainews, 20 May 2014, http://www.grainews.ca/2014/05/20/lentils-with-blight-can-be-misdiagnosed/

The simplest way to identify a nematode problem is with a SARDI PreDicta®B soil test (http://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b) prior to sowing.

Table 8: Resistance and tolerance of pulses to the major *Pratylenchus* species.

Crop	*Pratylenchus* neglectus		*Pratylenchus* thornei	
	Resistance	Tolerance	Resistance	Tolerance
Faba bean	R	-	MR	MI
Chickpea	S - MR*	MI - T*	VS - R*	MI - T*
Field pea	R	-	R	T
Lentil	R	T	R	MT
Vetch - Blanchefleur	MR	T	S	I - MI
- Languedoc	MR	T	MS	I - MI
- Morava⁽ᵈ⁾	MR	T	MS	I - MI

* Chickpea varieties have a range of resistances and tolerances to *Pratylenchus* species
Source: Southern lentil best management practices training course, (2016), Pulse Australia

10.21 Viruses

10.21.1 Viruses in pulses

Lentil is infected by many viruses worldwide. Fortunately only a few are currently of major economic importance in Australia (Table 9).

Major viruses that are known to infect lentil in Australia include[39]:

- Cucumber mosaic virus (CMV)
- Alfalfa mosaic virus (AMV)
- Beet western yellow virus (BWYV), also known as Turnip yellows virus (TuYV)
- Bean yellow mosaic virus (BYMV)
- Pea seedborne mosaic virus (PSbMV)
- Bean leafroll virus (BLRV)

Less common viruses that occur on lentil in Australia are:

- Soybean dwarf virus (SbDV), syn Subterranean clover red leaf virus (SCRLV)
- Subclover stunt virus (SCSV)
- Clover yellow vein virus (ClYVV)
- Tomato spotted wilt virus (TSWV)
- Broad bean wilt virus (BBWV)

39 Pulse Australia (2016) Southern lentil best management practices training course – 2016. Pulse Australia.

Table 9: Virus categories and general symptoms.

Virus	Aphid transmission	Seed transmission*	Visual symptom type	Visual symptoms	Virus type (genus)
AMV	Non-persistent	Yes	Shoot tip	Necrotic or chlorotic local lesions, sometimes mosaics that do not necessarily persist.	alfamovirus
BBWV	Non-persistent	No	Mosaic, shoot tip	Vein clearing, mottling and necrosis of shoot apex, plant wilts, mottled, malformed and stunted.	fabavirus
BLRV	Persistent	No	Top yellowing	Upward leaf-rolling accompanied by interveinal yellowing of older leaves and flowers abscised.	luteovirus
BWYV/PhBV	Persistent	No	Top yellowing	Interveinal yellowing of the older or intermediate leaves. Mild chlorotic spotting, yellowing, thickening and brittleness of older leaves.	luteovirus
BYMV	Non-persistent	Yes	Mosaic	Transient vein chlorosis followed by obvious green or yellow mosaic. Usually no leaf distortion.	potyvirus
CMV	Non-persistent	Yes	Shoot tip	Mosaics, stunting and possibly some chlorosis.	cucumovirus
ClYVV	Non-persistent	No	Shoot tip, mosaic	Mosaics, mottles or streaks, vein yellowing or netting.	potyvirus
PSbMV	Non-persistent	Yes	Mosaic	Systemic dark and light-green zonal leaf mottle, slight to moderate downward rolling of leaf margins. Distortions of leaf shape associated with mottle patterns. Seed markings.	potyvirus
SCRLV	Persistent	No	Top yellowing	Mild yellowing, stunting and reddening.	luteovirus
SCSV	Persistent	No	Top yellowing	Top yellows, tip yellows or leaf roll. Leaf size reduced, petioles and internodes shortened.	nanavirus
TSWV	Persistent	No	Shoot tip, mosaic	Necrotic and chlorotic local lesions, mosaic, mottling, leaf shape malformation, vein yellowing, ringspots, line patterns, yellow netting and flower colour-breaking.	tospovirus

*Seed transmission in lentil is significant for some viruses and minimal for others, but of no epidemiological significance. However, it is important for quarantine to keep foreign virus strains out of Australia.
Source: Southern lentil best management practices training course, (2016), Pulse Australia

In 2013 a virus that was earlier thought to be a strain of BWYV was identified in Australian pulse crops: Phasey bean virus (PhBV), which causes causes symptoms that are similar to BLRV and SbDV. It has been found on lentil, but its current economic importance is not yet clear.

Cucumber mosaic virus (CMV) is present in most lentil crops surveyed in South Australia and Victoria. It occasionally causes heavy losses, usually when high populations of aphids have infested the crop at an early stage. Combinations of CMV, Alfalfa mosaic virus (AMV) and Beet western yellow virus (BWYV) are often present in plants tested from these surveys.

There are several other viruses of economic importance on lentil globally that are not present in Australia. Strict quarantine regulations are in place in order to keep the country free of these and other exotic pathogens.

Seasonal variation in virus infection is quite common. The South Australian Research and Development Institute (SARDI) found relatively low virus infection rates in lentil in SA in 2014 (Table 10).[40] BWYV infected canola crops across Victoria, SA and NSW in 2014, but was only detected at a high infection rate in one lentil crop in SA.

Table 10: Results of virus testing in South Australia in 2014.

Crop type	Number of crops or trials tested	Test period	Number of crops with positive virus tests (average % infection rate in brackets)					
			BWYV	PSbMV	CMV	AMV	BLRV	BYMV
Lentil	10	Jul–Aug	3 (4%, 1 at 92%	0	3 (1%, 1 at 100%)	0	0	0
	4	Sep–Oct	3 (2.7%)	0	2 (6.5%)	1 (4%)	0	0

Source: Diseases of pulse crops in 2014, (2015), GRDC Update Papers, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02/Diseases-of-pulse-crops-in-2014.
Source: R Kimber, J Davidson, M Rodda, M Aftab, J Paull (2015) Diseases of pulse crops in 2014. GRDC Update Papers, 10 February 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02/Diseases-of-pulse-crops-in-2014

10.21.2 How viruses spread

Viruses need aphid vectors to spread from infected to healthy plants. The exception is Tomato spotted wilt virus (TSWV), which is transmitted by specific thrip species. None of the persistently transmitted viruses are seed-transmitted. Pea seedborne mosaic virus (PSbMV) strains that can be seed-transmitted in lentil are reported overseas, but not in Australia. Aphid activity is the most important factor for virus development in lentil crops.

The most important factors that predispose pulse crops to severe virus infection are:

- Infected seed.
- Close proximity to a substantial virus reservoir (e.g. lucerne, summer weeds).
- A wetter than average summer–autumn with green material to allow uncontrolled multiplication of aphids during the time when numbers are usually low. When aphids are present early in the season epidemics are more likely to occur and the level of damage will be higher.
- Early spring flights of the aphids.

Viruses can be classified by the manner in which they are transmitted by insect vectors – persistent and non-persistent.

Persistent transmission

These viruses are ingested by the insect and are passed to healthy plants through the saliva. It can take more than a day for these insects to become infectious, but the insect will remain infectious for the rest of its life.

40 R Kimber, J Davidson, M Rodda, M Aftab, J Paull (2015) Diseases of pulse crops in 2014. GRDC Update Papers, 10 February 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02/Diseases-of-pulse-crops-in-2014

Not all aphid species are vectors of this kind of virus in pulses so the identification of aphid species is very important. The main vectors of these viruses are pea, cowpea and green peach aphids. Viruses include BWYV, BLRV and SCSV. Infection will start with random plants and increase as the vectors colonise the crop. Aphids generally only become visible in the crop once they have colonised.

Insecticides that kill aphids can work in suppressing the spread of these types of viruses as transmission rates increase dramatically when the aphids fly.

Non-persistent transmission

Insects transfer these viruses on their mouth parts directly by carrying it from an infected plant to a healthy one. It can only infect one or two more plants at a time.

Many aphid species are vectors of this type of virus including ones that do not colonise legumes but just land and probe while searching for their preferred hosts (e.g. oat and turnip aphids). Viruses include PSbMV, AMV, CMV and BYMV.

Insecticides are less effective at suppressing these types of viruses as they do not act fast enough. They may make the situation worse as the insecticide can agitate aphids and increase virus spread.

10.21.3 Symptoms

Initially, virus transmission from seed leads to scattered diseased plants (Figure 20). but by the time the crop matures, luteoviruses may have been spread by aphids across the entire crop. When primary infection occurs via aphids colonising the lentil crop, infections occur in patches. Plants infected late in the season are able to produce viable seed that can be a source of infection if the virus is seed-transmitted.

Cucumber mosaic virus (CMV) on lentil causes chlorosis, leaf distortion and stunting of the plant (Figure 21).[41]

CMV is more commonly found in lentil and lupin that in other crop types, but has a wide host range that also includes chickpea, field pea and faba bean, as well as minor pulse crops such as lathyrus and narbon bean.

Alfalfa mosaic virus (AMV) on lentil causes a necrotic tip growth, twisting and deformation of leaves and stunting (Figure 22).

Beet western yellows virus (BWYV) also known as Turnip Yellows Virus (TuYV) on lentil causes mild mosaic, light green or yellow leaves (Figure 23). A reduction in leaf size and stunting may occur. Infected plants produce very little seed.

Beet western yellows virus (BWYV) on lentil causes yellowing on lower and middle leaves, but tips grow out green (Figure 24 and Figure 25), high incidence near bare areas in lentil). Stunting may occur.

Pea seedborne mosaic virus (PSbMV) does not generally cause symptoms in lentil, but there may be some chlorosis in new shoots, mottling on leaves, shoot tip necrosis and stunting of plants.

Tomato spotted wilt virus (TSWV) on lentil causes tip necrosis and plant death. Economically significant incidences have been found in the northern region in pulses, especially since the introduction of Western flower thrips, a highly efficient TSWV vector. However, it does not appear to be a major problem as yet in the southern region. Note that other diseases and symptoms can be confused with TSWV, including frost damage.

41 M Aftab, A Freeman, F Henry (2013) Temperate Pulse Viruses: Cucumber Mosaic Virus (CMV), AG1207, Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/temperate-pulse-viruses-cucumber-mosaic-virus-cmv

Photo 14: *Virus patches in lentil Note initial infection area (dead plants) and spread from there.*

Photo: W. Hawthorne, formerly Pulse Australia via Southern lentil best management practices training course, (2016), Pulse Australia.

Photo 15: *Cucumber mosaic virus (CMV) in lentil.*

Photo: Southern lentil best management practices training course, (2016), Pulse Australia.

Photo 16: *Cucumber mosaic virus (CMV) and Alfalfa mosaic virus (AMV) in lentil Note the bare area around the infected plants.*

Source: W. Hawthorne, formerly Pulse Australia via Southern lentil best management practices training course, (2016), Pulse Australia

Photo 17: *Bean yellow mosaic virus (BYMV) in lentil.*

Photo: R. Jones, DAFWA via Southern lentil best management practices training course, (2016), Pulse Australia

Photo 18: *Beet western yellows virus (BWYV) in lentil.*

Photo: W. Hawthorne, formerly Pulse Australia via Southern lentil best management practices training course, (2016), Pulse Australia

Photo 19: *Beet western yellows virus (BWYV), high incidence near bare areas in lentil.*

Photo: W. Hawthorne, formerly Pulse Australia via Southern lentil best management practices training course, (2016), Pulse Australia

10.21.4 Economic importance

Viruses are generally not considered a devastating problem of lentil in the southern region, but should not be ignored. A 2012 GRDC study estimated incidence of lentil viruses ranged from 5–100% of crops depending on the virus and the season (Table 11). Infection can reduce yield and seed quality.[42]

Table 11: Incidence and faba bean crop area affected by virus.

Virus	Incidence (%)	Area of crop (%)
Alfalfa mosaic virus	100.0	19.0
Bean leafroll virus	30.0	13.5
Bean yellow mosaic virus	24.0	7.0
Beet western yellows virus	30.0	55.5
Cucumber mosaic virus	100.0	67.5
Pea seedborne mosaic virus	24.0	7.0
Soybean dwarf virus	5.0	0.0
Tomato spotted wilt virus	5.0	0.0

Incidence as a proportion of years when the disease occurs and area as a percentage of crop area affected when the disease develops. No incidence was listed for Clover yellow vein virus or Subterranean clover stunt virus

Source: Murray and Brennan (2012)The current and potential costs from diseases of pulse crops in Australia, (2012), GRDC, https://grdc.com.au/Resources/Publications/2012/06/The-Current-and-Potential-Costs-from-Diseases-of-Pulse-Crops-in-Australia

Viruses are usually present to a certain extent in all crops. Whether they damage the crop or not depends on the growth stage at infection and the number of plants infected. Viruses rarely affect all plants in a crop; more typically individual plants or clusters are affected.

42 K Perry, P Mangano, P Umina, A Freeman, R Jones, W Hawthorne, J Davidson (2010) Aphids and viruses in pulse crops fact sheet. GRDC, Western and Southern regions, July 2010, http://www.grdc.com.au/GRDC-FS-AphidsandVirusesinPulses

Detections and damage from virus in lentil in southern Australia include:

- The BWYV (synonym: TuYV) outbreak in 2014 damaged canola crops in SA, Victoria and NSW. While there was concern that it could spread to pulse crops including lentil, the cold conditions over winter substantially reduced the spread of virus by aphids.[43]
- BWYV appears to be present in many lentil crops grown. In 2009 there was significant crop damage and patchiness due to BWYV in lentil crops that were thin or affected by herbicide or nutritional disorders. That year there was considerable aphid activity following earlier summer–autumn rains and a mild winter–early spring
- In 2006, BLRV occurred at high levels in southern NSW and some SA and Victorian crops.
- In 2006 and 2007, a minority of lentil crops in Victoria and SA had very high levels of CMV.
- In SA in 2006, AMV was found at high levels in all crop types but not in 2007.
- Both CMV and AMV have been detected in seed lots of lentil.
- BYMV occurs commonly at a low frequency in lentil crops and has not caused any serious losses.
- ClYVV caused plant death in spring-sown lentil grown adjacent to irrigated white clover in South Australia in the late 1990s. Similar symptoms are seen in lentil crops on occasions, but can be confused with other causes.
- PSbMV has infected lentil grown near PSbMV infected field pea crops in SA, but harvested grain does not seem to show the characteristic seed markings typically seen in field pea or faba bean.

Virus studies in Western Australia have measured the impact of infection on individual lentil plants:[44]

- AMV decreased shoot dry weight by 74–76% compared with asymptomatic plants, as well as reduced seed yield (81–87%) and individual seed weight (10–21%).
- CMV decreased shoot dry weight by 72–81% compared with asymptomatic plants, as well as reduced seed yield (80–90%) and individual seed weight (17–25%).

While viruses occur in all states, they are a more of a problem in northern NSW and southern Queensland, occasionally causing total crop failures in chickpea.

Damage caused by viruses varies greatly from season to season and depends on the prevalence of aphids. Infection is more likely to cause yield loss when infected seed stock is sown, and aphids arrive early in the season. When aphids arrive late other plants can compensate for individual plant losses.

10.21.5 Disease cycle

Aphids bring viruses into lentil crops from surrounding plants, mostly legumes (like lucerne or clovers). Some viruses, like BWYV, AMV, CMV, BYMV and TSWV, have a host range that includes non-legume species. Hence other plant species (e.g. sow thistle, turnip weed) can act as a virus source at the start of the season.

CMV and AMV are non-persistently transmitted by a range of aphid species. The luteoviruses are persistently aphid-transmitted, but are more vector specific. Correct identification of the aphid is important for effective management. TSWV is spread by thrips.

Probing and feeding needs to be prolonged for persistently transmitted viruses (0.1–4.0 hours for luteoviruses), but only needs to be brief for non-persistently

43 B Coutts, R Jones, P Umina, J Davidson, G Baker and M Aftab (2015) Beet western yellows virus (synonym: Turnip yellows virus) and green peach aphid in canola, GRDC Updates Paper, 10 February 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02/Beet-western-yellows-virus-synonym-Turnip-yellows-virus-and-green-peach-aphid-in-canola

44 LJ Latham, RAC Jones, BA Coutts (2004) Yield losses caused by virus infection in four combinations of non-persistently aphid-transmitted virus and cool-season crop legume. Australian Journal of Experimental agriculture 44, 57-63

transmitted viruses. Eventually aphids colonise the lentil plant and become very visible in the crop.

Crop loss depends on the growth stage at infection and the number of plants infected. Early and widespread infections lead to the greatest losses.[45]

Aphid activity is influenced by seasonal conditions and will require early monitoring in nearby crops and pastures. See 7.1 for more information on monitoring and managing aphids.

10.21.6 Management options

There are no proven methods for controlling viruses.

Virus management in pulses aims at prevention through integrated pest management, that involves controlling the virus source, aphid populations and minimising virus transmission into and within the pulse crop.

While a large population of aphids is required to inflict feeding damage, virus transmission can occur before aphids are seen to be present. Pre-emptive management is required.

Management options at the planning stage:[46]

- Suppress the virus source within the crop by purchasing virus-tested seed. Only retain seed from crops with no visible symptoms. Grade out smaller grain, which is more likely to be infected. PSbMV, CMV, BYMV and AMV survive through seed transmission. A threshold of 0.1% seed infection is recommended for sowing in high-risk areas, and <0.5% for low-risk areas.
- Distance crops from lucerne, weeds or other species that act as a reservoir for viruses, diseases and aphids.
- Control volunteer weeds and self-sown pulses that are a green-bridge host for viruses and a refuge for aphids and their multiplication during summer and autumn.
- Rotate pulse crops with cereals to reduce virus and vector sources (aphids or other insects) and where possible avoid close proximity to perennial pastures (e.g. lucerne) or other crops that host viruses and aphid vectors.

Management options at sowing and in-crop:

- Use a seed treatment of Gaucho 600 Red® (imidacloprid), which is registered for early aphid protection to control persistently transmitted viruses.
- Retain cereal stubble, as aphids are less likely to land in stubble.
- Sow at recommended times to avoid autumn aphid flights.
- Sow at recommended plant densities to achieve early closure of the crop canopy. Closed canopies deter aphids.
- Note that high seeding rates and narrow row spacing to provide early canopy closure assists in aphid control, but conflicts with management of fungal diseases.
- Manage crops to minimise seedling stress through disease, herbicide damage and poor nutrition. Stressed crops are more attractive to aphids.
- Insecticides after emergence may be effective for persistently transmitted viruses. However, they may not be effective for non-persistently transmitted viruses as the insecticide can agitate aphids and increase virus spread.
- Monitor lentil and nearby crops and pastures for aphids. Be prepared to use insecticide when there may be localised flights.

45 K Perry, P Mangano, P Umina, A Freeman, R Jones, W Hawthorne, J Davidson (2010) Aphids and viruses in pulse crops fact sheet. GRDC, Western and Southern regions, July 2010, http://www.grdc.com.au/GRDC-FS-AphidsandVirusesinPulses

46 W Hawthorne, M Materne, J Davidson, K Lindbeck, L McMurray, J Brand (2015) Lentil: Integrated disease management, Pulse Australia website, http://pulseaus.com.au/growing-pulses/bmp/lentil/idm-strategies

Insecticide resistance is becoming more common in aphids. Growers should only consider applying insecticide for virus control if they consider their crops to be at high risk. Insecticides aimed at controlling damage from aphid feeding are normally too late to control virus spread and damage.

10.21.7 Virus testing

Diagnostic testing is available for plant viruses. Only some tests can be performed with relative ease in the field. Current testing options may not detect the less common viruses.

Detection of virus n one or two plants is not proof that the virus is causing a problem. It is important to check for a range of viruses, as the one detected by a test may not be the virus actually causing symptoms.

Detection of a seedborne virus does not mean there will be virus present in progeny seed. Seed samples from the crop require testing to determine if seed infection has occurred.

Serological testing for viruses is available through DDLS Seed Testing and Certification (formerly AGWEST Plant Laboratories), TASAG ELISA and pathogen testing service or Agrifood Technology.

TASAG also sell Agdia Immunostrips test kits. A result can be obtained in minutes.

DAFWA Diagnostic Laboratory Services (DDLS) Seed Testing and Certification

DDLS conduct seed tests for CMV.

Department of Agriculture and Food
Reply Paid 83377
3 Baron Hay Court, South Perth, WA 6151
Ph: 08 9368 3721
Email: DDLS-STAC@agric.wa.gov.au
https://www.agric.wa.gov.au/plant-biosecurity/ddls-seed-testing-and-certification-services

TASAG

TASAG offer in-house virus testing of plants or seed and test kits that can be used in the field (Agdia Immunostrips test kits, US website www.agdia.com).

Contact: Peter Cross
New Town Laboratories
13 St John's Ave, New Town, Tasmania, 7008
Ph: 03 6165 3252
Email: Peter.Cross@dpipwe.tas.gov.au
http://dpipwe.tas.gov.au/biosecurity-tasmania/plant-biosecurity/plant-health-laboratories/tasag-elisa-testing

Agrifood Technology

Agrifood conduct testing for CMV and AMV.

Contact: Robert Rantino or Doreen Fernandez
260 Princes Highway, Werribee, VIC 3030, Australia
Postal: PO Box 728, Werribee, VIC 3030, Australia
Phone: 1800 801 312
http://www.agrifood.com.au/index.php/services/food-safety

MORE INFORMATION

For more information see:
GRDC fact sheet: Aphids and viruses in pulse crops http://www.grdc.com.au/GRDC-FS-AphidsandVirusesinPulses

Pulse Australia webpage: Managing viruses in pulses http://pulseaus.com.au/growing-pulses/publications/manage-viruses

Agriculture Victoria webpage: Managing viruses in pulse crops http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/managing-viruses-in-pulse-crops

MORE INFORMATION

Agriculture Victoria webpage: Seed health testing in pulse crops http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/seed-health-testing-in-pulse-crops

DDLS Seed Testing and Certification (formally AGWEST Plant Laboratories) https://www.agric.wa.gov.au/plant-biosecurity/ddls-seed-testing-and-certification-services

TASAG ELISA Testing Services: http://dpipwe.tas.gov.au/biosecurity-tasmania/plant-biosecurity/plant-health-laboratories/tasag-elisa-testing

FEEDBACK

MORE INFORMATION

For more information see:

Plant Health Australia: Lentil anthracnose http://www.planthealthaustralia.com.au/wp-content/uploads/2013/03/Lentil-anthracnose-FS.pdf

CropPro webpage: Victorian disease manual – Lentil anthracnose http://www.croppro.com.au/crop_disease_manual/ch08s04.php

10.22 Exotic diseases with potential to impact on Australian crops

If you suspect an exotic disease, immediately contact Plant Health Australia's Exotic Plant Pest Hotline on 1800-084-881.

10.22.1 Lentil anthracnose

Colletotrichum truncatum

Importance

Lentil anthracnose is an exotic disease for Australia as it has not been observed here in lentil.[47] It has devastating effects on lentil crops in Canada, and current Australian lentil varieties are susceptible to this disease.

Anthracnose on lentil is caused by *Colletotrichum truncatum*, while Lupin anthracnose is caused by *Colletotrichum gloeosporoides*.

C. truncatum has a very wide host range, affecting other legumes including field pea, bean species, vetch, soybean and peanut. While strains of the *Colletotrichum truncatum* fungus have been found on other pulse crops in Australia, the strain that attacks lentil has not been recorded.

Necrotic lesions on stems, leaves and pods result in plant damage and dead patches in the crop. Yield reductions can be as high as 60–70%.

Symptoms

The first symptoms are green-white lesions on leaves after the first tendril forms, but before flowering, when plants have 8–12 nodes on the main stem (Photo 20). Irregular shaped, light-brown lesions develop on the base of stems and progress up to leaves and pods in the canopy (Photo 21 and Photo 22).

Infected plants lodge and have abnormally dark brown stems. As infection advances and the plant matures, lesions become brown in colour and this is often followed by leaf drop with similar lesions on the stems.

Microsclerotia (black, pinhead-sized structures) form from older lesions and blacken the stems, with stem lesions eventually girdling the stem, causing wilting. Defoliation of lower leaves and ultimately death of affected plants may occur (Photo 23).

There are a number of other infections that result in lesions and wilting in lentil, including Botrytis grey mould and Sclerotinia stem rot. The distinguishing feature of Lentil anthracnose is the blackened lesions which girdle the stems and ultimately kill the plant. Plant samples showing suspected Anthracnose-like symptoms should be sent for diagnosis.

47 Plant Health Australia (2013) Lentil anthracnose. Plant Health Australia fact sheet, http://www.planthealthaustralia.com.au/wp-content/uploads/2013/03/Lentil-anthracnose-FS.pdf

Photo 20: *Early stages of Lentil anthracnose leaf lesion development.*

Photo: R. Morrall, University of Saskatchewan via Southern lentil best management practices training course, (2016), Pulse Australia.

Photo 21: *Lentil anthracnose.*

Photo: J. Davidson, SARDI via Southern lentil best management practices training course, (2016), Pulse Australia.

Photo 22: *Early Anthracnose stem lesion development prior to development of microsclerotia.*

Photo: G Chongo, Agriculture and Agri-Food Canada via Southern lentil best management practices training course, (2016), Pulse Australia.

Photo 23: *Heavy anthracnose infection in lentil.*

Photo: R. Morrall, University of Saskatchewan via Pulse Australia (2016) Ref 30.

Spread

Anthracnose is spread by spores that are small and light. These may be present on infected stubble and spread to new plants by rain splash, or can be spread longer distances by wind, particularly as trash during and after harvest. Spores and infected soil can also be spread by machinery, clothing and animals, and seed may also be infected. Spores can be viable for five years or longer in the soil, infecting subsequent lentil or other host crops.

Disease management

The disease can be managed with foliar fungicides.

Methods to quickly detect any possible incursion and to positively identify the Anthracnose fungus have been established using molecular marker technology to distinguish the lentil-attacking strain from any other related fungus species.

Entry potential: Medium. Entry through infected seed or via seed lots contaminated with infected lentil trash or soil.

Establishment and Spread potential: High as evidenced by the climatic conditions similar to those in overseas countries where *C. truncatum* is a serious problem. Also other races/strains of *C. truncatum* already occur in Australia on other crop host species.

Economic impact: High. All of the current Australian varieties are susceptible. Anthracnose could have a dramatic effect on production.

Overall risk: High.

10.22.2 Rust

Uromyces viciae-fabae

Importance

The *Uromyces* pea and lentil rusts are major fungal pests affecting *Vicia* spp. (faba bean, vetch and lentil) as well as *Pisum* spp. (field pea, garden peas, etc)[48] and other members of the pea family. Each strain of *U. viciae-fabae* is host-specific with the two strains that affect lentil and pea not found in Australia.

Strains of *Uromyces viciae-fabae* occur in Australia on faba bean and vetch. *U. viciae-fabae* is considered a high economic threat to lentil and field pea because of potential yield losses through reduced production.

Symptoms

Rusts can build up rapidly and are mostly seen as the weather warms above 20°C. Leaves, stems and pods can be infected (Photo 24).

48 Plant Health Australia (2013) Pea and lentil rust. Plant Health Australia fact sheet, http://www.planthealthaustralia.com.au/wp-content/uploads/2013/03/Field-pea-and-Lentil-rust-FS.pdf

MORE INFORMATION

For more information see Plant Health Australia: Pea and lentil rust http://www.planthealthaustralia.com.au/wp-content/uploads/2013/03/Field-pea-and-Lentil-rust-FS.pdf

The first symptoms are minute, whitish, slightly raised spots that, as they enlarge, change to orange-brown in colour, often surrounded by a light coloured halo (Photo 25).

Photo 24: *Lentil rust.*

Photo: K. Lindbeck, NSW DPI via Pulse Australia (2016) Ref 30.

Photo 25: *Lentil rust.*

Photo: K. Lindbeck, NSW DPI via Pulse Australia (2016) Ref 30.

Surveillance

Characteristic rust spots on the leaf surfaces and other plant parts are an obvious indicator that rust is present.

The *Uromyces* lentil and pea rusts could be confused with other rusts. The strains of *U. viciae-fabae* that infect faba bean and vetch are present in Australia. If faba bean infestation is high, *U. viciae-fabae* may also infest adjacent field pea crops. If resistant varieties show symptoms, samples should be taken for further testing.

Neither lentil nor pea rust has been recorded on field peas in Australia. If rust symptoms are seen on lentil or field pea a sample should be sent for further testing to identify the species.

Entry potential: Medium. Entry potential via contaminated seed (rust is not seedborne, but spores may travel alongside seed). High establishment and spread potential, economic impact considered medium.

Establishment and spread potential: High. Rust spores are small, light and may survive for several days. They can be spread large distances by windblown infected plant debris during harvest into adjacent paddocks or easily attach to clothing, machinery and tools, allowing movement and spread between farms and regions.

Economic impact: High. A destructive disease of lentil considered to be a high economic threat due to potentially high yield losses through reduced production.

Overall risk: Medium

10.22.3 Fusarium wilt

Fusarium oxysporum f. sp. *Lentis*

The primary host of *Fusarium oxysporum* f. sp. *lentis* is lentil and it is host-specific.[49] Fusarium wilt affects stems, roots, growing points, flowers and seeds. Seedling wilt is characterised by sudden drooping and drying of leaves and whole seedling. Adult symptoms appear at flowering to late pod-fill, with sudden drooping of top leaflets, leaflet closure without premature shedding, and dull green foliage followed by wilting of the whole plant or individual branches. Root systems will appear normal, with a slight reduction in lateral roots.

The pathogen has a low entry potential but high, however high establishment and spread potential. It is viable in soil and debris for up to three years and spores spread by mechanical means and on seed.

Australian breeding lines are screened overseas for resistance to Fusarium.[50]

Entry potential: Low.

Establishment and spread potential: High.

Economic impact: High. A destructive disease of lentil.

Overall risk: Medium.

10.22.4 Aphanomyces root rot

Aphanomyces euteiches

Economic importance

This root rot has been observed in recent years in parts of northern NSW in faba bean.[51] It is unlikely to be a major pathogen of lentil at present. However, the expansion of this crop into regions with heavy soils and high rainfall, or irrigated fields, increases the risk of losses.

Symptoms

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

Disease cycle

The fungus survives in soil and is exacerbated by waterlogging. It can spread from crop to crop in the soil, either via 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.

49 Pulse Australia (2016) Southern lentil best management practices training course – 2016. Pulse Australia.

50 GRDC (2011) DAV00119 PBA Lentil breeding - expansion project. Project outline, GRDC, https://grdc.com.au/research/projects/project?id=708

51 Pulse Australia (2016) Southern lentil best management practices training course – 2016. Pulse Australia.