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Sclerotinia management for narrowleaf lupin crops in Western Australian farming systems DAW2104-002RTX: Project results summary for 2021-2023 research results

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: Project results summary for 2021-2023 research results.

Key messages:

- Extensive research has been conducted in 2021-2023 to expand our understanding of the distribution of *Sclerotinia sclerotiorum* incidence in lupin in WA, the infection process, yield and grain quality impacts, and management strategies. The research was conducted via commercial crop surveys, and experiments in the field, lab, controlled environment and glass houses by Department of Primary Industries and Regional Development (DPIRD) and collaborators Centre for Crop and Disease Management (CCDM), Mingenew Irwin Group (MIG), and lupin growers.
- Commercial crop surveillance has found Sclerotinia in lupin caused by *Sclerotinia sclerotiorum* distributed across the WA wheatbelt with incidence significantly higher in wet growing seasons. Potential for significant yield impact appears greatest in the medium and high rainfall zones of the Kwinana North and Geraldton port zones where infection occurs earlier in the season and generally at higher incidence.
- Research has shown that foliar fungicide application for control of canopy Sclerotinia in lupin provided an average yield response of 11% in trials conducted in the Geraldton port zone in 2021-22. This significant yield response was found where Sclerotinia incidence of the untreated was significant (i.e., 30% or more plants found to be infected). In 2023, there was no significant yield response to foliar fungicide application in any field trials due to low disease incidence.
- To be most effective, fungicide needs to be applied before disease symptoms are seen so understanding the disease risk factors is important for making application decisions.
- Sclerotinia risk is higher in lupin crops grown in paddocks that have: a previous history of the disease, high plant density, heavy soil type, early canopy closure and good yield potential and in seasons where weather is favourable for disease spread (ongoing moisture during winter and wet spring).
- A Lupin sclerotinia disease risk assessment guide has been compiled for the Western region to help growers understand the disease drivers, and prioritise which paddocks and which growing seasons disease management may be required.
- Foliar fungicide applied at a vulnerable crop stage (e.g., crop flowering – early pod emergence on the main spike) that precedes or coincides with favourable weather conditions for the Sclerotinia pathogen is more likely to be profitable. A wet spring and presence of other diseases will increase the chances of obtaining a yield response from fungicide application for canopy Sclerotinia.
- Foliar fungicide application during crop flowering generally does not provide any reduction in incidence of ground level (basal) Sclerotinia infection or yield losses associated with it.

The project

The 4-year project (2021-2024 growing seasons) is an investment of the Grains Research and Development Corporation (GRDC) and Department of Primary Industries and Regional Development (DPIRD) with DPIRD research being conducted in Geraldton, Northam and Albany assisted by subcontractors the Mingenew-Irwin group (MIG) and Centre for Crop and Disease Management (CCDM). Research activities include field surveys, controlled environment and laboratory experiments, small plot field trials and large grower-scale field trials.

Aims:

- Gather data on the distribution and economic/disease impact from Sclerotinia stem rot (SSR) in commercial lupin crops in WA.

- Expand understanding on the epidemiology and the infection process of Sclerotinia in lupin in the canopy and at ground level (basal). Ultimately determine which growing seasons and paddock scenarios are lupin Sclerotinia likely to be a problem in, and when preventative action is likely to be needed and profitable.

- Better understanding of how cultural practices influence disease development (e.g., crop rotation, row spacing, plant density and sowing time) and the effectiveness and optimum timing of fungicides for management of both canopy and basal Sclerotinia infection.

Distribution and severity of Sclerotinia in lupin in WA

Historically Sclerotinia in lupin was an issue in the Geraldton port zone only but, with more canola being grown across the WA wheatbelt, the disease is now found in many areas and appears to be becoming a more regular issue. Regional disease surveillance has found Sclerotinia in lupin is generally a problem in wetter growing seasons in areas where lupins are grown in close rotation with canola that has previously been infected with Sclerotinia. This is now an established issue for lupin (and potentially other legumes) as the disease inoculum (sclerotia) distribution in soil continues to intensify.

Commercial crop surveillance

Annual disease surveillance of commercial lupin crops was conducted in 2021, 2022 and 2023 across all the port zones as part of an endemic disease survey (Figure 1). This involved surveying 51 lupin crops in 2021, 49 in 2022 and 44 in 2023. In each crop 25 plants were assessed for disease incidence and severity. All crops surveyed were narrow leaf lupin except for a very small proportion of the Geraldton port zone crops being Albus lupin. This was a joint effort by the Disease surveillance project and the Lupin Sclerotinia project and results are presented in Tables 1 and 2.

Sclerotinia in lupin is favoured by ongoing wet weather and dense crops with early canopy closure. Sclerotinia incidence in crops (canopy and basal infection) was significantly higher in 2021 and 2022 in all port zones than in the dry 2023 growing season (Table 1).

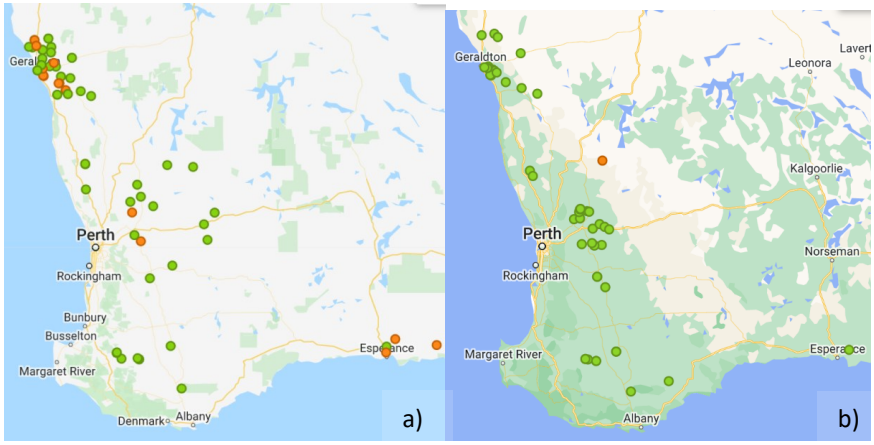

Figure 1 a) and b). Locations of lupin crops surveyed as part of both the Disease surveillance project and Lupin Sclerotinia project activities in 2021 (a) and 2022 (b) shown in orange or green. Please ignore different marker colours which do not symbolise anything relevant to this report.

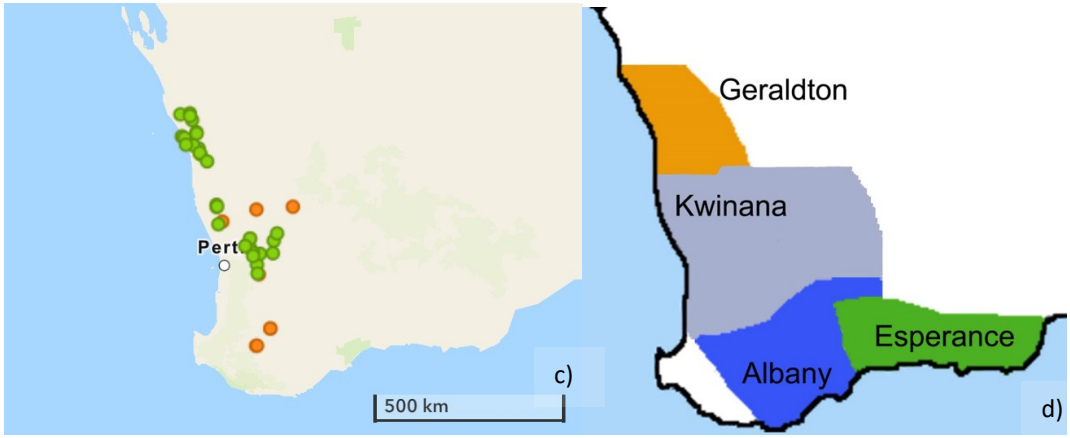

Figure 1 c) and d). Locations of lupin crops surveyed as part of both the Disease surveillance project and Lupin Sclerotinia project activities in 2023 (1c) shown in orange or green. Please ignore different marker colours which do not symbolise anything relevant to this report. Map in 1d) shows WA grain delivery port zones. For the purposes of the project Kwinana north and south are combined.

Incidence of Sclerotinia infection within infected paddocks was higher in Geraldton and Kwinana port zones than in the Albany port zones in growing seasons that favoured disease infection (2021 and 2022) (Table 2).

Lupin Sclerotinia infection (both canopy and basal) was found to be at significantly higher incidence across the Kwinana port zone in 2022 than in 2021. In 2022 in Kwinana south 67% of paddocks surveyed had Sclerotinia (canopy and/or basal) whereas in 2021 no southern paddocks had infection. In Kwinana north 92% of paddocks surveyed had Sclerotinia in 2022, whereas in 2021 it was 60%. In Kwinana east 100% of paddocks surveyed in 2022 had Sclerotinia whereas in 2021 it was only 17%.

Table 1: Percentage of lupin crops surveyed (prevalence) that had Sclerotinia in the canopy or at ground level (basal) in each port zone in 2021, 2022 and 2023. No lupin surveys were conducted in Esperance in 2023. Surveys conducted by DPIRD staff through Disease Surveillance and Lupin Sclerotinia Projects.

	2021		2022		2023	
Port zone (# paddocks surveyed 2021,2022,2023)	Canopy	Basal	Canopy	Basal	Canopy	Basal
Geraldton (22,15, 17)	95	90	87	40	29	0
Kwinana (15, 24, 19)	20	13	75	38	5	32
Albany (10, 8, 8)	70	10	67	17	50	13
Esperance (4, 2, 0)	25	25	50	50		
All sites (51, 49, 44)	63	47	44	22	23	16

Table 2. Percentage average incidence of infected lupin plants *within infected paddocks* in each port zone surveyed in 2021, 2022 and 2023 by DPIRD staff through Disease Surveillance and Lupin Sclerotinia Projects.

	2021		2022		2023	
Port zone (# paddocks surveyed 2021,2022,2023)	Canopy	Basal	Canopy	Basal	Canopy	Basal
Geraldton (22,15, 17)	41	11	26	3	16	0
Kwinana (15, 24, 19)	24	8	7	1	8	6
Albany (10, 8, 8)	4	4	4	1	16	4
Esperance (4, 2, 0)	4	8	2	4		

Field trial research

Replicated field trials are being conducted by DPIRD, Mingenew Irwin Group and growers, including small sown plots, opportunistic small plot trials in commercial crops, and paddock scale trials.

Weather, canopy conditions and the infection process

Research is finding that Lupin Sclerotinia development is highly dependent on seasonal weather conditions, even more than canola Sclerotinia, and only develops to significant levels in years where there is sufficient rainfall across the growing season.

There are three trigger points which are all required for Sclerotinia stem rot to develop – germination of sclerotia, petal infection and crop infection (canopy or basal). Regular rainfall, high humidity and specific temperature conditions are required at each part of the infection cycle for crop infection to initiate crop, persist and spread (Figure 2).

- Sclerotia (the black rat dropping like fruiting body of the fungus left behind after harvest of previous year's crops that were infected by Sclerotinia, in soil or stubble) are primed in WA for germination by hot summer temperatures as found by Centre for Crop and Disease Management (CCDM).
- Germination of sclerotia carpogenically to form apothecia (tiny mushrooms <0.5mm, Figure 3) requires cool temperatures (10-20°C) and humid/moist conditions and usually occurs when the crop canopy closes over. Interestingly, apothecia regularly form in June or July in the cool conditions at Albany, however, the actual canopy infection process usually does not commence in Albany port zone until September/October when temperatures warm up.
- Release of windborne Sclerotinia ascospores by apothecia leads to petal infection as long as this coincides with the time that the crop is flowering. Petal infection requires high relative humidity (>90%) and moisture, along with mild temperatures <25°C.
- Canopy infection in lupin plants requires similar weather conditions but with temperatures 16-22°C. Infected lupin petals do not necessarily have to drop into the canopy (as occurs in canola), but many remain in-situ and infect emerging pods by direct contact. Lupin leaves are also involved, with some infected falling lupin petals infecting leaves which subsequently wrap around the stem/pods and cause infection. Canopy infection can develop extremely rapidly (within weeks) under favourable weather conditions and can be difficult to manage with foliar fungicides when high disease pressure present.
- Ongoing wet soil conditions (saturated soil) are required for basal Sclerotinia to occur. It tends to be more of an issue in wet growing seasons and when crops are dense and soil types loamy, ideal for retaining soil moisture.

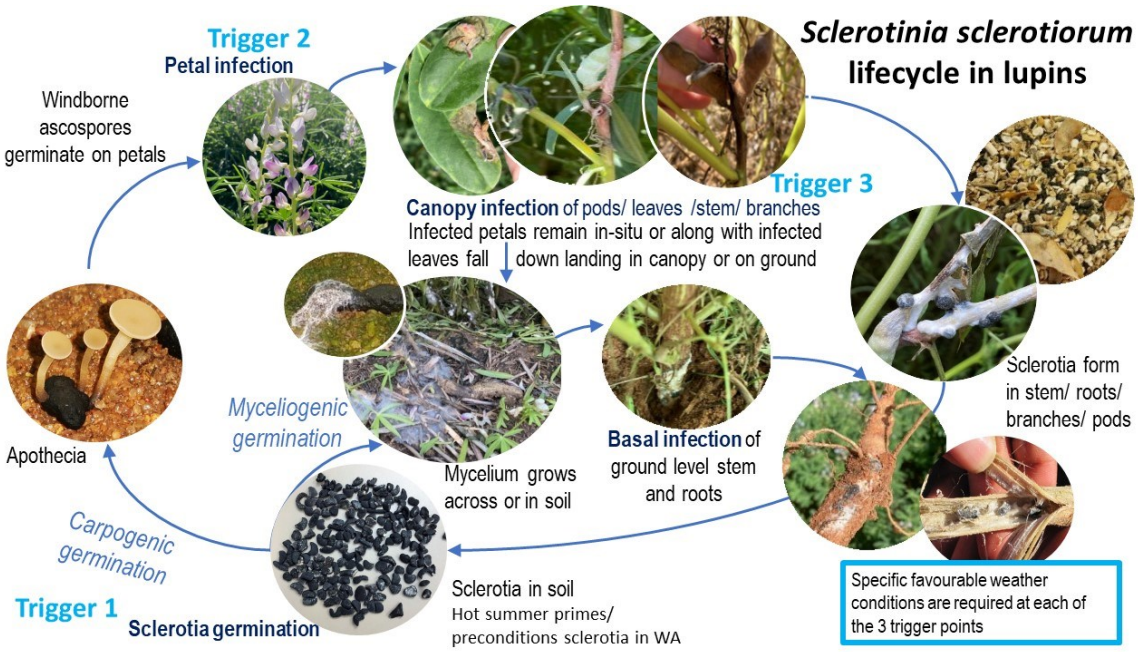

Figure 2. The infection cycle of the *Sclerotinia sclerotiorum* pathogen in lupin via two pathways. Carpogenic germination of sclerotia leads to canopy infection, while myceliogenic germination of sclerotia can lead to basal (ground level) infection.

Figure 3. Carpogenic germination of sclerotia on left dish and myceliogenic germination of sclerotia on the right dish as observed during experiments.

The 2021 and 2022 growing seasons were both characterized by an early start (late March/early April), dense crops with early canopy closure in most areas and above average rainfall in late winter in most parts of WA where lupins are grown. In 2022, a warm dry period in May/June delayed the commencement of the Sclerotinia disease cycle (at least in the north) but all port zones had a long soft spring and above average yields.

In 2023, the break to the season was late in most areas (June) and growing season rainfall was significantly below average (decile 1-3) in Geraldton and Kwinana port zones. The growing season finished early with a hot dry spring. Crops were patchy and had late limited canopy closure, and reduced crop yields, even in the Albany port zone where widespread waterlogging led to poor yields.

Temperature differences in winter between the northern and southern port zones appeared to be an important driver for the Sclerotinia infection process in 2021 and in 2022. In both growing seasons, moisture and humidity were not lacking for the most part in all port zones, and it was evident that if conditions were too cold (<16°C) in winter, as occurred in the Albany port zone, infection was delayed. In cooler southern regions, infection only occurred at low incidence within paddocks. It occurred late in the season (late spring) often when temperatures were starting to warm up, but this was often when crop flowering was finishing. In comparison, the north was more prone to epidemics, infection earlier in the growing season (winter- spring) and higher incidence and severity within infected crops. Research on the role of temperature in the infection cycle is continuing to be investigated.

Disease severity and so, while the prevalence of Sclerotinia in southern regions is significant, the potential for significant yield impact appears greatest in the medium and high rainfall zones of the Kwinana North and Geraldton port zones.

In 2022, 5 of the 15 field trials conducted by the project, had Sclerotinia at moderate to high levels (canopy Sclerotinia >30% incidence plants infected) and all were in the Geraldton port zone (Table 4). This was significantly fewer than in 2021, when 7 out of 10 field trials conducted had moderate to high levels of infection (Table 3). This disease is sporadic and although much of the 2022 growing season appeared favourable weather wise, it was a crucial dry period in autumn that likely led to delayed Sclerotinia infection in the Geraldton and Kwinana port zones. Years of below average rainfall (such as 2023) or where dry periods occur during crucial parts of the disease cycle (such as autumn and spring) will limit or prevent development and spread of Sclerotinia in lupin if crop flowering does not overlap with ascospore release. In 2023, all 12 field

trials conducted by the project had extremely low incidence of Sclerotinia (canopy <10%, basal <5%).

Identifying crops at high disease risk

Field trials and monitoring sites conducted in this project have confirmed that Sclerotinia infection in lupin is favoured in dense crops with history of Sclerotinia, early closed canopies that are protected from wind and on loamy soil types that allow humidity levels to build up from ongoing soil moisture. Periods of extended high humidity under thick crop canopies in 2021 and 2022 favoured Sclerotinia infection, while open thin crops in 2023 did not have the ongoing moisture and humidity (Figures 4 and 5). Further information is available in Lupin sclerotinia disease risk assessment guide which has been compiled by this project for the Western region. It is designed to present key information on the disease drivers, and help with prioritising which paddocks and which growing seasons disease management may be required in.

Figure 4. Photos of a lupin crop at Mingenew in a) 2023 on left and b) 2022 on right showing lack of canopy coverage in 2023 as opposed to full canopy cover and densely growing crop in 2022.

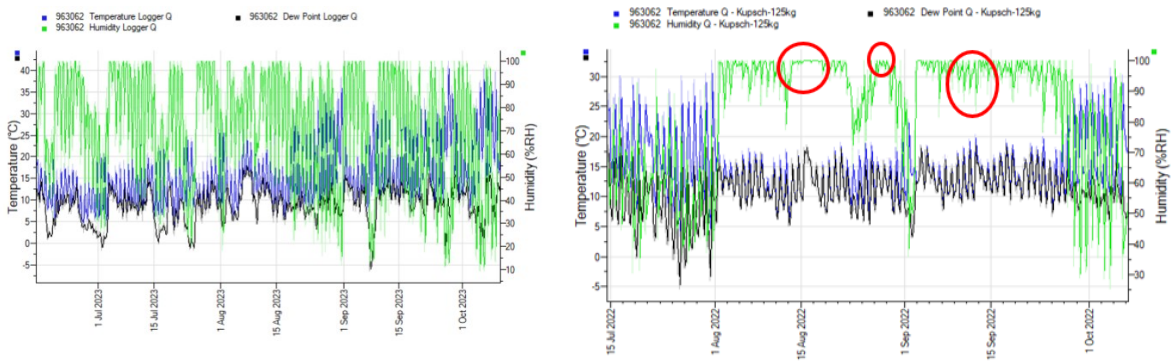

Figure 5. Relative humidity and temperature under a lupin crop at Mingenew in a) 2023 and b) 2022. The red circles show long periods of consistently high humidity that favours Sclerotinia development in the crop.

Yield, grain quality impact and fungicide timing of canopy Sclerotinia

Infection on the main spike and pods including branch pods has been found to be the most common part of the plant infected (rather than stems) and is likely to be the main cause of yield loss from the disease in lupin. Sclerotia can form in pods and branches and contaminate grain at harvest. Fungicide application in lupin needs to focus on protecting the emerging main spike pods rather than the stems (as is the case in canola). Fungicide application from 100% bloom to early pod emergence is likely to be most effective.

Field trials have found that yield responses are variable and are not guaranteed, making decisions on value of management in each cropping situation challenging. Tables 3 and 4 show 2021 and 2022 results. In 2023, the dry, short growing season limited disease development and out of 5 fungicide trials conducted, none had a significant yield response.

Table 3. Yield results (t/ha) of seven trials conducted in the Geraldton port zone (GPZ) in 2021 for this project. Sclerotia contamination of grain was significantly reduced by foliar fungicide application at two of the sites (Morawa and Geraldton).

	Morawa Narrow-leaf	**Geraldton** Narrow-leaf (TOS2)	**Georgina** Albus	**Alma** Narrow-leaf	**Mingenew** Narrow-leaf	**Chapman Valley** Narrow-leaf	**Northamp-ton** Albus
Untreated	2.5	3.0	2.0	1.5	2.1	2.78	0.4
Foliar fungicide applied at late flower /early pod emergence on main spike	2.6	3.6	1.9 -2.1	1.5	2.1	3.03	0.8
LSD (10%)	0.09	0.445	ns	ns	ns	0.247	0.158
% Yield response above untreated	4%	23%				9%	100%
% Maximum canopy incidence in untreated	85%	34%	61%	100%	<1%	7%	58%
Comments	Fungicide significantly reduced sclerotia in grain	Fungicide significantly reduced sclerotia in grain	Late sown crop, fungicide applied in late Aug	Early sown crop, fungicide applied in early July	Trace of Sclerotinia	Trace of Sclerotinia	High sclero incidence but also severe anthracnos

In field trials conducted in the Geraldton or Kwinana port zones in 2021 and 2022, a single foliar fungicide application gave a yield response in six out of 14 trials (three out of six trials in 2021; three out of eight trials in 2022) where Sclerotinia was the dominant disease. Yield increases generally ranged from 4-23% (average of 11%) compared to the untreated plots. In general, the yield responses were found in untreated trial plots that had 30% or more plants infected with Sclerotinia and greater responses were found where other diseases such as anthracnose, Phomopsis or brown spot were also present. In 2022, where there was a particularly soft finish to the season (long, wet, mild spring), a greater yield response was found when fungicide was applied relatively late (at flowering/podding of branches) as it provided protection into spring when Sclerotinia was most active. Generally, though the best management practice to consider each season is a single fungicide application timed to protect emerging main spike pods if the growing season is favourable for disease (as described above).

Table 4. Yield results (t/ha) of nine fungicide application trials conducted in 2022 for this project. Some trials are not shown as disease incidence was too low (2 in Albany port zone, 2 in Geraldton port zone). Sclerotia contamination of grain was significantly reduced by foliar fungicide application one site (Bolgart).

	Yield (t/ha)								
	Narngulu NLL (Opportunistic trial, sown late April) Small plot	**Narngulu** NLL (TOS1-13/4) Small plot	**Narngulu** NLL (TOS2-11/5) Small plot	**Narngulu** Albus (TOS1&2) Small plot	**Bootenal** Albus Sown late May Grower trial	**Bootenal** NLL Sown late May Grower trial	**Moonyoonooka** NLL Sown 10 May Opportunistic within grower paddock	**Morawa** NLL Grower trial Sown 13 April	**Bolgart** NLL Grower trial
Untreated	6.0	5.3	5.3	4, 4.2	0.8	2.8	2.8	4	3.5
Fungicide spray at early pod emergence on main spike	5.9-6.1	5.5	5.4	3.9, 4.4	1.2	3	2.8	4.6	3.5-3.9
LSD (10%)	NS	Ns	Ns	Ns	0.3	0.17	Ns	0.06	NS
% Yield response above untreated					50	7	11	15	
% Maximum canopy incidence in untreated	8	7	4	TOS1 15% TOS2 3%	39	30	39	37	18
Comments		Double spray (early pod MS +3 wks) gave 8% yield response		Low sclero, low anthracnose	Low sclero, severe anthracnose	Low sclero and Phomopsis	High sclero, salvage late spray gave 11% yield response, also had Phomopsis and BGM	Moderate sclero +moderate pleiochaeta (brown spot stem+pod) Fungicide was applied at a late growth stage when pods were forming on second order branches	

In 2021 and 2022 cool (<16°C) temperatures in winter in the Albany port zone delayed infection until late spring, too late to significantly impact yield. In both years, disease incidence was minimal, fungicides did not significantly reduce Sclerotinia symptoms and provided no yield or grain quality benefit.

A yield loss assessment method is being used to develop a lupin Sclerotinia loss calculation tool that will be refined further in the coming growing season for both canopy and basal infection types.

Sclerotia contamination of grain was significantly reduced by fungicide application only in four out of nineteen trials conducted in 2021-2023. Our research has found that sclerotia contamination of grain is highly variable and extent of contamination is affected by several factors (such as harvest height, harvester fan speed etc). To date there is no clear correlation with disease incidence and foliar fungicide application.

Lab research on fungicide effects on the Sclerotinia pathogen and lifecycle progress

In research by Centre for Crop and Disease Management (CCDM), eleven diverse Sclerotinia sclerotiorum isolates collected from across WA showed sensitivity to a range of foliar fungicide active ingredients when tested on agar in 2023. The majority were highly effective at inhibiting actively growing Sclerotinia mycelium.

Another set of lab experiments on soil, conducted by DPIRD in controlled temperature and lighting growth cabinets investigated whether fungicides could be valuable for halting the commencement of the Sclerotinia infection cycle. A range of foliar fungicides were directly applied to sclerotia (before germination) and also actively germinating sclerotia (i.e., sclerotia with apothecia). All fungicide treated sclerotia still produced apothecia and mycelium. Some fungicides significantly reduced the number of days mycelium was present on sclerotia and/or reduced the number of apothecia produced by sclerotia compared to untreated. Fungicide treatment did not significantly reduce the lifespan of existing apothecia or prevent later germination (myceliogenic or carpogenic). Consequently, at this stage growers should not spend effort or expense on spraying sclerotia or apothecia with fungicide to try to reduce risk of Sclerotinia in crops.

Basal Sclerotinia

In 2021, 2022 and 2023, basal (ground level) Sclerotinia caused by *Sclerotinia sclerotiorum* was first observed from mid-August in Geraldton trials when the plants were generally at pod emergence on main spike and leaf drop had commenced. It was also found in other locations during spring crop surveys. In contrast, basal infection caused by *Sclerotinia minor* has been observed earlier in the growing season, including seedling stage. Further research is needed to understand if basal infection caused by *Sclerotinia sclerotiorum* is growth stage dependent or solely determined by seasonal weather and environmental conditions (e.g., if it requires leaf litter on the ground to spread mycelium so only occurs after leaf drop has occurred). Initial studies are showing basal infection can reduce root and shoot growth. Under saturated soil conditions, myceliogenic germination of sclerotia (Figure 3) can lead to fungal hyphae (mycelia) growing between soil particles and infecting roots of plants (Figure 6). Predicta B soil testing in several lupin crops with basal infection in 2022 and 2023 has found a significantly higher concentration of Sclerotinia DNA within the infected patches compared to the healthy-looking parts of the crop (>1m away). Research is investigating how basal Sclerotinia may spread from these higher concentration patches to other parts of the crop and how infection causes yield loss in lupin.

Figure 6. The treatments in translucent tubes monitored during the study showing the impact of Sclerotinia myceliogenic germination on lupin plants in the left tube which was inoculated with sclerotia vs the right tube which was not inoculated.

Yield impact from basal infection can be significant (can result in complete plant death) but will depend on when in the season and at what growth stage it occurs. Research by the project is

continuing to understand the infection process, yield impact and if anything can be done with fungicides to interrupt the infection process.

In the majority of trials conducted in 2021 and 2022, foliar fungicide application did not reduce ground level Sclerotinia (basal infection). This corroborates findings of DPIRD trials conducted in 2016 and 2021. Research results to date indicate that any significant reduction in basal infection should be seen as an unexpected bonus to fungicides reducing canopy infection and not be relied upon as a rule. Ground level Sclerotinia infection is often at and below ground level so foliar fungicides applied at or after canopy closure are unlikely to be effective at managing this type of infection once it is present.

Agronomic strategies – Time of sowing, crop rotation, crop density, lupin variety/species

Time of sowing, crop density (sowing rate), soil type, and crop rotation history are all significant factors in determining risk of Sclerotinia infection in lupin crops. Results below are largely from field trials conducting in the 2021 and 2022 growing seasons. Due to the non-conducive growing season in 2023, field trials had very low levels of Sclerotinia so value of integrated disease management (IDM) strategies could not be determined.

Trials have been designed to investigate time of sowing, row spacing, seed rate, lupin varieties, fungicide timing, fungicide active ingredients, and fungicide application in higher water volumes.

Research is continuing to investigate the effect of

- crop density including row spacing and seeding rate on Sclerotinia incidence and yield impact
- crop sequences (rotation) for building up sclerotia burden left behind in the soil and the impact on the next crop.

Crop density – weather loggers under the canopy in seed rate trials have found there were generally more sustained periods of high humidity under the higher seed rates (e.g., 150-200kg/ha) than under the lowest seed rate (50 kg/ha). Research to date is showing that there is potential for lower seed rate and wider row spacing to be strategies that reduce canopy humidity and consequently Sclerotinia risk in lupin.

Lupin species – research has found that Albus lupin (*Lupinus albus*) does not have the extensive canopy cover or consistent under canopy humidity of narrowleaf lupin (*Lupinus angustifolius*). However, a yield response to fungicide is more likely in Albus lupin due to vulnerability to anthracnose infection (highly damaging) which fungicide application at flowering / podding can also reduce.

Lupin variety – flowering time is a significant factor in determining the vulnerability of a variety to Sclerotinia infection. If the flowering coincides with the release of Sclerotinia ascospores and favourable weather follows, then Sclerotinia infection risk increases. Research is ongoing to investigate the interactions of variety growth stage at vulnerable times in the season and if any varieties are more prone to infection or yield and grain quality loss.

Time of sowing – a crop is more at risk of Sclerotinia infection when its time of flowering overlaps with the time that Sclerotinia ascospores are present at the site. So, risk varies each growing season, depending upon the time of crop emergence and flowering, and the time of commencement of the Sclerotinia lifecycle. Research has found that in years with an early break, early sown crops develop denser canopies than later sown crops and are generally at

greater risk of developing high incidence of Sclerotinia infection. Equally though these crops are more likely to be higher yielding so research is continuing to consider economic considerations. Field trials sown in Geraldton in 2021 and 2022 found that early sown crops (early April) had more consistent high humidity throughout the growing season and higher incidence of Sclerotinia infection than later sown crops.

Crop rotation - field experiments conducted over multiple years are investigating how crop rotations affect Sclerotinia development and carryover of sclerotia in the current and future canola and lupin crops. The aim is to determine, if possible, optimum order and spacing of lupin and canola crops in rotation to reduce Sclerotinia impact. Research to date has found quantity of sclerotia remaining behind in soil or stubble after an infected crop has been harvested is highly variable so no conclusions have yet been drawn.

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Further information

- Ciara Beard, DPIRD on (08) 9956 8504, 0438 468 484, or ciara.beard@dpird.wa.gov.au
- Lupin sclerotinia disease risk assessment guide (GRDC factsheet)
- DPIRD Website, search for 'Sclerotinia stem rot in lupins'

dpird.wa.gov.au