SOUTHERN
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GRDC GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

LUPIN

SECTION 8

FOLIAR DISEASES

OVERVIEW | ANTHRACNOSE | BROWN LEAF SPOT | PHOMOPSIS STEM AND POD BLIGHT | CUCUMBER MOSAIC VIRUS (CMV) | BEAN YELLOW MOSAIC VIRUS (BYMV) | SCLEROTINIA STEM AND COLLAR ROT | MINOR FOLIAR DISEASES IN SOUTHERN REGION LUPIN CROPS

MORE INFORMATION

Agriculture Victoria 'Pulse Disease Guide': http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/pulse-disease-guide#utm_source=www-vic-gov-au&utm_medium=vanity-url-301ssredirect&utm_content=pulse diseaseguide&utm_campaign=agriculture

NSW Department of Primary Industries 'Lupin Growth and Development': http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/516183/Procrop-lupin-growth-and-development.pdf

GRDC 'Crop Disease Au' App: https://grdc.com.au/apps

Australian Pesticide and Veterinary Medicines Authority: http://apvma.gov.au/

GRDC 'Crop Disease Au' App: https://grdc.com.au/apps

GRDC 'Grains and Legume Handbook – Chapter 7 Disease Identification and Control': https://grdc.com.au/grainlegumehandbook

Infopest: http://www.infopest.com.au/

CropPro: http://www.croppro.com.au/crop_disease_manual/ch10.php

DPIRD-GRDC MyCrop and MyCropApp: https://grdc.com.au/apps https://www.agric.wa.gov.au/mycrop

DPIRD Diagnostic Laboratory Services (DDLS)-Plant Pathology: https://www.agric.wa.gov.au/ddls-seed-testing-and-certification

GRDC 'The Current and Potential Costs from Diseases of Pulse Crops in Australia': https://grdc.com.au/resources-and-publications/all-publications/publications/2012/06/the-current-and-potential-costs-from-diseases-of-pulse-crops-in-australia

DPIRD Lupin Diagnostic Tool: www.agric.wa.gov.au/lupin-diagnostic-tool

Foliar diseases

8.1 Overview

The main fungal and viral diseases affecting lupin foliage, stems and pods in the southern region are:

- Anthracnose (*Colletotrichum lupini*)
- Brown leaf spot (*Pleiochaeta setosa*)
- Phomopsis stem and pod blight (*Phomopsis leptostromiformis* and *Diaporthe toxica*)
- Cucumber mosaic virus (CMV)
- Bean yellow mosaic virus (BYMV)
- Sclerotinia stem and collar rot (*Sclerotinia sclerotiorum* and *Sclerotinia minor*).

Minor foliar diseases that can also affect lupin crops in the southern region in some years include:

- Grey leaf spot (*Stemphylium botryosum*)
- Cladosporium leaf spot (*Cladosporium sp.*)
- Grey mould (*Botrytis cinerea*)
- Bean leaf roll virus (BLRV)
- Alfalfa mosaic virus (AMV)
- Powdery mildew (*Erysiphe polygoni*).

Lupin yield losses from foliar diseases are typically rare in most southern growing areas due to widespread adoption of fungicide-based seed treatments and wider crop sequences.

But, left unchecked in some years and situations, several of the major diseases have potential to cause significant crop losses.

Damage can be prevented or curtailed with an integrated management approach involving variety choice, crop rotations, crop hygiene and targeted seed-based and foliar fungicide use.

Reducing the impact of these diseases will allow lupin production levels in South Australia, Victoria and New South Wales to be maintained. This, in turn, underpins cereal and canola production by supporting viable and profitable rotations — especially on sandy soils.

Lupin variety responses to a range of foliar diseases are shown in Table 1.[1]

1 CropPro (2016) Identification and management of field crop diseases in Victoria, GRDC and Department of Environment and Primary Industries Victoria, http://www.croppro.com.au/crop_disease_manual/

FEEDBACK

Table 1: Lupin variety disease reactions.[2]

	PLEIOCHAETA ROOT ROT	BROWN LEAF STEM	BROWN SPOT POD	PHOMOPSIS	ANTHRACNOSE
NARROW LEAF					
PBA Bateman$^{\Phi}$			MS	MR	MR
Jenabillup$^{\Phi}$	R	R	MS	R	MS
Jindalee	MR	MR	R	R	MS
Mandelup$^{\Phi}$	R	MS	R	R	MR
PBA Barlock$^{\Phi}$		MS	MR	R	R
PBA Gunyidi$^{\Phi}$	R	MS	R	R	MR-R
Quilinock$^{\Phi}$	R	MR-MS	MR	S	S-VS
Wonga	R	MS	MR	S	R
ALBUS LUPIN					
Murringo$^{\Phi}$	MR			Intermed	VS
Kiev Mutant	VS	MR	MR	S	VS
Luxor$^{\Phi}$	R	MR	MR	S	VS
Rosetta	MR	MR	MR	S	VS

Disease tolerance: R = Resistant MR = Moderately resistant
MS = Moderately susceptible S = Susceptible VS = Very susceptible.

2 CropPro (2016) Identification and management of field crop diseases in Victoria, GRDC and Department of Environment and Primary Industries Victoria, http://www.croppro.com.au/crop_disease_manual/

FEEDBACK

A summary of lupin diseases, symptoms and control tactics is outlined in Table 2.

Table 2: Lupin disease guide summary.[3]

Disease	Organisms	Symptoms	Occurrence	Inoculum source	Control
Brown leaf spot	*Pleiochaeta setosa*	Dark spots on leaves and pods, leaves drop off, lesions may girdle stem	Very common but losses usually minor in dry areas, yield loss can be significant in cool damp areas	Spores in soil and lupin trash, rain splash and wind blown rain splash and wind blown rain splash	Fungicide seed dressings, crop rotation, variety selection, early sowing
Pleiochaeta root rot	*Pleiochaeta setosa*	Browning and rotting of tap and lateral roots, seedling plant death	Serious reduction in lupin plant density and vigour	Spores in soil infecting roots usually at seedling stage, spread also by rain splash	Rotation minimum 4 years between lupin, sowing 4—5 cm deep to avoid spore layer, fungicide seed dressings
Rhizoctonia	*Rhizoctonia spp.*	Bare patches in crop, spear tipped root ends, hypocotyl rot and stain	Can be severe in isolated patches, reduces stand density, favoured by minimum tillage, wet soils and mild conditions	Soil-borne infection on wide host range, survives as fungal fragments in soil and plant debris	Tillage prior and during sowing, rotation has no effect, increased seeding rate
Anthracnose	*Colletotrichum lupini*	Stems bend over, sticky dark brown lesions in crook of bend, pods and leaves above crook twist and deform, dark lesions with pale centres on leaves, stems and pods	Severe infections can result in complete crop failure	Spores surviving in soil are transported by vehicles, machinery, animals and people, spread in crop by rain splash and wind	Clean seed and machinery, 4 year break between lupin, resistant varieties, fungicide seed dressings reduce seedling infection
Cucumber mosaic virus	Virus	All growth after infection is dwarfed, leaflets are yellowed and bunched	Early widespread infection Severely reduces yield. Minor infections prevent use of harvested grain as seed	Seed-borne infection in narrow leaf lupin, aphids transmit the disease within a crop	Sow clean seed, use a seed test, high sowing rates and cereal barriers around crops reduce aphid transmission
Bean yellow mosaic virus	Virus	Brown streaks on stem, shepherd crook, pods blackened and flat, plants wilt and die	Occurs in all lupin growing areas. Can be severe in higher rainfall areas	Seed-borne in albus, aphid spread in crop, many host species	Sow virus free seed. High plant density, cereal barrier

3 CropPro (2016) Identification and management of field crop diseases in Victoria, GRDC and Department of Environment and Primary Industries Victoria, http://www.croppro.com.au/crop_disease_manual/

FEEDBACK

MORE INFORMATION

Agriculture Victoria 'Certification Requirements for Lupin Anthracnose': http://agriculture.vic.gov.au/agriculture/horticulture/moving-plants-and-plant-products/moving-plants-within-victoria/compliance-and-verification-agreements/lupin-anthracnose

GRDC 'Grain Legume Handbook – Chapter 7 Disease Identification and Control': https://grdc.com.au/grainlegumehandbook

DPIRD Diagnostic Laboratory Services (DDLS)-Plant Pathology: https://www.agric.wa.gov.au/ddls-seed-testing-and-certification

NSW Department of Primary Industry anthracnose eradication zone advice: http://www.dpi.nsw.gov.au/biosecurity/plant/recent-pest-arrivals/lupin-anthracnose

Agriculture Victoria quarantine rules: http://agriculture.vic.gov.au/agriculture/horticulture/moving-plants-and-plant-products/moving-plants-within-victoria/compliance-and-verification-agreements/lupin-anthracnose

8.2 Anthracnose (*Colletotrichum lupini*)

Figure 1: *Anthracnose can devastate lupin plants in susceptible varieties but can be managed.*

(SOURCE: SARDI)

- Risk increases with rainfall, use of infected seed and disease susceptible varieties
- Albus and yellow lupin are more susceptible than narrow leafed lupin
- Has occurred on the Eyre Peninsula in SA (but has not been sighted in recent years)
- Has been reported in commercial crops in NSW in 2016 and eradication zones have been set up
- VIC has no anthracnose reports (any sightings should be reported to CropSafe)
- All above-ground parts of the lupin plant can be infected
- Yield losses can be up to 50 percent in susceptible varieties
- Severe infection can lead to plant death
- Variety resistance can reduce the impact from seed-borne infection
- Registered seed dressings and foliar fungicides are effective control measures.

Anthracnose, caused by the fungus *Colletotrichum lupini*, is a highly destructive disease of lupin crops that can lead to total crop loss in susceptible varieties if not managed. But, typically, it can be eradicated from a paddock, farm or region by using correct rotations and hygiene practices, such as growing non-lupin crops for several years.

This disease has occurred in broadacre lupin crops in South Australia's Eyre Peninsular region in the past, but has not been seen in recent years. Quarantine restrictions for importation of SA lupins into VIC and NSW were put in place in 1996. More information about VIC quarantine rules is available at: http://agriculture.vic.gov.au/agriculture/horticulture/moving-plants-and-plant-products/moving-plants-within-victoria/compliance-and-verification-agreements/lupin-anthracnose

Lupin anthracnose permit requirements remain in place for used agricultural machinery, used packages and diagnostic samples.

Permit requirements regarding the movement of lupin seed and plants have been removed, although these items must still be certified. These pathways continue to be considered as posing a high risk for the entry, spread and establishment of this disease in Victoria.

FEEDBACK

The following previously regulated articles no longer require certification:

- Grain or husks - must be marketed as stock feed or for processing.
- Hay, straw or fodder - must be marketed as stock feed or for processing.[4]

Anthracnose was reported in NSW crops in 2016 and eradication zones have been set up. More information is available at: http://www.dpi.nsw.gov.au/biosecurity/plant/recent-pest-arrivals/lupin-anthracnose

In recent years, use of resistant varieties, less sowing of infected seed and registration of foliar fungicides for anthracnose have reduced the impact of this disease across southern Australia.

While SA growers need to be wary of anthracnose from a marketing perspective, its risk does not typically affect crop management.

Continued improved management of anthracnose is expected to enable retention of lupin in crop sequences in disease susceptible areas and help to reduce reliance on nitrogen (N) fertilisers and fungicides in cereal phases of the rotation.

The anthracnose pathogen survives on lupin stubbles and can persist for up to two years in (or on) infected seed, which will produce infected seedlings.

These seedlings have lesions on the root, hypocotyl, cotyledons, leaf petioles or stems, which – in turn – create an abundance of spores.

Spores can be splashed on to surrounding plants by rain and have been shown to travel more than 100 metres to establish the disease in new crops.

It is important that disease-free seed is obtained from reputable sources. Standard hygiene practice should apply when dealing with equipment, material or people from infected states.

Anthracnose-infected seed can cause significant yield losses (of up to 50 percent in some WA trials) in all lupin varieties due to the early establishment of infection.[5] Southern region lupin crops can be affected to a similar extent by this disease.

The most distinctive symptoms of anthracnose are bending and twisting of stems, with a lesion in the crook of the bend. These are very noticeable at flowering.

Stem lesions are typically dark brown, with a pale pinkish-orange spore mass in the lesion. The stem can be completely girdled by lesions, or so weakened that it breaks. Both the main stem and lateral branches can be affected and close inspection will often show similar symptoms on leaves.

Pods develop lesions similar to those on stems and are often twisted and distorted. Infections at this stage can result in complete loss of pods, or production of infected seed.

Infected seed can appear symptomless, or can be malformed with discoloration, fungal mycelium or pink spores on the seed surface. Seed testing can detect presence and levels of infection.

Management of anthracnose

- Use resistant varieties in high risk environments
- Test seed for presence and levels of infection and use clean seed
- Thiram (Group M3)-based seed dressing fungicides can reduce disease transmission
- Mancozeb (Group M3) active is registered for foliar application
- Under high disease pressure, foliar sprays are ideally applied at early podding on main stems and first order branches.[6]

4 Agriculture Victoria, Lupin Anthracnose, http://agriculture.vic.gov.au/agriculture/horticulture/moving-plants-and-plant-products/moving-plants-within-victoria/compliance-and-verification-agreements/lupin-anthracnose

5 Thomas, G (2004) Advanced management strategies for control of anthracnose and brown spot in lupins, GRDC Final Report, http://finalreports.grdc.com.au/DAW665

6 DPIRD-GRDC (2016) MyCrop Diagnostic Tool – Diagnosing anthracnose in narrow-leafed lupins, https://www.agric.wa.gov.au/mycrop/diagnosing-anthracnose-narrow-leafed-lupins

FEEDBACK

As shown in Table 1, the narrow leafed lupin varieties PBA Bateman$^{\Phi}$, PBA Jurien$^{\Phi}$, PBA Barlock$^{\Phi}$, Mandelup$^{\Phi}$ and Tanjil$^{\Phi}$ are resistant to athracnose, along with the albus variety Amira$^{\Phi}$.

Research has shown anthracnose resistance is most strongly expressed in stem tissue, offering good protection from the impact of seed-borne infection.

But resistant varieties can suffer significant yield losses from infection at the flowering and podding stages.[7]

In some years (at the request of marketers), a lupin 'anthracnose-free' segregation has been set up in the Eyre Peninsular region of SA for selected growers. This has enabled grain to be tested as free of anthracnose and eligible to be transported to approved markets in VIC and NSW. This has tended to occur in years of drought when feed demand exceeds supply in those states.

Anthracnose grain tests are the most common way to identify anthracnose freedom for marketing.

Paddock inspection for anthracnose freedom is usually the cheaper option per tonne of grain produced, but this is not available to lupin growers in some parts of the Eyre Peninsula.

To establish eligibility for paddock inspection, sowing seed must have been tested for anthracnose.

Certification requirements for lupin anthracnose were updated in Victoria in late 2015. For more information go to this link http://agriculture.vic.gov.au/agriculture/horticulture/moving-plants-and-plant-products/moving-plants-within-victoria/compliance-and-verification-agreements/lupin-anthracnose

Research has found fungicide seed dressings with the active ingredient thiram (at a rate of about 1.7-2 Litres/tonne seed) can reduce seed transmission of anthracnose by about 75 percent. Thiram gives poor control of Brown leaf spot, but can be safely used in conjunction with fungicides containing the Group 2 actives iprodione or procymidone for protection from both diseases.[8]

If seed testing shows zero anthracnose, use of a fungicide seed dressing is typically not needed.

Mancozeb (Group M3) is registered for foliar application to control anthracnose in lupin crops at rates of 1-2.2 kilograms per hectare.

Research trials in WA have found the optimum spray timing of foliar fungicide for this disease in lupin is before infection and at podding on first branches.[9]

This can be useful when more resistant varieties are not available or when lupin is grown in areas of high disease risk under high disease pressure.

Foliar fungicide application may also facilitate the production of higher yielding moderately resistant (MR) narrow leafed varieties (such as Mandelup$^{\Phi}$) in high yield potential, but high disease risk, areas.

Agronomic practices, such as stubble retention/sowing into standing stubble (except for into lupin stubble), avoiding sowing lupin following lupin and controlling volunteer lupin have been shown to reduce the spread of anthracnose from infected seed.

7 Thomas, G (2004) Advanced management strategies for control of anthracnose and brown spot in lupins, GRDC Final Report, http://finalreports.grdc.com.au/DAW665

8 Thomas, G (2004) Advanced management strategies for control of anthracnose and brown spot in lupins, GRDC Final Report, http://finalreports.grdc.com.au/DAW665

9 Thomas, G (2004) Advanced management strategies for control of anthracnose and brown spot in lupins, GRDC Final Report, http://finalreports.grdc.com.au/DAW665

FEEDBACK

MORE INFORMATION

GRDC 'Grain Legume Handbook': https://grdc.com.au/grainlegumehandbook

DPIRD-GRDC MyCrop: https://www.agric.wa.gov.au/mycrop

8.3 Brown leaf spot (*Pleiochaeta setosa*)

Figure 2: *Brown leaf spot on narrow leafed lupin leaves.*

(SOURCE: GRDC Grain Legume Handbook)

Figure 3: *Brown leaf spot on pods.*

(SOURCE: GRDC Grain Legume Handbook)

- Affects all lupin varieties
- Cotyledons, leaves, stems and pods can be infected
- Control tactics include rotations, resistant varieties, adequate crop nutrition and targeted fungicides
- Group 2 fungicide actives iprodione and procymidone-based seed dressing fungicides are registered for control and can reduce seedling infection.

Brown leaf spot (*Pleiochaeta setosa*) is a widespread and costly foliar disease of lupin crops.

All species are affected, including the commonly grown narrow leafed varieties Mandelup$^{\Phi}$, PBA Barlock$^{\Phi}$, PBA Jurien$^{\Phi}$ and new PBA Bateman$^{\Phi}$ and the albus variety Amira$^{\Phi}$.

Paddocks previously sown to lupin will have *Pleiochaeta* spores in the soil and these can persist for several years, making crop rotation with non-host species an integral control strategy.

FEEDBACK

Brown leaf spot infection occurs when spores are splashed by rain from the soil onto new lupin plants.

Crop damage can increase at early seedling stage, when plant growth rates are slowed by colder environments, late sowing, poor nutrition, herbicide damage or unfavourable soil type. Seedling infection has been shown to have the biggest impact on grain yield.

Infected cotyledons develop dark brown spots, rapidly become yellow and drop off.

Leaves develop dark brown spots, often become net-like, distorted and small and then drop off prematurely.

Brown flecks may be evident on infected stems and occasionally large brown-black cankers develop that kill the stem above the infection point.

Pods, particularly those set closer to the ground, may be flecked or develop larger brown lesions. Stem and pod infection are usually associated with leaf infection in the upper canopy.

Management of Brown leaf spot

- Rotate lupin paddocks to non-host crops for at least one year
- Sow lupin into retained cereal stubble to reduce rain splash of soil-borne spores on to foliage
- Use agronomic practices that promote seedling vigour and canopy closure – early sowing, adequate nutrition, care in herbicide use and higher seeding rates
- Select more tolerant narrow leafed lupin varieties
- Iprodione or procymidone-based seed dressing fungicides are effective.[10]

Seed dressing fungicides may be useful in high risk areas, such as on loamy and heavy soil types and where stubble is not retained, to reduce Brown leaf spot infection in seedlings.

But, on sandy soils, if stubble cover is high and there is no paddock history of Brown leaf spot, there is often no need to use a seed dressing.[11]

A potential agronomic issue for Brown leaf spot is weed control, with WA trials carried out in 2000-04 finding disease damage to leaves could increase with the use of the herbicide simazine (Group C).[12]

Glasshouse research in 2004-08 found Mandelup(p) infected with Brown leaf spot could tolerate commonly used post-emergent herbicides (with the actives diflufenican (Group F) and metribuzin (Group C) applied at registered label rates) without affecting plant growth, development or yield. It is advised that under low Brown leaf spot disease severity, these herbicides – alone or mixed with other actives – might increase disease severity and reduce yields.[13]

10 DPIRD-GRDC (2016) MyCrop Diagnostic Tool – Diagnosing brown spot in narrow-leafed lupins, https://www.agric.wa.gov.au/mycrop/diagnosing-brown-spot-narrow-leafed-lupins

11 DPIRD-GRDC (2016) MyCrop Diagnostic Tool – Diagnosing brown spot in narrow-leafed lupins, https://www.agric.wa.gov.au/mycrop/diagnosing-brown-spot-narrow-leafed-lupins

12 Thomas, G (2004) Advanced management strategies for control of anthracnose and brown spot in lupins, GRDC Final Report, http://finalreports.grdc.com.au/DAW665

13 Dhammu, H.S, MacLeod, W.J, Roberts, C, Payne, P.L.M, Antuono, M.F (2008) Interaction of brown leaf spot with post-emergent herbicides in narrow-leafed lupins, DAFWA, http://www.lupins.org/pdf/conference/2008/Agronomy%20and%20Production/HS%20Dhammu%20W%20MacLeod%20C%20Roberts%20P%20Payne%20and%20M%20DAntuono.pdf

FEEDBACK

MORE INFORMATION

DPIRD-GRDC MyCrop: https://www.agric.wa.gov.au/mycrop/diagnosing-phomopsis-stem-and-pod-blight-narrow-leafed-lupins

DPIRD 'Lupinosis': https://www.agric.wa.gov.au/livestock-biosecurity/lupinosis-sheep

8.4 Phomopsis stem and pod blight (*Phomopsis leptostromiformis, Diaporthe toxica*)

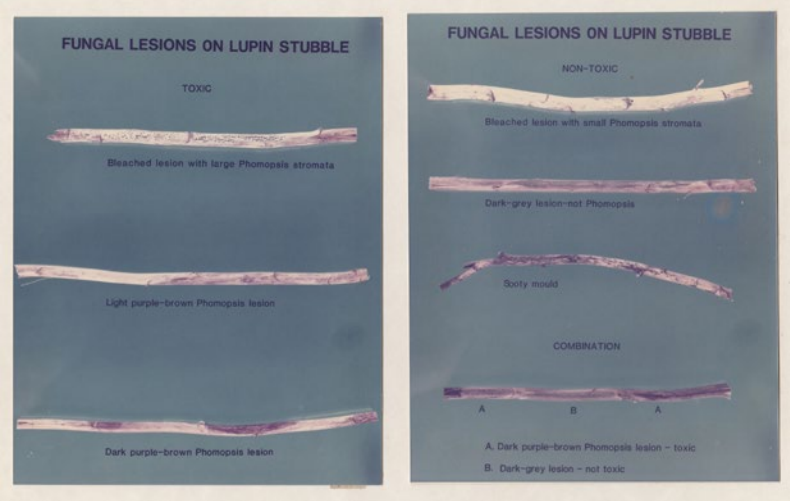

Figure 4: *Phomopsis symptons on lupin stubble.*

(SOURCE: DPIRD)

Figure 5: *Phomopsis infection of narrow leafed lupin crops.*

(SOURCE: W. Hawthorne)

- Phomopsis fungus infection can cause lupinosis in livestock
- Infects lupin stems, leaves, pods and seed and causes yield losses
- Narrow leafed varieties more susceptible than albus
- Control tactics include more resistant varieties and extending lupin crop sequences.

The major impact of phomopsis stem blight (*Phomopsis leptostromiformis*) and phomopsis pod blight (*Diaporthe toxica*) is production of a mycotoxin (*phomopsin*) as the fungus grows in mature lupin stems.

This can cause livestock sickness or death from lupinosis if grazing of infected stubble is poorly managed.

Crop symptoms of phomopsis typically appear on senescing lupin stems as dark-purplish lesions that bleach with age and contain black fruiting bodies. It can cause plants to lodge.

FEEDBACK

Small black fruiting bodies develop on lupin stubble, often after summer rain, which stimulates growth of the fungus and the production of toxins and makes it dangerous for grazing.

Re-infected seedlings in subsequent crops develop deep-yellow to brown, irregular shaped lesions on stems below the cotyledons. Severe lesions may girdle the stem and kill the plant.

Pod lesions can lead to infected seeds, which appear as either normal or are discolored light yellow to reddish-tan. Web-like grey mould of the fungus may be seen on the seed coat and inside the seed pod.

Figure 6: *Dr Kurt Lindbeck, plant pathologist at the New South Wales Department of Primary Industries, says small, raised black fruiting structures within a lesion on a lupin plant or lupin stubbles are symptomatic of the disease phomopsis.*

(SOURCE: GRDC)

Figure 7: *Phomopsis infection on lupin seed.*

(SOURCE: GRDC Grain Legume Handbook)

Management of phomopsis

- Use more resistant varieties in high risk areas
- Extend lupin phases in crop rotation planning
- Destroy infected crop residues with burning or cultivation
- Take care when grazing lupin stubbles in high risk areas
- Remove stock from lupin stubbles when summer rain is imminent.[14]

14 DPIRD-GRDC (2016) MyCrop Diagnostic Tool – Diagnosing phomopsis stem and pod blight in narrow-leafed lupins, https://www.agric.wa.gov.au/mycrop/diagnosing-phomopsis-stem-and-pod-blight-narrow-leafed-lupins

FEEDBACK

Narrow leafed lupin tends to be more prone to phomopsis stem and pod blight than albus lupin. But PBA Bateman$^{\Phi}$, PBA Jurien$^{\Phi}$, PBA Barlock$^{\Phi}$, Jindalee, PBA Gunyidi$^{\Phi}$, Wonga and Mandelup$^{\Phi}$ have moderate resistance to both stem and pod infection.

If weather conditions favor the pathogen, including prolonged rainfall or high humidity in late spring and summer, stubble can develop some toxicity and require care with grazing. But current commercial varieties do not produce highly toxic stubbles.[15]

Increasing the breaks between lupin crops allows weathering and breakdown of infected stubble, reducing disease inoculum.

8.5 Cucumber mosaic virus (CMV)

Figure 8: *Cucumber mosaic virus is seed and aphid-borne and narrow leafed lupin varieties are more susceptible than albus lines.*

(SOURCE: DPIRD)

- Seed and aphid-borne
- Spread by sowing infected seed and via aphid vectors
- Seed testing for infection is advised
- Neonicotinoid-based insecticide can be used on seed
- Suppressing aphid transmission is a key management tactic.

Infected seed is the most common source of Cucumber mosaic virus (CMV) incidence in lupin crops. Narrow leafed varieties are more susceptible than albus lines.

Lupin and lentil crops in south eastern Australia tested between 2000 and 2010 were the most likely of all crops tested to be infected with this disease.

A seed infection level of 1 percent means one plant in every 100 plants will typically be virus-infected and these will tend to be randomly distributed across the paddock.

Secondary infection occurs by aphids, which acquire the virus from primary infected plants (or weeds, clover or other pulse crops) and spread it to healthy crops.

Aphid species that spread CMV include Green peach aphid (*Myzus persicae*), Blue green aphid (*Acyrthosiphon kondoi*) and Cowpea aphid (*Aphis craccivora*) that colonise lupin crops.

MORE INFORMATION

GRDC 'Fact Sheet – Resistance Management Strategy for the Green Peach Aphid in Australian Grains': www.grdc.com.au/GPAResistanceStrategy

GRDC 'Back Pocket Guide – Crop Aphids': https://grdc.com.au/CropAphidsBackPocketGuide

DPIRD 'Cucumber Mosaic Virus': https://www.agric.wa.gov.au/grains-research-development/cucumber-mosaic-virus-narrow-leafed-lupins

15 DPIRD-GRDC (2016) MyCrop Diagnostic Tool – Diagnosing phomopsis stem and pod blight in narrow-leafed lupins, https://www.agric.wa.gov.au/mycrop/diagnosing-phomopsis-stem-and-pod-blight-narrow-leafed-lupins

FEEDBACK

The disease is also spread by migrants of common non-lupin colonising aphid species, especially Oat aphid (*Rhopalosiphum padi*) and Turnip aphid (*Lipaphis erysime*).

CMV infection causes lupin leaves to become pale, bunched and down-curled with faint mosaic patterns.

It can severely stunt plant growth and the earlier a plant becomes infected, the fewer the pods set, the smaller the size of seed produced and the lower the crop yield.

With late infections, symptoms tend to be restricted to tip leaves.

As shown in Table 3, yield losses from CMV can be as high as 60 percent when all plants in a crop become infected. Losses are greatest when seed with more than 1 percent infection is sown, aphids arrive early and widespread plant infection occurs.[16]

Table 3: Effect of sowing CMV-infected seed on yield and subsequent seed transmission (data from Western Australian field trials).[17]

Scenario	1	2	3	4
Initial CMV seed infection level	5%	0.5%	5%	0.5%
Aphid arrival	Early	Early	Very late	Very late
Final crop infection	89—95%	34—53%	1—2%	0.1%
Yield loss	36—53%	ns	ns	ns
Harvested CMV seed infection level	12—13%	7%	0.6%	0.1—0.2%

NOTE: ns=yield impact is not statistically significant

Management of CMV

- Grow virus resistant varieties
- Sow tested seed with virus levels less than 0.1-0.5 percent
- Eliminate weeds and self-sown pulses for aphid and disease control
- Monitor and control aphids, especially during early crop growth
- Rotate lupin crops with cereals to break disease cycles
- If necessary, use seed treatment containing neonicotinoid-based insecticide
- In-crop insecticides have shown to be ineffective.[18]

Lupin varieties differ in rates of susceptibility to aphid colonisation and aphid-borne viruses, such as CMV.

Further information about resistance ratings to this and other viruses can be found at this link: https://grdc.com.au/resources-and-publications/all-publications/publications/2016/12/sa-sowingguide2017

Moderately resistant narrow leafed lupin varieties include PBA Bateman$^{\Phi}$, PBA Jurien$^{\Phi}$, PBA Barlock$^{\Phi}$, PBA Gunyidi$^{\Phi}$, Jenabillup$^{\Phi}$ and Wonga.

Sowing healthy lupin seed is key to managing CMV in lupin and samples can be sent to commercial testing services, including DPIRD's Diagnostic Laboratory Services (DDLS)-Plant Pathology, to test infection levels.

16 DPIRD (2016) Cucumber mosaic virus in narrow-leafed lupins, https://www.agric.wa.gov.au/grains-research-development/cucumber-mosaic-virus-narrow-leafed-lupins?page=0%2C1

17 DPIRD (2016) Cucumber mosaic virus in narrow-leafed lupins, https://www.agric.wa.gov.au/grains-research-development/cucumber-mosaic-virus-narrow-leafed-lupins?page=0%2C1

18 DPIRD (2016) Cucumber mosaic virus in narrow-leafed lupins, https://www.agric.wa.gov.au/grains-research-development/cucumber-mosaic-virus-narrow-leafed-lupins?page=0%2C1

FEEDBACK

In low-risk areas of the southern region, it is advisable to sow seed with less than 0.5 percent infection to reduce risk of yield loss in 'typical' seasons.

Seed infection of less than 0.1 percent (shown as a zero result from a 1000 seed test) is recommended for grain crops in high risk areas and for seed certification crops in any rainfall zone. But it is advised that the outcome of sowing seed infected with a range of levels of CMV will vary significantly from year to year and site to site.[19]

Sowing seed with a high level of infection, coupled with early arrival of aphids, can initiate early epidemics of CMV that can result in high disease incidence, reduced yield and increased infection in harvested seed.

When there is a dry start to the growing season, sowing seed with a high level of infection can result in minimal yield loss and reduction in infection levels in harvested seed. The aphids arrive much later, resulting in a much reduced CMV spread.

Figure 9: *Cucumber mosaic virus can lead to stunted, bunched plants with down-curled leaves, as shown on left.*

(SOURCE: GRDC)

Seed dressing insecticides containing the active neonicotinoid have been found to help prevent crops from early feeding of aphids and can stop the infection of crops from viruses.

Agronomic practices such as sowing early into retained stubble, away from neighboring lupin crops, at high seeding rates and using narrow row spacing will promote early crop canopy coverage and deter aphids from landing.

This will shade over the seed-infected and early infected plants, denying aphids access to the crop.

Maximising weed control will also reduce the spread of CMV from lupin to weeds and from weeds back to lupin.

Research in WA has found insecticides applied in-crop crops are ineffective at controlling CMV.[20]

19 DPIRD (2016) Cucumber mosaic virus in narrow-leafed lupins, https://www.agric.wa.gov.au/grains-research-development/cucumber-mosaic-virus-narrow-leafed-lupins?page=0%2C1

20 DPIRD (2016) Cucumber mosaic virus in narrow-leafed lupins, https://www.agric.wa.gov.au/grains-research-development/cucumber-mosaic-virus-narrow-leafed-lupins?page=0%2C1

FEEDBACK

MORE INFORMATION

GRDC 'Grains Legume Handbook': https://grdc.com.au/grainlegumehandbook

DPIRD 'Bean Yellow Mosaic Virus': https://www.agric.wa.gov.au/lupins/bean-yellow-mosaic-virus-lupins

8.6 Bean yellow mosaic virus (BYMV)

Figure 10: *When Bean yellow mosaic virus affects a lupin plant, the youngest growth can bend over and cause a 'shepherd's crook' appearance.*

(SOURCE: DPIRD)

- Spread by aphid species that colonise lupin
- Can be seed-borne in albus varieties (not narrow leafed lines)
- Crop yield losses can be up to 80 percent if left unchecked
- Late summer and early autumn rain can increase spread
- Integrated disease management based on agronomic practices is needed
- Test for and sow virus-free seed.[21]

Bean yellow mosaic virus (BYMV) can be a serious disease if found in narrow leafed lupin crops in some years and situations and not managed. However, pulse crop surveys during the past 10 years in Victoria, SA and NSW indicate it is typically a minor issue.

Disease risk is typically highest in seasons with high summer/autumn rainfall that promotes early build-up and migration of aphids that carry BYMV.

Crops neighboring clover-based pastures, or containing clover/weeds, are at the greatest risk of infection.

If disease is present, there are two common strains that affect southern region lupin crops. The necrotic strain (BYMV-N) kills the infected plant and the less abundant non-necrotic (BYMV-NN) strain causes stunting without killing the plant.

DPIRD has a comprehensive guide to diagnosing BYMV at this link: https://www.agric.wa.gov.au/mycrop/diagnosing-bean-yellow-mosaic-virus-non-necrotic-narrow-leafed-lupins[22]

21 DPIRD (2016) Management of aphids in Western Australian lupin crops, https://www.agric.wa.gov.au/grains-research-development/management-aphids-western-australian-lupin-crops

22 DPIRD-GRDC (2016) MyCrop Diagnostic Tool – Diagnosing Bean yellow mosaic virus – non necrotic in narrow-leafed lupins, https://www.agric.wa.gov.au/mycrop/diagnosing-bean-yellow-mosaic-virus-non-necrotic-narrow-leafed-lupins

FEEDBACK

BYMV-N symptoms include:

- Occurs before pod set
- Necrotic streaking of the youngest portion of the shoot
- This bends over, causing a shepherd's crook appearance
- The growing tip dies
- Leaves become pale, wilt and fall off
- Necrotic streaking and blackening spread across the stem
- Fast plant death without seed production.[23]

BYMV-NN symptoms include:

- Occurs after pod set and is rare
- Virus is slower to spread
- Stunted pale plants
- Deformed and often fleshy leaves
- Pods blacken and fail to fill while the rest of the plant grows normally (known as black pod syndrome).[24]

Management of BYMV

- Promote early crop canopy coverage – sow early, use high seeding rates and narrow row spacing
- Direct drill into retained stubble – groundcover reduces aphid landing
- Rotate lupin with non-host crops
- Ensure good weed control
- Insecticides applied in-crop are ineffective to control BYMV.[25]

There is typically only a brief period between initial BWYV symptoms appearing in young lupin crops and plant death.

This means incoming aphids can only acquire the virus from infected plants for one to two weeks and infection levels decline rapidly with increasing distance into the crop.

Management of this virus centres on agronomic practices that:

- Eliminate clover/weed regrowth under lupin crops
- Avoid sowing adjacent to clover based pastures
- Deter aphid landing by reducing bare ground exposure.

This can be achieved by tactics such as promoting early canopy development, sowing into retained stubbles, using high seeding rates and adopting narrow row spacing.

High plant densities will tend to dilute the proportion of plants infected and increase compensatory growth of healthy plants.

Sowing a non-host crop (for example, a cereal) or a border strip between crops and adjacent pasture can also be effective, as incoming aphids lose the virus when they probe the non-host. This helps to reduce spread into the crop from an external source.[26]

23 DPIRD (2016) Bean Yellow mosaic virus in lupins, https://www.agric.wa.gov.au/lupins/bean-yellow-mosaic-virus-lupins

24 DPIRD (2016) Bean Yellow mosaic virus in lupins, https://www.agric.wa.gov.au/lupins/bean-yellow-mosaic-virus-lupins

25 DPIRD (2016) Bean Yellow mosaic virus in lupins, https://www.agric.wa.gov.au/lupins/bean-yellow-mosaic-virus-lupins

26 DPIRD (2016) Bean Yellow mosaic virus in lupins, https://www.agric.wa.gov.au/lupins/bean-yellow-mosaic-virus-lupins

FEEDBACK

MORE INFORMATION

DPIRD-GRDC MyCrop: https://www.agric.wa.gov.au/lupins/lupin-foliar-diseases-diagnosis-and-management

DPIRD-GRDC MyCrop 'Sclerotinia Collar Rot': www.agric.wa.gov.au/mycrop/diagnosing-sclerotinia-collar-rot-narrow-leafed-lupins

8.7 Sclerotinia stem and collar rot (*Sclerotinia sclerotiorum, Sclerotinia minor*)

Figure 11: *Sclerotinia stem rot is an increasing problem in Australian lupin crops and is characterised by fungal growth and sclerote on the stem and pods.*

(SOURCE: GRDC Grain Legume Handbook)

- Sclerotinia stem rot is an increasing problem
- It is most common in high rainfall areas
- It usually affects plants after flowering in warm and damp conditions
- Sclerotinia collar rot is less prevalent but can be an issue in canola-lupin rotations
- Outbreaks are sporadic and typically yield losses are low
- In severe cases, sclerotia become mixed with harvested seed and incurs grain grading costs.

Incidence of sclerotinia stem rot (*Sclerotinia sclerotiorum*) has increased in recent years in the southern region, mostly as a result of expanded canola plantings.

In lupin crops, it tends to occur during flowering when ascospores infect petals.

Under constant humid and wet weather, infected petals fall and lodge in branches and infect stems and pods.

It can take two or three weeks for in-crop symptoms to be seen.

Sclerotinia stem rot symptoms include lesions in the upper half of the main stem, branches and on flowers and pods.

The fungus produces a white cottony-looking growth that girdles the stem, causing the plant parts above the lesion to wilt and die.

Individual pods or complete flower spikes can be completely covered by white fungal growth, which produces hard black sclerotia (of 2-8 mm in diameter).

Stems become bleached looking and infected plants stand out from the rest of the crop. The lifecycle of sclerotinia is illustrated in Figure 3.

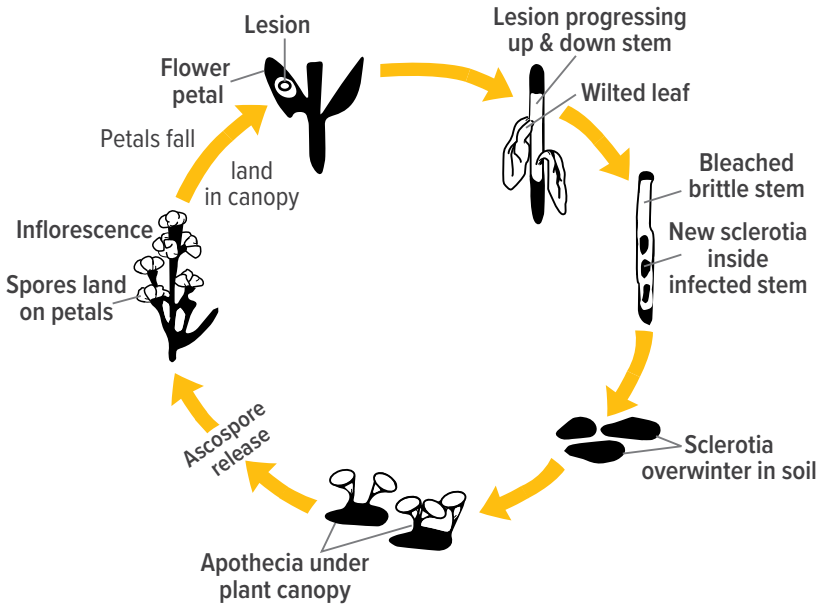

Figure 12: *Sclerotinia sclerotiorum disease cycle.*

(SOURCE: DPIRD)

In cases of sclerotinia collar rot (*Sclerotinia minor*), lesions and fluffy white growth appear on stems just above ground level and contain small black fruiting bodies called sclerotia.

Researchers are investigating the impact of both forms of sclerotinia on lupin production and possible interactions with anthracnose control (especially fungicide application) in WA.

Lupin infected with sclerotinia can have lower yield due to plant death. In severe cases, grain requires grading after harvest to remove sclerotia.

Disease management can be difficult, as sclerotia can survive in the soil for many years.[27]

Management of sclerotinia

- Rotate lupin crops with non-host species (cereals)
- Avoid sowing lupin in close rotation with other broadleaf crops, such as canola
- Control broadleaf weeds during the rotation
- Foliar fungicides are not registered for sclerotinia in lupin crops.

Crop rotation with non-host species, such as cereals, and extended breaks between lupin and canola crops can help to break the sclerotinia disease cycle.

There are no foliar fungicides currently registered for treatment of sclerotinia in lupin crops.

27 Thomas, G, Beard, C (2015) Mingenew Irwin Group Presentation, http://www.mig.org.au/author/zoe/page/3/

FEEDBACK

Primary risk factors for disease in susceptible areas include:

- Presence of sclerotinia in paddock or neighbouring paddock from previous sclerotinia infection in lupin or canola (or other broadleaf crop/pasture) within the past three or four years
- Medium-high rainfall areas and/or seasons with wet springs
- Densely growing crops on heavier soil types that maintain moisture longer and create a humid environment favoured by the pathogen.[28]

It is recommended to avoid sowing lupin in close rotation with other broadleaf crop species, such as canola, especially where these are the main break crops of choice.

Cereals are non-hosts and provide the most effective disease break, although sclerotia can survive for several years.

WA researchers are investigating the use in lupin crops of fungicide products registered for sclerotinia stem rot in canola in WA.

They are also developing a forecasting tool for sclerotinia outbreaks and incidence.

Trials have, to date, found no significant differences in lupin variety resistance to sclerotinia, as shown in Figure 4.[29]

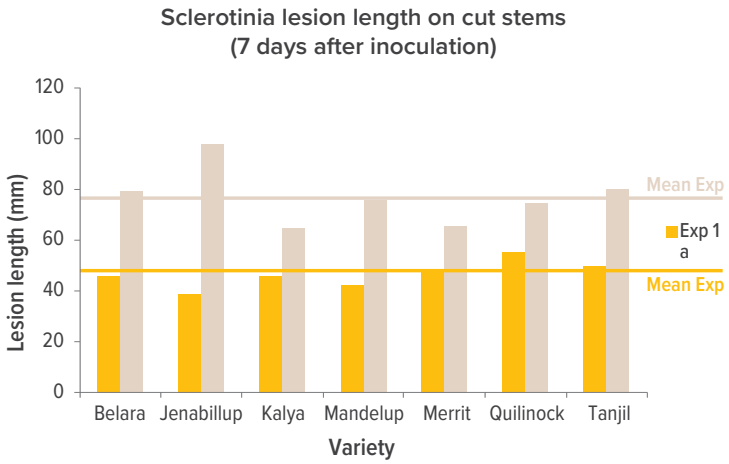

Figure 13: *Sclerotinia lesion length on cut stems (7 days after inoculation).*

(SOURCE: DPIRD)

28 DPIRD-GRDC (2016) MyCrop Diagnostic Tool – Diagnosing sclerotinia collar rot in narrow-leafed lupins, https://www.agric.wa.gov.au/mycrop/diagnosing-sclerotinia-collar-rot-narrow-leafed-lupins

29 Thomas, G, Beard, C (2015) Mingenew Irwin Group Presentation, http://www.mig.org.au/author/zoe/page/3/

FEEDBACK

8.8 Minor foliar diseases in southern region lupin crops

Disease	Location	Symptoms	Management	Useful resources
Grey leaf spot (*Stemphylium botryosum*)	Leaves, stems, pods	Brown semi-circular or circular lesions/spots on leaves that can expand and become ash-grey. Brown 'pockmark' lesions on stems and pods. Premature or complete defoliation can occur.	Disease uncommon and rarely economically damaging. Current varieties carry effective genes for resistance.	https://www.agric.wa.gov.au/lupins/lupin-foliar-diseases-diagnosis-and-management
Cladosporium leaf spot (*Cladosporium sp.*)	Leaves, flowers	Dark grey circular spots on flowers and leaves.	Incidence and yield impact rare. No specific control measures, except crop rotations.	https://www.agric.wa.gov.au/lupins/lupin-foliar-diseases-diagnosis-and-management
Grey mould (*Botrytis cinerea*)	Leaves, stems, pods	Lesions on flowers, stems and pods, grey fuzzy mould that may contain sclerotia. May be more common in albus than narrow leafed lupin.	Incidence and yield damage rare, no specific control measures except crop rotations.	https://www.agric.wa.gov.au/mycrop/diagnosing-grey-mould-narrow-leafed-lupins and https://www.agric.wa.gov.au/lupins/lupin-foliar-diseases-diagnosis-and-management
Powdery mildew (*Erysiphe polygoni*)	Leaves, stems, pods	White powdery growth on leaves, stems and pods.	Affects all species but serious crop damage has not been reported. No specific management strategies needed, except crop rotations.	https://www.agric.wa.gov.au/lupins/lupin-foliar-diseases-diagnosis-and-management

MORE INFORMATION

DPIRD-GRDC MyCrop: https://www.agric.wa.gov.au/lupin-diagnostic-tool

GRDC 'Grains Legume Handbook': https://grdc.com.au/grainlegumehandbook