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GROWNOTES™

GRDC™ GRAINS RESEARCH & DEVELOPMENT CORPORATION

CHICKPEA

SECTION 9

DISEASES

KEY DISEASE MANAGEMENT STRATEGIES FOR CHICKPEA | FUNGAL DISEASE MANAGEMENT STRATEGIES | INTEGRATED DISEASE MANAGEMENT | RISK ASSESSMENT | ASCOCHYTA BLIGHT | BOTRYTIS GREY MOULD | SCLEROTINIA | PHYTOPHTHORA ROOT ROT | ROOT ROTS INCLUDING DAMPING OFF (FUSARIUM, RHIZOCTONIA AND PYTHIUM SPP.) | COLLAR ROT (SCLEROTIUM ROLFSII) | FUNGAL DISEASE CONTROL | VIRUSES

Diseases

Key messages

- Several foliar fungal diseases, some seedling root diseases, viruses and root lesion nematode can affect chickpea (Table 1).
- The most significant fungal disease of chickpea in Western Australia is Ascochyta blight. Disease management of chickpea should primarily focus on ascochyta blight.
- Chickpea crops in south-eastern Australia are being hit by a more virulent strain of ascochyta blight. This strain has not been detected in Western Australia (WA).
- The new varieties PBA HatTrick(D) and PBA Boundary(D) have improved resistance to Ascochyta and require fewer or no fungicide sprays. [1]
- The diseases Botrytis grey mould (BGM; *Botrytis cinerea*) and sclerotinia white mould (*Sclerotinia sclerotorium* and *S. minor*) were major diseases of chickpea in WA prior to the incursion of Ascochyta blight, and may again become significant diseases in chickpea varieties resistant to Ascochyta blight. [2]
- Integrated disease management in chickpeas involves paddock selection, variety choice, seed dressing, strategic fungicide use and hygiene.
- Stay up to date with local Crop diseases forecasts for your region.

Table 1: *Key features of the main chickpea disorders, at a glance.*

Disorder and cause	Seed-borne?	Symptoms	Distribution and occurrence	Survival and spread	Management
Seed-borne root rot: *Botrytis cinerea* *Ascochyta rabiei*	Yes	Seedlings wilt and die, epicotyl rots.	Random individual plants (not patches).	Seed.	Quality seed; seed treatment.
Phytophthora root rot (PRR): *Phytophthora medicaginis*	No	Rapid wilting and yellowing; defoliation from lower leaves; rotted roots; plants easy to pull up.	Patches; poorly drained areas; heavy rainfall; can occur at any time; history of medics, lucerne or PRR	Oospores in soil and residue persist for many years; survives saprophytically; spread by water and soil.	Varietal selection; avoid paddocks with history of PRR; rotation; seed treatment.
Waterlogging: root anoxia	No	Very rapid death; little defoliation; roots not rotted but may be dark; plants hard to pull up.	Patches; poorly drained areas; heavy rainfall; can occur at any time; history of medics, lucerne or PRR	Caused by insufficient supply of oxygen to roots.	Avoid low-lying or poorly drained paddocks or areas within paddocks.

1 GRDC Chickpea disease management fact sheet. (2013) Northern Region.

2 DAFWA. Desi Chickpea Essentials. https://www.agric.wa.gov.au/chickpeas/desi-chickpea-essentials

Disorder and cause	Seed-borne?	Symptoms	Distribution and occurrence	Survival and spread	Management
Sclerotinia root and stem rot: *Sclerotinia spp.*	Yes (ad-mixed)	Wilting and death; bleached root, collar and stem tissue; white cottony mould at site of lesion; sclerotia at lesions or inside stems.	Root and collar lesions result from direct infection from sclerotia; stem lesions result from airborne ascospores released from sclerotial apothecia, scattered or patches; favoured by denser canopies; wet events.	Sclerotia persist in soil for many years; wide host range including pulses, canola, sunflowers and broadleaf weeds but not cereals or grasses.	Avoid paddocks with history of Sclerotinia of its hosts; rotate with cereals; some varieties more susceptible.
Rhizoctonia rot: *Rhizoctonia solani*	?	Death of seedlings, stunting of survivors due to root damage, re-shooting after damping-off of epicotyl.	Can be a problem in irrigated crops grown immediately after cotton. Often occurs in 1–5 m stretches of row.	Survives as sclerotia and on decomposing trash. Probably present in most soils.	Allow time for decomposition of (preceding) crop debris. Tillage should help.
Ascochyta blight: *Ascochyta (Phoma) rabiei*	Yes	Ghosting of tissues; lesions with concentric rings of pycnidia; stem stumps; plant death.	Small patches enlarge rapidly in wet weather to kill large areas of crop.	Chickpea residue very important in spread especially header dust and surface water flow; infected seed; volunteers.	Follow chickpea Ascochyta blight management package published annually; includes foliar fungicides.
Boytrytis grey mould (BGM): *Botrytis cinerea.*	Yes/no	Stem, flower pod and leaf lesions covered in grey mould.	Occurs later in season when canopy closes and warm humid conditions persist; individual plants or patches.	Can flow-on from seed-borne root rot but pathogen has wide host range and airborne spores can blow around; dormant fungal remnants can survive in soil.	Avoid highly susceptible varieties; plant on wider rows; follow chickpea Ascochyta blight management package.
Root-Lesion nematodes. *Pratylenchus spp.*	No	General poor growth; small black lesions on lateral roots sometimes visible.	Often affects large parts of crop; P. thornei more prevalent on high clay soils.	Wide host range; survives and spreads in soil; anhydrobiosis allows nematodes to persist for prolonged dry periods.	Farm hygiene; rotate with resistant species; grow tolerant varieties.
Alfalfa Mosaic virus (AMV), Cucumber mosaic virus (CMV)	Yes	Initially bunching, reddening, yellowing, wilting or death of shoot tips; later discoloration.	Initially scattered plants often at edges of crop; more common in thin stands.	Viruses persist and multiply in weeds and pasture legumes; aphid-borne except for CpCDV (leafhopper).	Establish uniform stand by using recommended sowing rates and times; sowing into standing stubble.
Phloem-limited viruses (luteoviruses): BLRV (Bean leaf roll virus), SCRLV (Subterranean clover red leaf virus), BWYV Beet western yellows virus, SCSV (Subterranean clover stunt virus)	No	Death of entire plant; Luteovirus infected plants often have discoloured phloem.	Close to lucerne; seasons or districts with major aphid flights.		Cereal stubble deters aphids; grow resistant varieties.
CpCDV (Chickpea chlorotic dwarf virus)	-	Reddening, proliferation of axillary branching.	Individual or small clusters of plants. Maybe more at edges of crop.	Potentially via leafhopper transmission.	-

Source: K Moore, NSW DPI and M Fuhlbohm, Qld Gov

Table 2: *Key facts about the biology of major chickpea diseases.*

Disease	Survival	Spread	Infection by
Ascochyta blight	Stubble, seed, volunteers	Stubble, seed water-splashed spores	Water-splashed spores
Botrytis grey mould	Stubble, seed, sclerotia, alternative hosts	Stubble, seed, soil, airborne spores	Airborne spores
Phytophthora root rot	Oospores, alternative hosts	Soil and surface water	Waterborne spores
Sclerotinia rot	Sclerotia in soil and seed, alternative hosts	Soil and water, airborne spores	Airborne spores or directly into crowns

Table 3: *Resistance ratings of Western Australian Chickpea to common diseases.*

Variety	Ascochyta blight foliage	Botrytis grey mould	Root-Lesion nematode
Desi			
Ambar⍉	R	S	–
Neelam⍉	R	MS	–
PBA Slasher⍉	R	S	MRMS
PBA Striker⍉	MR	S	–
Genesis 510	R	MS	
Genesis 836	MS	MS	
Kabuli			
Genesis 079	R	MS	MR

NOTE: That these disease ratings for Ascochyta blight do not include the new strain impacting crops in the Southern cropping region.

Source: PIRSA

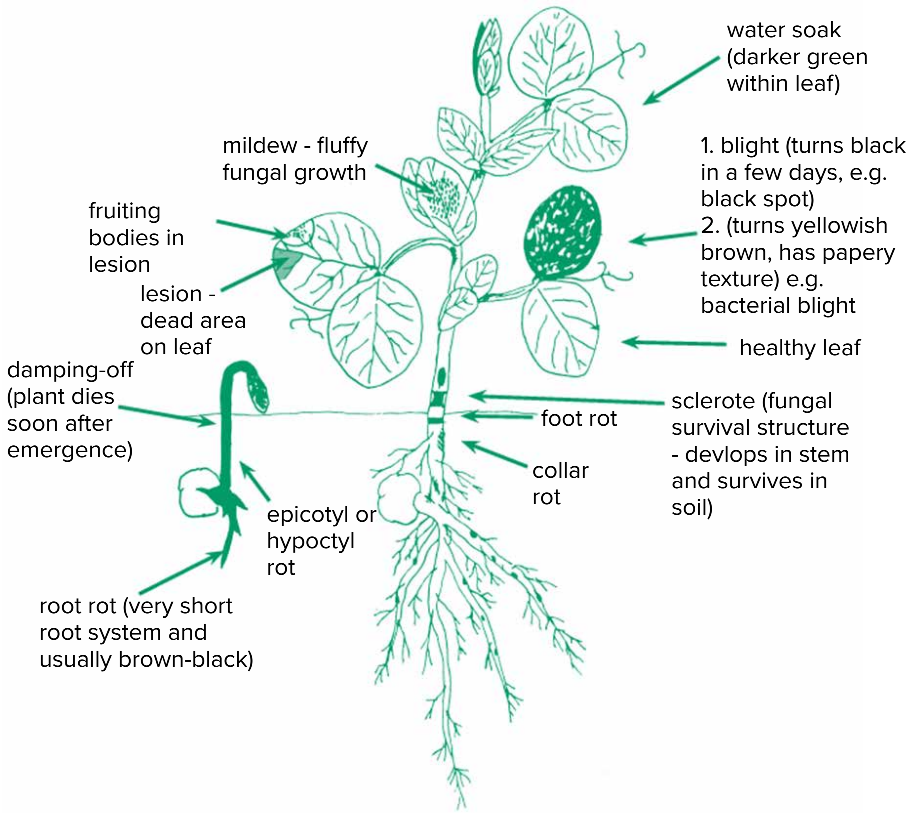

Figure 1: *Chickpea disease diagnosis terms.*

Source: Grain Legume Handbook

9.1 Key disease management strategies for chickpea

- Variety selection is critical. Ideally grow an ascochyta resistant variety.
- Paddock isolation from chickpea stubble is a high priority (greater than 500 m).
- Paddock history:Aim for a break of at least four years between chickpea crops.
- Seed source: Use seed from a paddock where disease was not detected.
- Fungicide seed dressing is effective and should be used, especially in high disease risk situations.
- Sowing date: Do not sow too early, even with an ascochyta resistant variety.
- Sowing depth: If using an ascochyta susceptible variety, sow deeper than normal.
- Sowing rate: Aim for 35–50 plants per square metre, depending on the situation and crop type (kabuli or desi).
- Hygiene: Reduce disease sources and prevent spread of disease.
- Foliar fungicides: Ascochyta resistant varieties still require foliar fungicide at podding. Success is dependent on monitoring, timeliness of spraying and correct fungicide choice. Early detection and correct disease identification are essential.
- Manage aphids and virus: Ground surface cover, healthy plants and crop canopy are important. Control aphids at their source (host) crop.
- Harvest management: Harvest early to minimise disease infection of seed.
- Crop desiccation enables even earlier harvest. [3]

3 Pulse Australia Ltd (2012) Southern Pulse Bulletin PA #08. Chickpea disease management strategy. http://pulseaus.com.au/storage/app/media/crops/2012_SPB-Chickpea-disease-management.pdf

9.2 Fungal disease management strategies

Disease management in pulses is critical, and relies on an integrated management approach involving 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.

Note that the impact of disease on grain quality in pulses can be far greater than yield loss. This must be accounted for in thresholds because the visual quality of pulses has a huge impact on price for food products. Examples are Ascochyta blight in most pulses and Pea seed-borne mosaic virus in field peas.

A plant disease may be devastating at certain times, yet under other conditions it may have little impact. The interactions of host, pathogen and environment are all critical points in disease development, and all can be represented by the disease triangle (Figure 2 and 3). Diseases such as Ascochyta blight and PRR rot can cause total crop failures very quickly. The effects of BGM and root-lesion nematodes on crop performance and yield usually unfold more slowly, however, they can cause damage quickly when conditions are suitable.

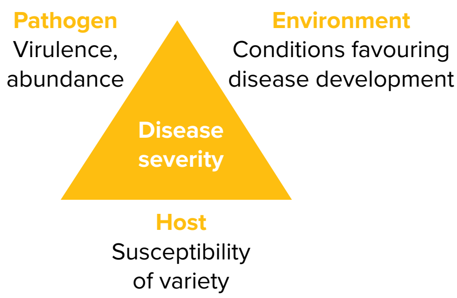

Figure 2: *The virus and some bacterial disease triangle*

Source: Jones 2012

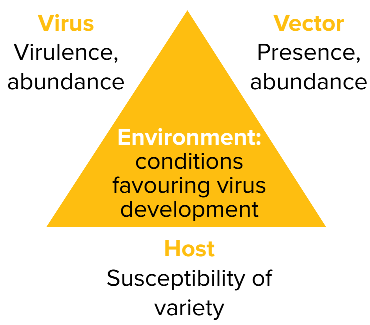

Figure 3: *The disease triangle*

Source: Agrios 1988

Disease management should be a consideration when planning any rotation, particularly at the beginning of the season. This is especially important for chickpea, where the first defence against disease begins with paddock selection. Other criteria such as seed quality and treatment are also vitally important. Determine which diseases have the highest priorities to control in the pulse crop being grown, and sow a variety that is resistant to those diseases if possible. Paddock selection and strategic fungicide use are part of the overall program to minimise disease impact. Fungicide disease control strategies alone may not be economic in high-risk situations, particularly if susceptible varieties are grown.

Key strategies:

- **Variety selection**. Growing a resistant variety reduces the need for foliar fungicides.
- **Distance**. Distance from any of last year's stubble of the pulse will affect the amount of infection for some diseases. Aim for a separation of at least 500 m.
- **Paddock history and rotation**. Aim for a break of at least four years between sowing of the same pulse crop. Having a high frequency of crops such as lentil, faba bean, vetch, field pea, chickpea, lathyrus or clover pasture puts pulses at greater risk of diseases such as Phoma blight, Sclerotinia rot and BGM. Ascochyta blight species are more specific to each pulse crop, but 3–4 year rotations are still important. Canola can also increase the risk of Sclerotinia rot.
- **Hygiene**. Take all necessary precautions to prevent the spread of disease. Reduce last year's pulse stubble if erosion is not a risk and remove self-sown pulses before the new crop emerges.
- **Seed source**. Use seed from crops in which there were low levels of disease, or preferably no disease, especially at podding. Avoid using seed with known disease infection, particularly with susceptible varieties. Have seed tested for disease status.
- **Fungicide seed dressings**. Dressings are partially effective early in situations of high disease risk, particularly for diseases such as BGM, Phoma blight and Ascochyta blight. They are also effective for seed-borne disease control but not effective on viruses and bacterial diseases.
- **Sowing date**. To minimise foliar disease risk do not sow too early, so avoiding excessive vegetative growth and early canopy closure. Early crop emergence also coincides with greater inoculum pressure from old crop residues nearby. Aim for the optimum sowing window for the pulse and the district.
- **Sowing rate**. Aim for the optimum plant population (depending on region, sowing time, crop type, variety), as denser canopies can lead to greater disease incidence. Adjust seeding rate according to seed size and germination.
- **Sowing depth**. Sow deeper than normal any seed lot that is infected with disease to help reduce emergence of infected seedlings. The seeding rate must be adjusted upwards to account for the lower emergence and establishment percentage.
- **Foliar fungicide applications**. Disease-resistant varieties do not require the same regular foliar fungicide program that susceptible varieties need to control foliar diseases. Some pulses may require fungicide treatment for BGM if a dense canopy exists. Successful disease control with fungicides depends on timeliness of spraying, the weather conditions that follow, and the susceptibility of the variety grown. Monitoring for early detection and correct disease identification is essential. Correct fungicide choice is also critical.
- **Controlling aphids**. This may reduce the spread of viruses, but not eliminate them. Strategic or regular insecticide treatments are unlikely to be successful or economical. Usually the virus spread has occurred by the time the aphids are detected.
- **Harvest management**. Early harvest will help to reduce disease infection of seed, and is also important for grain quality and to minimise harvest losses. Crop desiccation enables even earlier harvest. Moisture contents of up to 14% are allowable at delivery. Do not prematurely desiccate as this can affect grain quality. [4]

4 Pulse Australia Ltd (2013) Northern chickpea best management practices training course manual—2013.

9.3 Integrated disease management

Disease management in chickpea is critical and relies heavily on an integrated management package involving paddock selection, variety choice, strategic fungicide use and crop hygiene.

Paddock selection based on Ascochyta blight infection is the first priority, followed by cropping history. The appropriate Ascochyta blight control strategy is adopted by determining the level of risk in combination with climatic conditions and the level of resistance afforded by the variety chosen.

Disease control strategies may not be economical in high-risk situations if varieties susceptible to Ascochyta blight are grown. [5]

Integrated disease management is an integrated approach of crop management to reduce chemical inputs and resolve ecological problems. Although originally developed for insect pest management, IDM programs now encompass diseases, weeds, and other pests.

Integrated disease management is performed in three stages: prevention, observation and intervention. It is aimed at significantly reducing or eliminating use of pesticides while managing pest populations at an acceptable level.

An IDM system is designed around six basic components:

1. Acceptable disease levels

- Emphasis is on economical control, not eradication.
- Elimination of the disease is often impossible, and can be economically expensive, environmentally unsafe, and frequently unachievable. IDM programs work to establish acceptable disease levels (action thresholds) and then apply controls if those thresholds are about to be exceeded. Thresholds are specific for disease and site. What is acceptable at one site may not be acceptable at another site or for another crop. Allowing some disease to be present at a reasonable threshold means that selection pressure for resistance pathogens is reduced.

2. Preventive cultural practices

- Use varieties best suited to local growing conditions and with adequate disease resistance.
- Maintaining healthy crops is the first line of defence, together with plant hygiene and crop sanitation. Crop canopy management is also very important in pulses; hence, time of sowing, row spacing and plant density and variety attributes become important.

3. Monitoring

- Regular observation is the key to IDM.
- Observation is broken into inspection and then identification. Visual inspection, spore traps, and other measuring tools are used to monitor disease levels. Accurate disease identification is critical to a successful program. Record keeping is essential, as is a thorough knowledge of the behaviour and reproductive cycles of target pests.
- Diseases are dependent on specific temperature and moisture regimes to develop (e.g. rust requires warm temperatures, Ascochyta blight often requires colder temperatures). Monitor the climatic conditions and rain likelihood to determine when a specific disease outbreak is likely.

4. Mechanical controls

- Should a disease reach unacceptable levels, mechanical methods may be needed for crop hygiene, for example, burning or ploughing in pulse stubble, removing hay, cultivating self-sown seedlings.

5. Biological controls

5 Pulse Australia Ltd (2011) Chickpea Integrated Disease Managment. http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/idm-strategies

- Crop rotation and paddock selection is a form of biological control.
- Using crops and varieties with resistance to the specific disease is also important. Other biological products are not necessarily available for disease control.

6. Responsible fungicide use

- Synthetic pesticides are generally used only as required and often only at specific times in a disease life cycle.
- Fungicides applied as protection ahead of conditions that are conducive to disease (e.g. sustained rainfall) may reduce total fungicide usage. Timing is critical with foliar fungicides, and may be more important than rate used. Protection is better than cure, because once the disease is established in the canopy there is an internal source of infection that is difficult, or even impossible, to control with later fungicide applications.

9.4 Risk assessment

Prediction of likely damage from a chickpea disease can be used at the paddock, whole farm, regional, state or national level. The choices of variety and disease management options are some of the factors determining risk.

Knowledge of your paddock, its layout (topography), soil parameters, and cropping history will help you to assess the level of risk.

9.4.1 Steps in risk assessment

1. Identify factors that determine risk

- *Pathogen.* Exotic *v.* endemic; biotypes, pathogenicity, survival and transmission, amenable to chemical management
- *Host.* Host range; varietal reactions, vulnerability. 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, dirty 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.* Not yet considered; plan being developed; plan in place?

3. What risk level is acceptable?

- *High.* Grower is prepared to accept substantial yield loss because potential returns are high and financial situation sound; crop failure will not affect rotation or other components of farming system.
- *Low.* Grower needs cash flow and cannot afford to spend much or lose the crop; failure seriously affects farming system.

9.4.2 Paddock selection

The selection of the most appropriate paddock for growing chickpea involves consideration of several important factors, some of which are related to the modes of survival and transmission of pathogens such as *Ascochyta rabiei*.

1. Rotation

- Develop a rotation of no more than one year of chickpea in four years.

- Plant chickpea into standing stubble of previous cereal stubble to enhance crop height and reduce attractiveness of the crop to aphids (aphids may vector viruses).
- Consideration also needs to be given to previous crops that may host pathogens such as *Sclerotinia, Rhizoctonia*.
- *Ascochyta rabiei* is chickpea-specific, whereas *Botrytis cinerea* has a wide host range including sunflower, bean, lentil, pea, and weeds (e.g. Euphorbia spp., groundsel and emufoot).
- Lucerne, medics and chickpea are hosts for *Phoma medicaginis var. pinodella* can be hosted by lucerne, clover, field pea, lupin and chickpea, as can *Phaseolus spp*.

2. History of chickpea diseases

- Previous occurrence of soil-borne diseases (Sclerotinia stem rot, PRR or *Pratylenchus* nematodes) constitutes a risk for subsequent chickpea crops for up to 10 years.
- Plant chickpea at least 500 m from the previous year's chickpea crop.

3. Weeds

- Almost all broadleaf weeds host *Sclerotinia spp.*
- Some of the viruses affecting chickpea also have wide host ranges. Weeds, particularly perennial legumes, host viruses and their aphid and leafhopper vectors (e.g. Cucumber mosaic virus).

4. Herbicide history

- Have triazine, sulfonylurea or other residual herbicides been applied in the last 12 months?
- The development of some diseases is favoured in herbicide-weakened plants. The presence of these herbicide residues in soil may cause crop damage and thus confusion over in-field disease diagnosis.

9.4.3 Regular crop monitoring

The two main diseases for which monitoring is necessary are Ascochyta blight and BGM. Following the monitoring process recommended for these diseases will provide the opportunity to assess the impact or presence of other diseases 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.

For Ascochyta blight

The initial symptoms will be wilting of individual or small groups of seedlings, or lesions on the leaves and stems of young plants, often in patches. Monitoring should commence 2–3 weeks after emergence, or 10–14 days after a rain event. This is because the initially infected seedlings soon die and symptoms are difficult to separate from other causes. 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 should occur every 2 weeks. When monitoring, look for signs of wilting in upper foliage (the 'ghosting' phenomenon) or small areas of dead or dying plants and, 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.

For Botrytis grey mould

Botrytis grey mould (BGM) is more likely to occur in well-grown crops where there is canopy closure. The critical stage for the first inspection will be at the commencement of flowering and then regularly through the flowering period. Lesions occur on stems, leaves and pods, and flower abortion and drop can occur; a fluffy grey fungal 'bunch of grapes' growth develops on affected tissue. Normal pod set will occur when daily temperature exceeds 15°C; BGM ceases to affect the plant once the maximum daily temperature exceeds ~28°C.

More regular crop monitoring may also be required if:

- high-risk situations exist such as non-optimal paddock selection
- shortened rotation
- immediately adjacent to last year's crop
- high disease pressure experienced last year
- a more susceptible variety is planted

9.4.4 Services and resources available to assist with disease forecasts, disease occurrence and identification

Crop disease forecasts

From an understanding of the biology of key plant pathogens it is possible to estimate the risks associated with particular diseases in key crops in Western Australia and Southern Australia. Research undertaken by DAFWA and collaborators from southern Australia has been used to develop tools to allow risk assessments to be made in the lead up to the cropping season. Keep up to date with the most recent DAFWA crop disease risk forecast.

Crop disease forecast estimates the risk of certain crop diseases during the cropping season for specific locations. For some diseases, it offers management practices to avoid potential yield losses.

Each weekly forecast, where relevant, accounts for varietal resistance, chemical options, agronomic yield potentials and losses, agronomic constraints (frost and terminal drought), risks of spore showers, disease severity and disease-related yield losses.

Inputs

No inputs from growers are required.

Outputs

A disease forecast report may include, for each location:

- forecast risk in tables or maps
- estimated severity or spore maturity
- sowing guide
- rainfall to date and stubble moisture
- suggested management practices

Reliability

The forecasts are updated regularly as part of ongoing research projects by the Grains Research & Development Corporation and the Department of Agriculture and Food Western Australia.[6]

PestFax

PestFax is a free weekly informative and interactive reporting service during the growing season. It provides risk alerts, current information and advice on pests and diseases threatening crops and pastures throughout the grain belt of Western Australia during each growing season. Subscribe and view the latest newsletter on the Pestfax page.

The PestFax map allows users to report pest and disease finds and view historic maps of past insect and disease reports.

6 Climate Kelpie. Crop disease forecast. GRDC, http://www.climatekelpie.com.au/manage-climate/decision-support-tools-for-managing-climate/crop-disease-forecast

Diagnosis tools and services

Correct diagnosis is crucial for successful management of crop diseases. DDLS Seed Testing and Certification (formally AGWEST Plant Laboratories) provides a wide range of chargeable services to assist with identification of crop foliar diseases, viruses, nematodes and root diseases. These include plant disease diagnostics (on leaves, whole plants, roots and soil), seed disease testing and weed and insect identification.

Refer to the DDLS page for more information and to request submission forms, sampling and postage instructions. For more information on sampling refer to the How to take a plant sample YouTube video.

The MyCrop app is available to assist you to correctly diagnose a constraint in your crop yourself. For more information refer to the How to diagnose crop constraints YouTube video, or visit the MyCrop page to download the MyCrop app. [7]

9.5 Ascochyta blight

Ascochyta blight, caused by the fungus *Phoma rabiei* (formerly *Ascochyta rabiei*), is a serious disease of chickpea in Australia. The fungus is different from the species of Ascochyta that infects faba beans, lentils and field peas. The fungus can infect all above ground parts of the plant and is most prevalent when cool, cloudy and humid weather occurs during the crop season. *Didymella rabiei*, the teleomorph of *Phoma rabiei,* has also been found in chickpea stubble in WA. [8]

In Western Australia, Ascochyta blight was first detected in 1998 in a single seed production paddock in the Walkaway area near Geraldton. This crop was subsequently destroyed and a 20 km chickpea exclusion zone was placed around the property. In addition, a quarantine restriction was placed on the import of chickpea seed into Western Australia, both from interstate and overseas. In this same year, Ascochyta blight was found in chickpea crops throughout eastern Australia, resulting in significant losses.

The first outbreak of Ascochyta blight in commercial chickpea crops in Western Australia was detected in July 1999. By the end of 1999, over 70 crops were found to be infected with all but two being in the Northern and Central agricultural regions. Due to the difficulty in detecting low levels of the disease, it is expected that many parts of the wheatbelt that now appear free of the disease may have a low level of infection. [9]

Ascochyta blight is now considered to be endemic in all growing regions with the exception of central Queensland. Unlike some insect control strategies, there is no economic threshold for Ascochyta. Management strategies are aimed at preventing the occurrence of disease and limiting its spread. [10]

Chickpea crops in southern Australia have recently been damaged by a more virulent strain of Ascochyta blight. Pulse pathologists in Victoria and South Australia have noted a marked decline in the resistance of several varieties of chickpeas, with varieties previously rated as moderately resistant performing like susceptible lines. There has not been any reported cases of the new strain in WA.

Ascochyta blight is managed through crop rotation, hygiene, seed treatment, prophylactic fungicide application and growing varieties with improved resistance. All growers and advisers need to regularly inspect their crops from emergence, through flowering, right up to plant maturity. Inspections should be undertaken 10–14 days after rain events, when new infections will be evident as lesions on plant parts.

7 DAFWA (2016) Crop diseases: Forecasts and management. https://www.agric.wa.gov.au/barley/crop-diseases-forecasts-and-management?page=0%2C0

8 J Galloway, WJ MacLeod (2003) Didymella rabiei, the teleomorph of Ascochyta rabiei, found on chickpea stubble in Western Australia. Australasian Plant Pathology, 32(1), 127–128.

9 I Pritchard (2000) Managing Ascochyta blight. Journal of the Department of Agriculture, WA, Series 4, Vol 41. DAFWA, http://researchlibrary.agric.wa.gov.au/cgi/viewcontent.cgi?article=1010&context=journal_agriculture4

10 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

Economic importance

The widespread occurrence of this disease in 1998 had a negative impact on the chickpea growing industry. To successfully grow varieties with an Ascochyta disease rating less than moderately resistant, foliar fungicides need to be applied throughout the growing season to avoid serious yield losses. Varieties rated as moderately resistant (such as PBA SLASHER and Genesis™ 509) still require at least one fungicide at early pod set, but the risk of yield loss is minimal. When selecting varieties the added cost of fungicide applications needs to be considered before selecting and growing susceptible to moderately resistant varieties. [11]

9.5.1 Varietal resistance or tolerance

See Table 3 at the start of this section for varietal disease ratings.

Table 4 estimates gross margins for chickpeas with Ascochyta-susceptible versus Ascochyta-resistant varieties. Fungicide costs are based on eight applications at $20/ha per application for the susceptible variety versus one for the resistant variety. Assuming variety yields are the same, desi gross margin of $130 versus $270/ha may be achieved from a 1.5 t/ha grain yield. A $180 versus $420/ha return could be obtained from a kabuli yield of 1.0 t/ha. If choosing a variety susceptible to Ascochyta blight, growers should consider kabuli production in preference to desi where conditions are suitable. [12]

Table 4: *Estimated desi and kabuli returns.*

Grain yield (t/ha)	Grain price ($/t)	Fungicide cost Susceptible variety ($/ha)	Fungicide cost Resistant variety ($/ha)	Other costs All varieties ($/ha)	Gross margin Susceptible variety ($/ha)	Gross margin ($/ha) Resistant variety ($/ha)
Desi						
0.5	300	160	20	160	-170	-30
1.0	300	160	20	160	-20	120
1.5	300	160	20	160	130	270
2.0	300	160	20	160	280	420
Kabuli						
0.5	500	160	20	160	-70	70
1.0	500	160	20	160	180	420
1.5	500	160	20	160	430	570
2.0	500	160	20	160	680	820

Source: Pulse Australia

9.5.2 Damage caused by disease

WA's chickpea industry grew rapidly from the mid-1990s and rose to be a significant 70,000 hectare grain legume crop until the arrival of the fungal disease Ascochyta blight in 1999 devastated the industry. Currently production is less than 10,000 tonnes. [13] Unlike some insect control strategies, there is no economic threshold for Ascochyta. Management strategies are aimed at preventing the occurrence of disease and limiting its spread. [14] The high-risk and increased cost of controlling

11 Agriculture Victoria (2016) Ascochyta Blight of Chickpea. DEPI, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/ascochyta-blight-of-chickpea

12 Pulse Australia Ltd (2007) Chickpeas in South Australia and Victoria. http://www.pulseaus.com.au/storage/app/media/crops/2007_Chickpeas-SA-Vic.pdf

13 https://www.agric.wa.gov.au/pulses/western-australian-pulse-industry

14 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

Ascochyta blight often makes desi chickpea production unprofitable but higher value kabuli types may remain profitable. [15]

9.5.3 Symptoms

Phoma rabiei infects the leaves, stems and pods of chickpea plants, causing tan/brown, rounded lesions on affected plant parts. This disease is usually first noticed in late winter when small patches of blighted plants appear throughout the paddock (Figure 4). Usually the first symptoms are the wilting of individual or small groups of seedlings. Plants appear as if premature haying-off has occurred. Initially Ascochyta blight appears on the younger leaves as small water-soaked pale spots. These spots rapidly enlarge under cool and wet conditions, joining with other spots on the leaves and blighting the leaves and buds. [16]

Figure 4: *Wilting of individual or small groups of seedling.*

Source: Pulse Australia

Ascochyta leaf ghosting symptoms may appear 4–7 days after rainfall or heavy dew (Figure 5). [17]

Figure 5: *Ghosting symptoms of chickpea.*

Source: Pulse Australia.

15 L McMurray, J Brand, J Davidson, K Hobson, M Materne, (2006, September). Economic chickpea production for southern Australia through improved cultivars and strategic management to control Ascochyta blight. In Proceedings of 13th Australian Agronomy Conference (p. 65).

16 Agriculture Victoria (2016) Ascochyta Blight of Chickpea. DEPI, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/ascochyta-blight-of-chickpea

17 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

Lesions usually begin as a pale green-yellow discolouration on leaves and stems and progress into small, round lesions with dark brown margins and pale grey to tan sunken centres (Figure 6). Note the concentric circles of brown-black dots in the centre of the lesions. These small black spots (pycnidia), or fruiting bodies are unique to Ascochyta blight. Pycnidia, less than 1 mm in diameter, can be seen in the affected areas. Pycnidia are also present in stem lesions. In severe cases of infection the entire plant dries up suddenly.

Figure 6: *Lesions on chickpea leaves caused by Ascochyta blight.*

Source: Pulse Australia

Lesions on stems at first tend to be oval shaped, with brown centres and a darker margin. Elongated lesions can often form and girdle the stem (Figure 7). The stem may die and break off. Regrowth may occur from the broken stem. Affected areas on the pods tend to be round and sunken, with pale centres and dark margins.

Figure 7: *Stem lesion of chickpea leading to girdling and breakage of stem.*

Source: Pulse Australia

- Leaf lesions: Lesions usually begin as a pale green-yellow discolouration on leaves and stems and progress into small round lesions with dark-brown margins and pale grey to tan sunken centres. Toward the centre of the lesion, fruiting bodies called pycnidia develop (appearing as black specks), often in concentric rings. These pycnidia produce spores, which spread on wind-borne stubble and/or water (rain-splash) to infect other plants. Note the concentric circles of brown-black dots in the centre of the lesions. These are the pycnidia or fruiting bodies that are unique to ascochyta blight. Ascochyta leaf ghosting may appear 4–7 days after infection following rainfall or heavy dew.
- Stem lesions: Lesions on stems at first tend to be oval shaped, with brown centres and a darker margin. Lesions often girdle the stems of the plant, causing them to weaken and subsequently break off.
- Pod lesions: Pod lesions are similar in appearance to leaf lesions. They lead to infection of the seed. DO NOT keep planting seed from any crop that has been identified as having Ascochyta blight (Figure 8). [18]

18 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

Figure 8: *Pod lesions look similar to leaf lesions and lead to infection of the seed.*

Source: Pulse Australia

The fungus can penetrate the pod and infect the seed. Pod lesions are similar in appearance to leaf lesions. Severe pod infection usually results in reduced seed set and infected seed. When infected seeds are sown, the emerging seedlings will develop dark brown lesions at the base of the stem. Affected seedlings may collapse and die.

9.5.4 Conditions favouring development

Initial crop infection is due to the introduction of either infected planting seed or from movement of infected trash by wind, machinery or animals. Spores of the fungus can survive for a short time on skin, clothing and machinery. Subsequent in-crop infection and spread occurs when inoculum is moved higher in the canopy or to surrounding plants by wind or rain-splash during wet weather. The disease spreads during cool, wet weather from infected plants to surrounding plants by rain splash of spores. This creates large blighted patches within crops. Pycnidia produce spores, which infect other plants through wind-borne stubble and/or water (rain-splash). There are no other known hosts of *Phoma rabiei* in Australia. [19,20]

Ascochyta blight-infected stubble blown about during and after harvest is a major cause of short–medium–distance dispersal (metres to kilometres) along with movement of infected trash by water, machinery or animals.

Ascochyta blight can increase rapidly on volunteer chickpeas if wet weather occurs during spring–summer–autumn. Paddocks with chickpea stubble should be regarded as a source of inoculum even if Ascochyta blight was not observed in last season's chickpea crop. The pathogen can survive at least three years in the paddock.

Ascochyta blight can develop over a wide range of temperatures (5–30°C) and needs only 3 hours of leaf wetness to infect (Figure 9). However, the disease develops fastest when temperatures are 15–25°C and relative humidity is high (the longer relative humidity remains high, the more severe will be the infection).

Subsequent in-crop infection occurs when spores are moved higher in the canopy or to surrounding plants by rain-splash during wet weather. Multiple cycles of infection will occur during the growing season whenever environmental conditions are favourable.

19 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

20 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

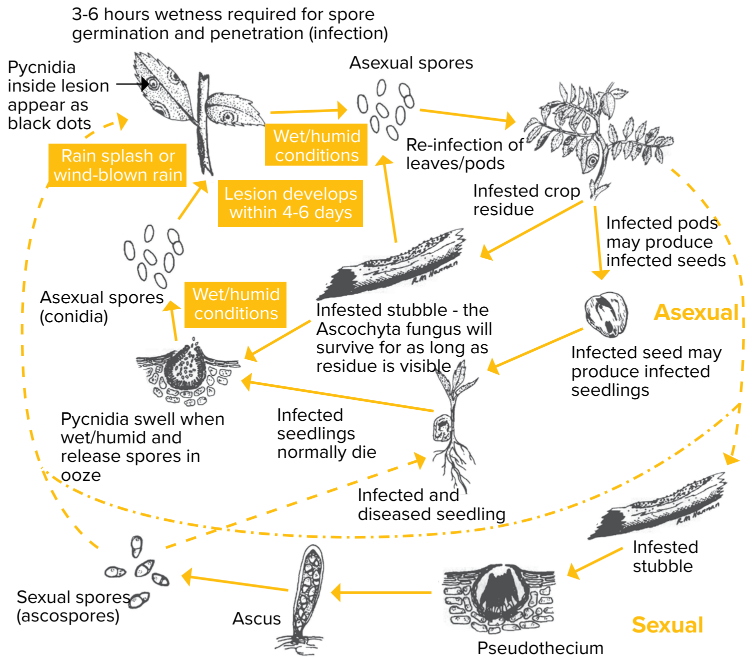

Figure 9: *Life cycle of Ascochyta blight pathogen. Note: Only the asexual phase is known to occur in Australia at this time.*

Drawings by RM Hannan. Source: Can. J. Pl. Path. 19:215–224, 1997

9.5.5 Management of disease

Monitoring

- When inspecting crops, look for signs of wilting in upper foliage and small areas of dead or dying plants.
- Check in a range of locations across the field following a 'V' or 'W' pattern.
- Spend at least 1 to 2 hours inspecting each crop for Ascochyta blight.
- Ensure good hygiene when moving between crops and farms.

Take extra care when inspecting crops that are growing:

- under centre pivot or lateral-move irrigators;
- from seed whose ascochyta status is unknown; and
- from seed that was not treated with a registered fungicide seed dressing. [21]

If Ascochyta is suspected

If Ascochyta is suspected mark the spot and take samples for diagnosis. DO NOT enter other chickpea paddocks wearing the same clothing. All other chickpea crops on the property need to be inspected for Ascochyta blight. Be sure to follow the hygiene practices outlined below.

- Place samples of suspected Ascochyta-infected plants into a plastic bag then seal the bag and keep the samples cool.
- Suspect samples should be referred to a plant pathologist or agronomist familiar with the disease for identification.
- Unnecessary movement within a suspected Ascochyta-infected crop should be avoided until the sample has been fully assessed.

21 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

- Most importantly, do not visit other chickpea crops until all clothing has been disinfected or changed and machinery has been washed of all plant material and dirt. [22]

Hygiene

The spores of Ascochyta can adhere to clothing, machinery, vehicles, people and animals when moving through infected paddocks, so hygiene is a vital component of IDM when Ascochyta is found in a crop. Wear waterproof pants, overboots or rubber gum boots when entering a suspected infected paddock, then decontaminate immediately after exiting.

- Farmers and advisors should take precautions to prevent spreading Ascochyta blight via clothing, footwear and vehicles.
- The recommended protocol is for clothing to be washed, changed or disinfected when moving between chickpea paddocks.
- Wash boots in a mixture of 10% bleach and 90% water solution or methylated spirits upon leaving an infected chickpea crop.
- Clothing must be machine-washed in hot water before being worn when entering another chickpea crop.
- Extra care should be taken to remove soil and plant material from boots and vehicles.
- Hands and arms should be washed in warm soapy water or a suitable disinfectant.
- The use of heavy-duty plastic bags to cover boots and legs is a common practice when checking crops. After inspecting the crop, remove these plastic covers and place them in another bag and seal. Use another set of covers if you need to enter another chickpea crop.
- Farmcleanse® can be used to clean equipment. [23]

During harvest

Harvest Ascochyta -free paddocks before infected paddocks and preferably use your own harvester. Do not run the straw spreaders when harvesting, which will reduce the spread of small pieces of Ascochyta-infected stem and pods.

Thoroughly clean and decontaminate all machinery associated with harvesting in a well-defined and identifiable area before moving to another paddock or property.

Post-harvest

All grain harvested from an Ascochyta-infected paddock should be transported off-farm to receival sites in well-sealed trucks. If kept for a period on-farm it should be stored in well-sealed and labelled silos which must be thoroughly cleaned after the grain has been removed. Grain harvested from an Ascochyta-infected crop must not be retained as planting seed for other crops. Consideration may be given to incorporation of infected crop residues by the use of off-set discs immediately after harvest to enhance the rate of breakdown. Chickpea volunteers in the infected paddock, along fence lines and near sheds must be controlled. Chickpeas should not be grown in or adjacent to an Ascochyta-infected paddock for at least three years. [24]

Control

Follow the principles of Integrated Disease Management (IDM), which include:

- crop rotation and paddock selection
- clean seed and fungicide seed dressings

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22 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

23 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

24 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

- regular crop monitoring
- strict hygiene on and off farm
- strategic use of foliar fungicides

Note: Chickpea seed dressings only protect the emerging seedling from seed-borne Ascochyta and seed-borne botrytis. Seed dressings will not protect the emerged seedling from raindrop-splashed Ascochyta or wind-borne botrytis. [25]

See Section 3 Planting, 3.2 Seed treatments for more information.

9.5.6 Ascochyta blight management in Kabuli

Paddock selection

Keep at least a three-year break between chickpea crops in the same paddock. Equally importantly, sow new chickpea crops at least 500 m from any paddock (yours or your neighbours) in which chickpea was grown in the previous season. Ascochyta spores from infected chickpea stubble from the previous season are released in mid-winter and can be blown hundreds of metres, or even kilometres. Small pieces of infected chickpea trash (leaf, pod and stem) may be blown considerable distances during harvest and may also be moved about by winds throughout the summer and autumn. It is important to consider the risks from wind-blown trash prior to the break of the season and wind-borne spores after crop emergence when selecting paddocks to sow to chickpea. [26]

Seed

Test your seed for germination and Ascochyta blight infection. Do not sow seed if the Ascochyta infection level is above 0.25%. All kabuli seed should be treated with a fungicide seed dressing; this will reduce the transmission of seed-borne fungal infections and also help to protect the emerging seedling from soil-borne pathogens and seedling rots. Seed testing and seed dressing are complementary: seed testing ensures that seed with an unacceptably high level of infection is not being sown while seed dressing reduces, but does not eliminate, seed-borne infection. Seed dressing highly infected seed reduces the level of transmission, but may still result in high levels of initial infection of the emerged crop. [27]

Fungicide timing

Where crops of ALMAZ and KALKEE have been established following the above recommendations, growers should budget for two or three strategic fungicide sprays (chlorothalonil 720 g/L applied at 1.0–2.0 L/ha). This is a significant improvement over the regular spray schedule (every three to four weeks) previously recommended.

The fungicide spray is required four weeks after emergence (chlorothalonil 720 g/L applied at 1.5 L/ha). This early prophylactic spray is required to contain the spread from any Ascochyta blight infections resulting from wind-blown spores from last year's stubble, seed-borne infections or infected trash that has been carried into the paddock. The level of infection that requires application of a fungicide spray this early in the crop's life is very low and is below the level that can be reliably identified, even by a person who has considerable experience in identifying this disease in field crops. Additionally, application of an early spray will protect the crop against wind-borne spores released from chickpea stubble during the two to three weeks following the spray application.

A second spray (chlorothalonil 720 g/L applied at 1.0–2.0 L/ha) is recommended at full flowering to protect the developing pods and minimise the risk of reduced quality. The rate of fungicide application depends on the level of Ascochyta blight infection detected in the crop prior to spraying. The high rate (2.0 L/ha) would be

25 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

26 DAFWA (2016) Production packages for kabuli chickpea in Western Australia—post planting guide. https://www.agric.wa.gov.au/chickpeas/production-packages-kabuli-chickpea-western-australia-post-planting-guide

27 DAFWA (2016) Production packages for kabuli chickpea in Western Australia—post planting guide. https://www.agric.wa.gov.au/chickpeas/production-packages-kabuli-chickpea-western-australia-post-planting-guide

appropriate where Ascochyta blight can be easily identified in the crop and the low rate (1.0 L/ha) where only minor disease infection is evident after close inspection. If Ascochyta blight is not identified, even after close inspection of more than ten locations throughout the crop, a fungicide application may not be required at this time. A fungicide spray (chlorothalonil 720 g/L applied at 1.5 L/ha to 2.0 L/ha) may be required during pod filling if Ascochyta blight becomes evident in the canopy during late flowering or podding. [28]

9.5.7 Foliar fungicide programs

Differing spray programs have been developed based on each variety's Ascochyta rating (see Table 5). Chickpea Ascochyta fungicides are protectants only. Unlike wheat stripe rust fungicides, they have no systemic or kick-back action, and they will not eradicate an existing infection. To be effective, they must be applied before infection; i.e. before rain. The key to a successful Ascochyta spray program is regular monitoring combined with timely application of registered fungicides (Table 5). [29]

Table 5: *Foliar fungicides for the control of Ascochyta and Botrytis grey mould.*

Active ingredient	Example trade name	Rate	
		Ascochyta blight	Botrytis grey mould
Chlorothalonil (720 g/L)	Crop Care Barrack 720# Barrack Betterstick # Nufarm Unite 720#	1.0–2.0 L/ha	Not registered
Mancozeb (750 g/kg)	Dithane TM RainshieldTM	1.0–2.2 kg/ha	1.0–2.2 kg/ha
Mancozeb (420 g/L)	Penncozeb SC	1.8–3.95 L/ha	Not registered
Carbendazim (500 g/L)	Spin Flo	Not registered	500 mL/ha

These are the only registered chlorothalonil products. It is an offence to use any other product. Refer to current product label for complete 'Direction for use' prior to application.

Source: Pulse Australia

Note: Observations in 2010 Tamworth trials indicated that the natural resistance all plants have to pathogens and pests is compromised when plants are stressed from waterlogging, and that this reduced the ability to manage Ascochyta with a fungicide strategy that worked in less stressed plots. In a season when repeated cycles of infection occur, even MR varieties can have yield-reducing levels of disease. [30]

IN FOCUS

Economic chickpea production for southern Australia through improved cultivars and strategic management to control Ascochyta blight.

Experiments were sown at four locations over two seasons in southern Australia to assess fungicide (chlorothalonil or mancozeb) application timing and efficacy in controlling Ascochtya blight in cultivars varying in

28 DAFWA. (2016) Production packages for kabuli chickpea in Western Australia - post planting guide. https://www.agric.wa.gov.au/chickpeas/production-packages-kabuli-chickpea-western-australia-post-planting-guide

29 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

30 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

Ascochyta blight resistance. Resistant (R) cultivars were successfully grown with two or less fungicide applications during podding. Moderately resistant (MR), moderately susceptible (MS) and susceptible (S) cultivars always required at least three and up to nine fungicide applications to prevent yield loss. In all experiments the podding treatment of chlorothalonil had equivalent or greater grain yields than the mancozeb podding treatment. The use of resistant cultivars with one or two strategic foliar fungicide applications ensures chickpeas are a low risk, profitable option in medium rainfall (350–450 mm) cropping areas of southern Australia. [31]

Resistant (R) *(e.g. Genesis™ 090, Genesis™ 425)*

- Fungicide sprays are unlikely to be required before podding. Despite good foliar resistance to Ascochyta, the flowers and pods of R varieties can be infected, which can result in poor quality, discoloured seed or seed abortion and, in extreme situations, yield loss.
- Monitor the crop 10–14 days after each rain event.
- If Ascochyta is detected, apply a registered fungicide at early podding prior to rain. In high rainfall or high risk situations and where there is an extended pod filling period, further applications may be required.

Moderately Resistant to Resistant (MR/R) *(e.g. PBA HatTrick⒫, PBA Boundary⒫)*

- In most seasons, disease development will be slow and there will be no or minimal yield loss. In such seasons there is no cost benefit in applying a fungicide during the vegetative stage. Despite good foliar resistance to Ascochyta, the flowers and pods of MR/R rated varieties can be infected which can result in poor quality, discoloured seed or seed abortion and yield loss in severe situations.
- However, under high disease pressure, a reactive foliar fungicide strategy may be warranted during the vegetative period of the crop.
- Monitor the crop 10–14 days after each rain event.
- If Ascochyta is present in the crop apply a registered fungicide at early podding prior to rain to ensure pods are protected, and high quality, disease free seed is produced.

Moderately Resistant (MR) *(e.g. Flipper⒫)*

- In most seasons of low to moderate disease pressure, there is no cost benefit in applying a fungicide until after Ascochyta blight is detected.
- Monitor the crop 10–14 days after each rain event and if Ascochyta is detected apply a registered fungicide just before the next likely rain event.
- Continue monitoring and spray again if weather and disease levels indicate Ascochyta is likely to spread.

Moderately Susceptible to Moderately Resistant (MS/MR) *(e.g. Yorker⒫, Almaz⒫)*

- For all situations apply a registered fungicide before the first rain event after crop emergence, or three weeks after emergence or at the three branch stage of development, whichever occurs first.
- Monitor the crop 10–14 days after each rain event.
- If Ascochyta is found, apply a registered fungicide just before the next rain event.

31 L McMurray, J Brand, J Davidson, K Hobson, M Materne (2006) Economic chickpea production for southern Australia through improved cultivars and strategic management to control ascochyta blight. In Proceedings of the 13th Australian Agronomy Conference (65).

- Continue monitoring and spray again if weather and disease levels indicate Ascochyta blight is spreading.

Susceptible (S) varieties *(e.g. Jimbour, Kyabra⒟, Moti, PBA Pistol)*

- If the season favours Ascochyta, regular fungicide sprays will be needed from emergence until four weeks before maturity. Do not wait until you find the disease.
- Timing of the first two sprays is critical, because control is difficult or impossible after the disease has taken hold. The first spray must be applied before the first post emergent rain event, or three weeks after emergence or at the three leaf stage whichever occurs first. The second spray should be applied three weeks after the first spray. However, apply the second spray if two weeks have elapsed since the first spray and rain is forecast.
- Mancozeb is often the preferred fungicide for these first two applications as it can be applied with a Group A grass herbicide.
- Continue monitoring the crop 10–14 days after each rain event. If Ascochyta is found additional sprays will be required. If it has been two weeks or longer since the last application, spray again just before the next rain event. [32]

IN FOCUS

Management options for minimizing the damage by Ascochyta blight in chickpea

Ascochyta blight, a fungal disease caused by *Ascochyta rabiei (Pass.) Labrousse*, is the major constraint for chickpea production worldwide. Current cultivars only possess partial resistance to the pathogen, and this level of resistance can breakdown easily because the pathogen is highly variable due to potential for sexual recombination. The development of integrated disease management is the key for successful chickpea production. In this research the key crop management practices from the major chickpea growing areas in the world were summarised. Emphasis is on strategies and options that can be used to minimize the damage caused by this disease. The use of Ascochyta blight-free seed and seed dressing with effective fungicides reduces the probability of transmitting seed-borne disease to the seedlings. Deep-burying or burning of chickpea stubble minimizes stubble-borne inoculum. One to two years of non-host crops for warm and wet areas and 3–4 year crop rotation for cold and dry areas are required to reduce the levels of stubble-borne inoculum. The use of field isolation and sowing chickpea at a distance from previous chickpea crops will reduce the density of airborne ascospores released from infected debris. Optimum sowing date, deep sowing, optimising plant density, balanced nutrition, and alternative sowing patterns should be considered as a means of reducing Ascochyta blight pressure wherever possible. Sprays at seedling stage or before the occurrence of infection are crucial in short-season areas or where ascospores are the major sources of inoculum. Chickpea growers are strongly encouraged to adopt an integrated approach that combines all agronomic options, including cultivar selection, if they are to manage this disease economically and effectively. [33]

MORE INFORMATION

Chickpea: Ascochyta blight management.

32 K Moore, M Ryley, G Cumming, L Jenkins. Chickpea: Ascochyta blight management. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

33 YT Gan, KHM Siddique, WJ MacLeod, P Jayakumar, P (2006) Management options for minimizing the damage by ascochyta blight (Ascochyta rabiei) in chickpea (Cicer arietinum L.). Field Crops Research, 97(2), 121–134.

9.6 Botrytis grey mould

Botrytis grey mould (BGM) in chickpea is caused by the fungus *Botrytis cinerea*. *B. cinerea* is a significant pathogen of pulse crops, particularly lentils, ornamental plants grown under glasshouse conditions, and fruit including grapes, strawberries and apples. Flowers are especially vulnerable to BGM infection. *B. cinerea* does not infect cereals or grasses.

B. cinerea has been recorded on over 138 genera of plants in 70 families. Legumes and asteraceous plants comprise approximately 20% of these records. As well as being a serious pathogen, *B. cinerea* can infect and invade dying and dead plant tissue. This wide host range and saprophytic capacity means inoculum of *B. cinerea* is rarely limiting. If conditions favour infection and disease development, BGM will occur. This makes management of BGM different from chickpea Ascochyta, which is more dependent on inoculum, at least in the early phases of an epidemic.

B. cinerea also causes pre and post-emergent seedling death. This happens when chickpea seed, infected during a BGM outbreak, is used for sowing. Seedling disease does not need the wet conditions that are usually required for infection and spread of BGM later in the crop cycle. [34]

Economic importance

Botrytis grey mould is a serious disease of chickpeas in southern Australia and can cause total crop failure. Discoloured seed may be rejected or heavily discounted when offered for sale. If seed infection levels are >5% then it may be worth grading the seed. Crop losses are worst in wet seasons, particularly when crops develop very dense canopies.

9.6.1 Varietal resistance or tolerance

See Table 3 at the start of this section for varietal disease ratings.

9.6.2 Damage caused by BGM

Botrytis grey mould is the second most important disease of chickpeas and can infect plants at any stage of development. Under favourable conditions, the disease can develop rapidly, spread widely and cause complete yield loss. Chickpea genotypes with vigorous seedling growth, early canopy closure and early flowering are more likely to develop disease than other varieties. Use of badly infected seed can result in total crop failure where seed is not dressed with a fungicide. Crop losses are greatest in wet seasons, particularly when crops develop very dense canopies. [35]

9.6.3 Symptoms

The first symptom of BGM infection in a crop is often drooping of the terminal branches. If groups of plants are infected, these may appear as yellow patches in the crop (Figure 10). The diagnostic feature is a grey 'fuzz' which, under high humidity, develops on flowers, pods, stems and on dead leaves and petioles.

34 M Ryley, K Moore, G Cumming, L Jenkins. Chickpea: Managing Botrytis Grey Mould. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/botrytis-grey-mould

35 CropPro. Botrytis grey mould of Chickpeas. http://www.croppro.com.au/crop_disease_manual/ch05s06.php

Figure 10: *If groups of plants are infected, these may appear as yellow patches in the crop.*

Photo: Phil Davies. Source: Pulse Australia.

Lesions can develop anywhere along the stem but are usually first found on the lower part of the stems, often starting in leaf axils (Figure 11). Infected seeds are usually smaller than normal and are often covered with white to grey fungal growth.

Figure 11: *Lesions are usually first found on the lower part of the stems often starting in leaf axils.*

Source: Pulse Australia.

Infected seeds are usually smaller than normal and are often covered with white to grey fungal growth (Figure 12).

Figure 12: *Botrytis grey mould on seed.*

Photos: G. Cumming. Source: Pulse Australia

When a severely BGM-infected canopy is opened, clouds of spores are evident (avoid inhaling these). During dry weather the 'fuzz' is not obvious, but it develops again when wet weather returns (Figure 13). Small, dark brown/black resting bodies (sclerotes) of *B. cinerea* may develop on infected dead tissue, and are capable of producing spores on their surface.

Figure 13: *BGM on a chickpea flower.*

Photo: Phil Davies. Source: Pulse Australia.

The stem lesions caused by BGM can be confused with those caused by *Sclerotinia sclerotiorum* (at and above ground level) and by *Sclerotinia minor* (at ground level), but neither of these pathogens produce the grey 'fuzz' typical of BGM. Also, sclerotinia lesions tend to remain white, and are covered by a dense cottony fungal growth, in which irregular shaped black sclerotes develop.

In contrast, the sclerotes of *B. cinerea* are more rounded and usually develop after the stems die. They are smaller than the sclerotes of *S. sclerotiorum*, but larger than the angular sclerotes of *S. minor*. [36]

9.6.4 Conditions favouring development

Factors that favour infection and spread of BGM in favourable seasons include:

- early sowing (mid-April to early May) and narrow rows
- frequent overcast, showery weather
- limited supply of effective fungicides
- lack of BGM tolerant/resistant varieties

High biomass crops and early canopy closure often results in high in-crop humidity and poor penetration of fungicides. If the crop becomes lodged the situation is exacerbated.

Rainy weather not only favours the disease but wet paddocks also limit the spray opportunities for ground rigs.

Following a season where widespread BGM infection has occurred in a district there is often a shortage of disease-free seed for planting, and there is a high quantity of infected crop residue across a large area. Both of these factors will increase the disease risk for the following year. Whether BGM becomes a problem the following year will depend on seasonal conditions.

Over 10 million spores can be produced on a single 2 cm-long lesion on a chickpea stem. Consequently, *B. cinerea* has the capacity to rapidly develop during conducive weather conditions. The spores can be blown many kilometres, and if deposited on chickpea plants they can remain dormant until conditions favour spore germination.

Free moisture is necessary for germination and infection. Lesions and the grey 'fuzz' are evident 5–7 days after infection under ideal conditions.

B. cinerea is favoured by moderate temperatures (20–5°C) and frequent rainfall events. It does not become a risk until the average daily temperature (ADT) is 15°C or higher. The combination of early canopy closure, prolonged plant wetness and overcast weather results in high relative humidity and rapid leaf death in the canopy, conditions which are ideal for *B. cinerea*.

B. cinerea can survive on and in infected seeds, in infected stubble, on alternative hosts, in dead plant tissue and as sclerotes. The relative importance of these in Australia is unknown, but recent research in Victoria demonstrated that *B. cinerea* can survive for up to 18 months on infected stubble under field conditions. Other research from Western Australia suggests that sclerotes of *B. cinerea* cannot survive over summer because they lose their viability during hot weather. [37]

9.6.5 Management of BGM

Stubble management

It is likely that the pathogen can remain viable and capable of survival for as long as infected stubble remains on the soil surface. Burial of stubble removes the ability of *B. cinerea* to produce spores that can be blown around, and increases the rate of stubble breakdown by soil microbes.

Although burning of infected residues will also significantly reduce the amount of infected residues on the soil surface, it will not guarantee freedom from BGM in the following season.

36 M Ryley, K Moore, G Cumming, L Jenkins. Chickpea: Managing Botrytis Grey Mould. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/botrytis-grey-mould

37 M Ryley, K Moore, G Cumming, L Jenkins. Chickpea: Managing Botrytis Grey Mould. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/botrytis-grey-mould

Burying or burning stubble can significantly increase the risk of soil erosion and reduce water infiltration. [38]

Volunteer control (the green bridge)

Volunteer chickpea plants growing in or near paddocks where BGM was a significant problem are a likely method of carry-over and must be managed by application of herbicide or cultivation.

This will also reduce carryover of Ascochyta. [39]

Seed source and treatment

Obtain seed from a commercial supplier, or from a source known to have negligible levels of BGM. Irrespective of the source, all seed must be thoroughly treated with a registered fungicide seed dressing. Thiram based fungicide seed dressings are effective in significantly reducing, but not entirely eliminating, BGM from infected seed. [40]

See Section 3 Planting, 3.2 Seed treatments for more information.

Seedling emergence

Research on harvested seed has shown a germination test does not accurately predict emergence. Accordingly, growers are advised to conduct their own emergence test, as follows:

- After grading and treatment, sow 100 seeds at least 5 cm deep in the paddock that you intend for chickpeas and water if necessary.
- Count the number of seedlings that have emerged after one, two and three weeks and note their appearance. Do they look healthy or are they stunted and distorted?
- If you want to get an idea of variability in emergence and the paddock, replicate the test i.e. sow 100 seeds in 3–4 different locations in the paddock. This will also help identify potential herbicide residue problems. [41]

Paddock selection

Paddocks in which chickpeas were affected by BGM should not be re-sown to chickpea, faba bean or lentil the following season. Nor should chickpea be sown beside paddocks where BGM was an issue the previous season.

As for Ascochyta blight, chickpea should be grown as far away from paddocks in which BGM was a problem as is practically possible.

However, under conducive conditions, this practice will not guarantee that crops will remain BGM free, because of the pathogen's wide host range, ability to colonise dead plant tissue, and the airborne nature of its spores. [42]

Sowing time and row spacing

If long-term weather forecasts suggest a wetter-than-normal year (La Niña), consider sowing in the later part of the suggested sowing window for your district and on wider rows. Keep in mind, however, that WA soil types may not have enough nutrients to support very wide rows, and that wide rows may increase the risk of weeds, against which chickpeas are poor competitors. Planting on wider rows results in increased air movement through the crop and reduced humidity within the canopy.

38 M Ryley, K Moore, G Cumming, L Jenkins. Chickpea: Managing Botrytis Grey Mould. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/botrytis-grey-mould

39 M Ryley, K Moore, G Cumming, L Jenkins. Chickpea: Managing Botrytis Grey Mould. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/botrytis-grey-mould

40 M Ryley, K Moore, G Cumming, L Jenkins. Chickpea: Managing Botrytis Grey Mould. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/botrytis-grey-mould

41 M Ryley, K Moore, G Cumming, L Jenkins. Chickpea: Managing Botrytis Grey Mould. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/botrytis-grey-mould

42 M Ryley, K Moore, G Cumming, L Jenkins. Chickpea: Managing Botrytis Grey Mould. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/botrytis-grey-mould

Varietal resistance

All current commercial varieties suitable for the northern region are susceptible to BGM, although Howzat⒟ is reported to have slightly better resistance than other varieties.

Fungicide treatment

In areas outside central Queensland, spraying for BGM is not needed in most years.

However, in seasons and situations favourable to the disease, a preventative spray of a registered fungicide immediately prior to canopy closure, followed by another application two weeks later, will assist in minimising BGM development in most years. If BGM is detected in a district or in an individual crop, particularly during flowering or pod fill, a fungicide spray should be applied before the next rain event (Table 6).

None of the fungicides currently registered or under permit for the management of BGM on chickpea have eradicant activity, so their application will not eradicate established infections. Consequently, timely and thorough application is critical. [43]

Table 6: *Foliar fungicides for the control of Ascochyta and Botrytis grey mould.*

Active ingredient	Example trade name	Rate	
		Ascochyta blight	Botrytis grey mould
Chlorothalonil (720 g/L)	Crop Care Barrack 720# Barrack Betterstick # Nufarm Unite 720#	1.0–2.0 L/ha	Not registered
Mancozeb (750 g/kg)	Dithane TM RainshieldTM	1.0–2.2 kg/ha	1.0–2.2 kg/ha
Mancozeb (420 g/L)	Penncozeb SC	1.8–3.95 L/ha	Not registered
Carbendazim (500 g/L)	Spin Flo	Not registered	500 mL/ha

These are the only registered chlorothalonil products. It is an offence to use any other product. Refer to current product label for complete 'Direction for use' prior to application.

Source: Pulse Australia

9.7 Sclerotinia

Sclerotinia, caused by *Sclerotinia sclerotiorum* and *trifoliorum*, is an occasional disease of chickpeas but has caused significant crop losses in Australia. Sclerotinia can cause serious crop losses where a substantial number of plants within a crop are affected. Kabuli chickpeas appear more susceptible to this disease than Desi chickpeas, but both types can be seriously damaged under favourable conditions. Dense crops are likely to be the most severely affected, particularly under moist conditions. Grain quality can be decreased when infected with sclerotinia, which causes poor colour and shrivelled seed.

In WA, sclerotinia infection was prevalent in crops throughout the west midlands area in trials between 2011 and 2012, with 25% of canola crops infected. On average this has been at a level of 20% of plants although the range was 0 to 82%. In contrast, 14% of lupin paddocks have been infected with an average of 13% of plants infected. Canola is a good host for sclerotinia and its host ability may increase the risk of this disease for all broadleaf crops. [44]

43 M Ryley, K Moore, G Cumming, L Jenkins. Chickpea: Managing Botrytis Grey Mould. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/botrytis-grey-mould

44 W Parker (2013) Profitable crop and pasture sequencing 2013 trial report. DAFWA, https://www.agric.wa.gov.au/grains-research-development/profitable-crop-and-pasture-sequencing-2013-trial-report?page=0%2C0

9.7.1 Varietal resistance or tolerance

There are no grain legumes that are resistant to sclerotinia. [45]

9.7.2 Damage caused by disease

Sclerotinia can cause serious crop losses where a substantial number of plants within a crop are affected. This disease has caused total crop failure where chickpeas were sown in the same paddock in successive years. However in many situations it only affects a small proportion of plants within the crop. Kabuli chickpeas appear more susceptible to this disease than desi chickpeas but both types can be seriously damaged under favourable conditions. Dense crops are likely to be the most severely affected, particularly under moist conditions. Grain quality can be decreased when infected with sclerotinia, which causes poor colour and shrivelled seed. [46]

9.7.3 Symptoms

There are two *Sclerotinia spp* that attack chickpeas and they can be distinguished by the size of their sclerotes (survival structures).

- *S. sclerotiorum* produces large irregular shaped sclerotes 5–10 mm in diameter as high up as 20–30 cm on the stem
- *S. minor* produces sclerotes that are angular and much smaller, rarely larger than 2–3 mm in diameter

What to look for:

A small number of dead plants scattered throughout a paddock. Affected plants first wilt and rapidly die, often without turning yellow. Later, as the plant dries out the leaves turn a straw colour (Figure 14).

Figure 14: *Plants killed by S. sclerotiorum (left). Fungal weft of sclerotinia in the lower canopy of a chickpea crop (right).*

Photos: Kevin Moore

On the surface of the root, just below ground level, small black fungal bodies called sclerotia (which are irregular in size and shape), can sometimes be seen mingled with white cottony fungal mycelium (Figure 15).

45 G Thomas. (2010). Sclerotinia and grain legumes – is it an issue? http://www.australianoilseeds.com/__data/assets/pdf_file/0018/8244/9_Thomas_-_Sclerotinia.pdf

46 CropPro. (2014). Sclerotinia of chickpeas. http://www.croppro.com.au/crop_disease_manual/ch05s03.php

Figure 15: *Early symptoms of stem infection by sclerotinia. Whit mycelial growth starting to develop (left). Comparison of stem infections caused by sclerotinia (top stem) and botrytis (lower stem) (right). Note the different colour of fungal growth.*

Source: http://www.croppro.com.au/crop_disease_manual/ch05s03.php

In spring, water-soaked spots may appear on the stems and leaves. Affected tissues develop a slimy soft rot from which droplets of a brown liquid may exude. Infected tissues then dry out and may become covered with a web of white mycelium of the fungus (Figure 16).

Figure 16: *Sclerotinia stem infection of chickpeas. White fluffy mycelium and sclerotia formation evident.*

Source: CropPro

9.7.4 Conditions favouring development

The disease is usually established from sclerotia (survival bodies of the fungus) present in the soil or introduced with contaminated seed. Outbreaks are more common when very wet conditions occur in July.

The sclerotia germinate in moist soil and either directly infect roots or produce air-borne spores (Figure 17) which attack the above ground parts of the plant. Once established, the fungus rapidly moves to adjacent healthy tissue. Within a few days of infection, plants start to wither then die.

Figure 17: *Ascospore infection of chickpea stem by S. sclerotiorum*

Photo: G. Cumming. Source: Pulse Australia

Sclerotia formed on infected plants enable the fungus to survive to the following year. Individual seeds can be contaminated with the fungus and/or sclerotia may be present in the seed sample. Sclerotia can remain viable in the soil for up to eight years.

Soil-borne sclerotia are the most important disease source for establishing disease in following crops. Seeds infected with sclerotinia can be the cause of disease establishment in otherwise sclerotinia-free areas. [47]

9.7.5 Management of sclerotinia

Before sowing

Use clean seed

Use of disease-free seed minimises the risk of disease and prevents establishment into a new area. It is important to avoid sowing chickpea in areas where the disease is known to be present. The seed harvested from infected crops should not be used for sowing.

47 Crop Pro. Sclerotinia of Chickpeas. GRDC, http://www.croppro.com.au/crop_disease_manual/ch05s03.php

Crop rotation

Crop rotation is the best method of control once the disease has become established. Cereal crops are not affected by sclerotinia and provide a good disease break. Pulse crops, oilseeds, legume based pastures and capeweed are all good hosts to this disease.

If a severe sclerotinia problem does occur, at least a four-year break from susceptible crops is required to substantially reduce the number of sclerotia in the soil. A longer break may be required as sclerotes can survive in the soil for up to eight years. The most practical option is to use legumes such as field peas or vetch which have some resistance to sclerotinia. In addition, burning of the disease infected stubble should be considered. Deep ploughing (5 cm) will also reduce the number of sclerotia, and so minimise disease carry over. Where a minor sclerotinia problem occurs, a two-year break from susceptible crops is advisable.

No commercial seed treatments or fungicides are known to manage this disease in crop. [48]

9.8 Phytophthora root rot

Phytophthora root rot (PRR) is a disease of chickpea caused by the fungus-like oomycete *Phytophthora medicaginis*. It can cause significant yield losses in wetter than normal seasons or following periods of soil saturation in normal seasons. Lucerne, perennial and annual medics (*Medicago* species) and other leguminous plants including sulla (*Hedysarum* species) and sesbania (*Sesbania* species) can also host *P. medicaginis*. [49]

In northern New South Wales this disease is a serious constraint to production but is much less common in WA.

PRR is soil and water-borne and can establish permanently in a paddock. Fungicide treatment is expensive and will not provide season-long control of this disease. It can only be managed with pre-planting decisions in commercial situations—planting into low risk paddocks and sowing the most resistant variety available if sowing into a medium or high risk paddock. [50]

9.8.1 Varietal resistance or tolerance

See Table 3 at the start of this section for varietal disease ratings.

9.8.2 Damage caused by PRR

Damage is greatest in wetter than normal seasons or during periods of soil saturation in normal seasons. Only one saturating rain event is needed for infection. Once a plant or crop is infected with PRR, nothing can be done to treat the current crop. [51]

9.8.3 Symptoms

Infection by *P. medicaginis* can occur at any growth stage, causing seed decay, pre- and post-emergence damping off, loss of lower leaves, and yellowing, wilting and death of older plants (Figure 18). The disease is usually observed late in the season but may also affect young plants. Badly affected seedlings suddenly wither and die with no obvious disease symptoms.

48 Agriculture Victoria (2012) Sclerotinia of Chickpeas. http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/sclerotinia-of-chickpea

49 K Moore, M Ryley, M Schwinghamer, G Cumming, L Jenkins. Chickpea: Managing Phytophthora root rot. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/phytophthora-root-rot

50 GRDC. (2015). Phytophthora root rot in chickpea. https://grdc.com.au/Media-Centre/Hot-Topics/Phytophthora-root-rot-in-chickpea

51 GRDC. (2015). Phytophthora root rot in chickpea. https://grdc.com.au/Media-Centre/Hot-Topics/Phytophthora-root-rot-in-chickpea

Figure 18: *Cultivated areas killed by phytophthora. Only plants on tops of contours survived (left) and phytophthora in water course (right). (Photos: Mark Schwinghamer.*

Source: Pulse Australia

Infected plants are often stunted with obvious yellowing and drying of the foliage. They have few lateral roots and the lower portion of the tap root is often decayed (Figure 19). The remaining tap root is usually discoloured dark brown to black. Sometimes the discolouration can extend to the base of the plant. The advancing margins of the lesions may also have a reddish-brown discolouration.

Figure 19: *Severely affected plants have no lateral roots (right) and defoliation below tips of stems.*

Photo: Joe Wessels. Source: CropProp

Symptoms are sometimes delayed if temperatures are cool and the soil is moist. Lateral roots and tap root die, or dark brown/black lesions girdle the taproots (Figure 20).

Figure 20: *New roots forming from the top of the taproot.*

Photo: Mike Fuhlbohm. Source: Pulse Australia

On young plants the lesions may extend up the stem for 10 mm or more above ground level (Figure 21).

Figure 21: *PRR basal lesions extending up the plant stem.*

Photo: Mal Ryley. Source: Pulse Australia

Plants with Phytophthora can be easily pulled from the soil. If conditions are mild, affected plants may partially recover by producing new roots from the upper part of the tap root. [52]

9.8.4 Phytophthora and waterlogging

PRR and waterlogging have similar symptoms (Table 7) and are both induced by transient or prolonged soil saturation and surface water. They usually occur in low lying areas of paddocks, or where water accumulates such as on the low side of contour banks or in watercourses, or where the soil has been compacted or has hard pans. However, under very wet conditions, entire paddocks can be affected.

52 K Moore, M Ryley, M Schwinghamer, G Cumming, L Jenkins. Chickpea: Managing Phytophthora root rot. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/phytophthora-root-rot

Table 7: *Symptoms of PRR and waterlogging.*

Phytophthora root rot	Waterlogging
Organism kills roots	Low oxygen kills roots
Chickpea, medics, lucerne are hosts	No link with cropping history or weed control
Occurs any time of year	Usually occurs later in the year
Symptoms onset occurs after a week or more	Symptoms onset occurs quite rapidly
Lower leaves often yellow and fall off	Plants die too fast for leaves to yellow or fall
Roots always rotted and discoloured	Initially roots not rotted or discoloured (tips black)
Plants easily pulled up and out	Plants not easily pulled up initially
Manage through paddock rotation varietal choice	Manage through paddock selection, no irrigation in reproductive phase

Source: Pulse Australia

Symptoms of waterlogging can be confused with those of phytophthora but differ in that:

- Plants are most susceptible to waterlogging at flowering and early pod fill.
- Symptoms develop within two days of flooding compared to at least seven days for phytophthora.
- Roots are not rotted and are not easily pulled from the soil at first.
- Plants often die too quickly for the lower leaves to drop off.

9.8.5 Conditions favouring development

Phytophthora medicaginis survives in soil mainly as thick-walled oospores, but some strains also survive as chlamydospores. Oospores can survive in soil for at least 10 years. In saturated soil the exudates from the roots of chickpea and other hosts stimulate the oospores to germinate and produce lemon-shaped sporangia. Inside these sporangia, zoospores develop and are released into the soil and surface water, where they are carried by moving water and 'swim' towards the roots and collars of chickpea plants.

Zoospores encyst on the root surfaces and germinate to produce hyphae that invade the roots. New sporangia develop from infected roots, enabling further cycles of infection to occur. Later, oospores are formed in the infected roots.

Zoospores are only capable of 'swimming' for a few millimetres, so long distance dispersal of *P. medicaginis* is by physical movement of soil and water infested with oospores, sporangia, zoospores and/or chlamydospores during floods and irrigation or by machinery. [53]

9.8.6 Management of PRR

Once a plant or crop is infected with PRR, there is nothing a grower can do.

There are no effective chemical sprays as there are for Ascochyta and Botrytis. Therefore, Phytophthora can only be managed by pre-sowing decisions and assessing risks for individual paddocks.

Development of the disease requires both the pathogen in the soil, and a period of soil saturation with water. Losses in a Phytophthora-infested paddock may be minor if soil saturation does not occur.

53 K Moore, M Ryley, M Schwinghamer, G Cumming, L Jenkins. Chickpea: Managing Phytophthora root rot. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/phytophthora-root-rot

The most effective control strategy is to not sow chickpeas in high-risk paddocks, which are those with a history of:

- Phytophthora noted in previous chickpea or lucerne crops;
- lucerne or annual or perennial medics;
- waterlogging or poorly drained paddocks or prone to flooding; and/or
- metalaxyl-based seed dressings.

Do not flood irrigate after podding has commenced, especially if the crop has been stressed.

If you choose to sow chickpeas in high-risk paddocks, grow a chickpea variety with the highest level of resistance. Particularly in medium risk situations, where medic, chickpea or lucerne crops have been grown in the past 5–6 years. [54]

9.9 Root rots including Damping off (*Fusarium, Rhizoctonia* and *Pythium spp.)*

All fungi responsible for root rot are soil dwellers. They can survive from crop to crop in the soil, either on infected plant debris or as resting spores. In wet soils, these fungi can invade plant roots and cause root rot. Wet conditions also encourage the spread of disease within a field.

9.9.1 Economic importance

Root rot diseases can occasionally be serious, especially when soils are wet for prolonged periods. The reduced root development causes the plants to die when they are stressed.

9.9.2 Symptoms

Affected seedlings gradually turn yellow and leaves droop. The plants usually do not collapse. The taproot may become quite brittle, except in Pythium root rot when they become soft. When plants are pulled from the ground the 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 (Figure 22). The leaves and stems of affected plants are usually straw-coloured, but in some cases may turn brown. Older plants dry-off prematurely and are often seen scattered across a field. In some cases, especially with Kabuli, seeds may rot before they emerge.

54 K Moore, M Ryley, M Schwinghamer, G Cumming, L Jenkins. Chickpea: Managing Phytophthora root rot. Pulse Australia Ltd, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/phytophthora-root-rot

Figure 22: *Rhizoctonia root rot. Optimum soil temperature is 24–26°C; disease is worse on light sandy soils.*

Source: CropIT

9.9.3 Management options

Root rot disease can be reduced by crop rotation. As this disease may also affect other pulses, chickpea should be sown in rotation with another non-legume crop. Chickpea should not be grown in areas subject to waterlogging. Damping-off in Kabuli chickpeas can be controlled using fungicide seed treatment.

9.10 Collar rot (Sclerotium rolfsii)

9.10.1 Economic importance

Collar rot is generally a minor disease in chickpea. However, the disease has been particularly severe in irrigated Macarena (Kabuli).

9.10.2 Symptoms

This disease is commonly observed at very low levels in chickpea crops sown during warmer conditions (up to six weeks after sowing) as isolated dead seedlings with a coarse web of white fungal threads encasing the tap root. However, in irrigated systems, the fungus can kill significant numbers of plants. The coarse threads of the fungus can be seen on or just under the soil surface, colonising decomposing trash or on the plant itself (Figure 23); these webs of mycelium can cover quite a substantial area around plants. On chickpea, plants will be killed outright and quite rapidly as the fungus invades around the soil level and girdles the vascular tissue. Plants will wilt and become bleached (a result of a toxin produced by the fungus). Younger seedlings may collapse but older plants may simply dry (without collapse). The characteristic signs of the pathogen will be the webs of coarse mycelium and the small (~1–2 mm) spherical brown sclerotia (survival and resting structures) of the fungus that attach to the fungal threads. The sclerotia look like canola seeds.

Figure 23: *Webs of Sclerotium rolfsii mycelium at the base of an infected chickpea plant.*

Photo: K. McCosker

9.10.3 Conditions favouring development

The fungus has a very wide host range including monocots (such as millet and barley) and dicots (such as cotton). The pathogen is also the causal agent of white mould in peanuts.

The pathogen rarely occurs where average winter temperatures fall below 0°C. The fungus survives in the soil mainly as sclerotia that remain viable for 2–3 years, but occasionally persists as mycelium in infected tissues or plant residues. Sclerotia germinate by hyphal or eruptive germination. Hyphal germination is characterised by the growth of individual hyphae from the sclerotial surface, while eruptive germination is characterised by plugs or aggregates of mycelium bursting through the sclerotial surface.

9.10.4 Management options

The disease is favoured by the presence of undecomposed organic matter on the soil surface and excessive moisture. If possible, avoid wetting and drying cycles during warmer periods, as this promotes germination of the sclerotia, and try to minimise inter-row cultivation, which pushes soil up around the base of plants. The fungus is a very effective saprophyte of cotton trash, so allowing time for cotton trash to break down prior to planting will reduce the activity of the fungus. Similarly, trash from other crops such as barley and millet are attractive substrates for the fungus.

9.11 Fungal disease control

9.11.1 When to spray

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

Fungal disease control is geared around protection rather than cure. 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.

9.11.2 Principles of spraying

A fungicide spray at the commencement of flowering protects early podset. Additional protection may be needed in longer growing seasons until the end of flowering. Fungicides last around 2–3 weeks.

Remember that all new growth after spraying is unprotected. Coverage and canopy penetration is critical, as only treated foliage will be protected. Translocation is very low in most products.

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

Timing of fungicide sprays is critical (Table 8). As Ascochyta blight and BGM can spread rapidly, DO NOT DELAY spraying. A spray in advance of a rainy period is most desirable.

Despite some fungicide washing off, the disease will be controlled. Delaying until after a rainy period will decrease the effectiveness of the fungicide as the disease has started to spread.

Repeat fungicide sprays depend on:

- amount of unprotected growth
- rainfall since spraying
- likelihood of a further extended rainy period

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

Table 8: *Principles of when to spray for fungal disease control in chickpea.* [55]

Disease	Occurrence	When to spray
Ascochyta blight	First appears under wet conditions	Resistant variety. Fungicide sprays are unlikely to be required before podding. Despite good foliar resistance to Ascochyta blight, the flowers and pods of resistant varieties can be infected which can result in poor quality, discoloured seed or seed abortion and, in extreme situations, yield loss. Moderately resistant variety. In most seasons, disease development will be slow and there will be no or minimal yield loss. In such seasons there is no cost benefit in applying a fungicide during the vegetative stage. Despite good foliar resistance to Ascochyta blight, the flowers and pods of MR/R rated varieties can be infected, which can result in poor quality, discoloured seed or seed abortion and yield loss in severe situations. However, under high disease pressure, a reactive foliar fungicide strategy may be warranted during the vegetative period of the crop. If Ascochyta blight is present in the crop, apply a registered fungicide at early podding prior to rain to ensure pods are protected, and high quality, disease free seed is produced. Susceptible variety. If the season favours Ascochyta blight, regular fungicide sprays will be needed from emergence until four weeks before maturity. Do not wait until you find the disease. Timing of the first two sprays is critical, because control is difficult or impossible after the disease has taken hold. The first spray must be applied before the first post-emergent rain event, or three weeks after emergence or at the 3-leaf stage, whichever occurs first. The second spray should be applied three weeks after the first spray. However, apply the second spray if two weeks have elapsed since the first spray and rain is forecast. Continue to monitor the crop 10–14 days after each rain event. If Ascochyta blight is found, additional sprays will be required. If it has been ≥2 weeks since the last application, spray again just before the next rain event. For all varieties regardless of resistance. If Ascochyta blight is detected, apply a registered fungicide at early podding prior to rain. In high-rainfall or high-risk situations and where there is an extended pod-filling period, further applications may be required
Boytrytis grey mould	Develops during warm (15–20°C), humid (>70%) conditions, usually at flowering.	During early to mid-flowering as a protective spray. Additional sprays may be necessary through flowering and pod-filling if disease progresses. Disease is favoured by warm weather (15–20°C) and high humidity (>70% RH)

55 K Moore, M Ryley, G Cumming, L Jenkins. (2015) Chickpea: Ascochyta blight management. Pulse Australia, Australian Pulse Bulletin, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight

Table 9: *Carryover of major pulse diseases, showing relative importance as sources of infection.*

Disease	Stubble	Seed	Soil
Ascochyta blight	***	**	*
Botrytis grey mould	***	***	*
Phytophthora root rot			***
Sclerotinia	*	*	***

9.12 Viruses

Key points

- Chickpea is distinct from other pulses in respect to virus diseases and how viruses spread in crops.
- Aphicide sprays and some other control strategies that are effective in other pulses are less effective.
- At present, the best control options for chickpea are the current best agronomic practices: retaining standing stubble, using optimal sowing rates and times, and controlling in-crop and fallow weeds [56]
- Virus management aims at prevention through integrated management practice that involves controlling the virus source, aphid populations and virus transmission into pulse crops.
- Rotate legume crops with cereals to reduce virus and vector sources and where possible avoid close proximity to perennial pastures (e.g. lucerne) or other crops that host viruses and aphid vectors.
- Eliminate summer weeds and self-sown pulses 'green bridge' that are a host for viruses and a refuge for aphids.
- Aphid activity is influenced by seasonal conditions and will require early monitoring in nearby crops and pastures and possible use an aphicide or cultural controls to reduce numbers.
- Sow directly into cereal stubbles, (preferably standing) and encourage rapid canopy cover through early planting, high planting density as bare soil is more attractive to some aphid species.
- Purchase virus tested seed or have farmer seed virus tested as PSbMV, CMV, BYMV and AMV depend largely on seed transmissions for survival.
- Gaucho® 350SD is now registered and when applied as seed treatment will help protect faba bean, field pea and lentil seedlings from early season aphid attack and reduce virus spread.

Viruses differ from most fungal diseases in that they infect plants systematically and no curative treatment is available. Virus infections are spasmodic and levels depend heavily on seasonal conditions and differ greatly between years and locations. Early infection can lead to stunting, reduced tillering and plant death, and losses can be high. Late infections have less impact, but can still affect seed quality. [57]

There are more than 14 species of virus that naturally infect chickpea. These viruses are spread by airborne insects, with aphids being the predominant vector. The occurrence of virus in chickpea is episodic and changes dramatically from season to season and location. Clovers, medics, canola/mustard, weeds and other pulses can host viruses that infect chickpea. The best control strategies to reduce risk of viruses are agronomic. These include retaining cereal stubble, sowing on time, establishing a

56 Pulse Australia Ltd (2009) Australian Pulse Bulletin PA #10. Virus control in chickpea–special considerations.

57 Pulse Australia Ltd (2015) Australian Pulse Bulletin: Managing viruses in pulses. http://www.pulseaus.com.au/growing-pulses/publications/manage-viruses

uniform closed canopy and controlling weeds. [58] Seed and foliar insecticides are not recommended for chickpea viruses. [59]

9.12.1 Symptoms

Viruses exhibit a varied range of symptoms and severity from relatively unapparent to plant death. The intensity and symptoms depend on virus and pulse species and to a lesser extent on virus strain, pulse variety, climatic conditions and plant stage at infection. Plants infected at an early stage or through seed will usually show more uniform discoloration and stunting, but when infected at the later stage discolouration will usually occur at the leaf tip before the whole plant starts to deteriorate (Figure 24).

Figure 24: *Kabuli Chickpea (centre) with low plant stand and high virus infection compared to kabuli (right) and desi (left) with good canopy.*

Source: Pulse Australia. http://www.pulseaus.com.au/growing-pulses/publications/manage-viruses

Foliage symptoms are often more visible on young leaves and can include yellowing (sometimes reddening), vein clearing, leaf mottle, leaf distortion, curling of leaves, reduced size, chlorotic or necrotic spotting, or more widespread necrosis. Shoot symptoms may be seen as bunching of young leaves, growth of auxiliary shoots, bending over of the growing point, tip or apical necrosis, streaking of stems, stunting and wilting or plant death.

Symptoms such as leaf yellowing, veining, mottling, and wilting can often be confused with nutrient deficiencies, herbicide damage or water stress unless sufficiently distinct. It is also difficult to tell which virus is present without resorting to laboratory tests on plant samples.

It is best to collect living tissue samples, and collection and packaging of fresh samples is simple. Instructions from local agronomists or Pulse Australia need to be heeded. Immediately place the sample with paper towelling into a plastic bag, seal it and refrigerate it until dispatched. Send the sample by priority post and do not leave it sitting around. [60]

9.12.2 Conditions favouring development

High levels of virus infections have occurred in recent years, resulting from infected plants in the previous spring as a virus source and a 'green bridge' of summer plant material to carry over these viruses and as a refuge for aphids. Warm dry conditions during autumn have favoured increased aphid activity and virus transmission.

Some aphid species prefer to land on plants surrounded by bare ground, and favour thin crop stands or areas within the crop which have low plant densities.

58 M Schwinghamer, T Knights, K Moore (2009). Virus control in chickpea--special considerations. Australian Pulse Bulletin PA 2009 #10

59 A Verrell (2013) Virus in chickpea in northern NSW 2012. GRDC Update Papers. 26 Feb 2013, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Virus-in-chickpea-in-northern-NSW-2012

60 Pulse Australia Ltd (2015) Australian Pulse Bulletin: Managing viruses in pulses. http://www.pulseaus.com.au/growing-pulses/publications/manage-viruses

Stressed plants are also more attractive to aphids, possibly due to a higher level of plant sugars, and are vulnerable to colonisation and can become a source of virus spread. Environmental factors that impacted on chickpeas in 2009 were extremely dry conditions early in the season that favoured aphid build. This was particularly evident in vetch crops. Then followed cold and wet conditions that included some transient water logging that stressed plants, making them more venerable to root diseases and aphid attack.

Chickpea that border lentil, canola or lucerne crops can be subjected to larger numbers of aphids, as they can readily colonise these crops and multiply quickly. Controlling aphids in these nearby host crops can potentially decrease aphid numbers moving through chickpea crops.

Types of transmission

Pulse viruses are transmitted either in a persistent or non-persistent manner by insects (mostly aphids). The mode of transmission has implications for the way a virus develops in the field and its management.

Persistently transmitted viruses

- Bean leafroll virus (BLRV)
- Beet western yellows virus (BWYV) (Figure 25)
- Subterranean clover red leaf virus (SCRLV)
- Subterranean clover stunt virus (SCSV)

Figure 25: *Beet Western Yellows Virus in kabuli (top) and in desi (bottom).*

Source: CropPro.

The general symptoms of BLRV on pulses are interveinal chlorosis, yellowing, stunting and leaf rolling (Figure 26). These symptoms could easily be confused with subterranean clover stunt virus (SCSV) or other luteoviruses such as beet western yellows virus (BWYV) and subterranean clover red leaf virus (SCRLV) or nutrient stress symptoms. [61]

Figure 26: *Chickpeas develop tip yellowing and stunting.*

Photo: S Kumari, ICARDA, Source: AgVic.

Persistent transmission means that once the insect becomes infectious, it remains so for the rest of its life. After an insect vector feeds on an infected plant, the virus has to pass through its body and lodge in the salivary glands before it can be transmitted to healthy plants. Not all aphid species are vectors of this kind of virus in pulses, so the identification of aphid species is very important.

BWYV is the main virus most commonly occurring in chickpea and lentil crops. It has a diverse natural host range including canola, pasture plants, lucerne and many weeds such as paddy melons, wild radish and some native legumes. BLRV is another, but is limited to fabacae (faba bean, field pea, chickpea, and lentil), lucerne, clovers and summer legumes.

Persistently transmitted viruses typically start with a random distribution of infected plants in autumn and increases during the season as vectors colonise the crop. Transmission rates can dramatically increase with large aphid flights that will often coincide with aphid activity and build up prior to sowing.

Non-persistently transmitted viruses

- Alfalfa mosaic virus (AMV)
- Bean yellow mosaic virus (BYMV)
- Cucumber mosaic virus (CMV)
- Pea seedborne mosaic virus (PSbMV)

Non-persistently transmitted viruses can be seed-borne (depending on the virus/crop combination), but require aphid vectors to spread during the season. [62]

9.12.3 Management of viruses

A virus management strategy to reduce the risk of infection may require a number of control measures relevant to the various virus and pulse types.

Better agronomy—better chickpeas

Field trials from 2012 and 2013 have shown that chickpea crops are at risk of increased damage from viruses when plant density is less than 20 plants/m^2. Significantly fewer plants are infected when plant densities are higher, and it is recommended to aim for over 25 plants/m^2.

61 Agriculture Victoria. (2013). Temperate pulse viruses: Bean leafroll Virus. http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/temperate-pulse-viruses-bean-leafroll-virus-blrv

62 Pulse Australia Ltd (2015) Australian Pulse Bulletin: Managing viruses in pulses. http://www.pulseaus.com.au/growing-pulses/publications/manage-viruses

Trial crops deficient in nitrogen, potassium, phosphorus or all three have been shown to have significantly more virus-affected plants than a crop with adequate nutrition.

Inter-row planting into standing wheat stubble significantly reduced virus incidence in small trial plots of PBA HatTrick⟑ compared with the same amount of stubble slashed low to the ground. The mechanism for this difference is unclear, but these results are in agreement with many field observations in large crops during virus outbreaks.

Although differences in virus resistance have been observed for different varieties, further screening is needed to strengthen confidence in these results under high disease pressure in different growing regions, and to identify for which virus species resistance is effective. Under low virus pressure in field trials, some of the better performing varieties included Flipper⟑ and PBA HatTrick⟑. However, both these varieties have been observed with high rates of infection under high disease pressure. The variety Gully is very susceptible to Ascochyta blight, but has moderate virus resistance so may be useful for breeding resistance into future varieties.

While a link could not be confirmed in the 2013 season between BWYV infections in canola and subsequent spread into nearby chickpea crops (van Leur et al. 2014), the sometimes high incidence of BWYV in canola indicates it may be prudent to avoid planting chickpea and other pulse crops next to canola. [63]

Best agronomic management can help to reduce damage by viruses and includes:

- Retain standing stubble, which can deter migrant aphids from landing. Where possible, use precision agriculture to plant between stubble rows. This favours a uniform canopy, which makes the crop less attractive to aphids.
- Plant on time and at the optimal seeding rate. These practices result in early canopy closure, which reduces aphid attraction (Figure 27).
- Ensure adequate plant nutrition.
- Control in-crop, fence line and fallow weeds. This removes in-crop and nearby sources of vectors and virus.
- Avoid planting adjacent to lucerne stands. Lucerne is a perennial host on which legume aphids and viruses, especially AMV and Bean leaf roll virus (BLRV), survive and increase.
- Seed treatment with insecticides, e.g. imidacloprid, are not effective for non-persistently transmitted viruses but may be effective for luteoviruses. Unfortunately, local data supporting seed treatment is lacking.
- Given the high incidence of Beet western yellows virus (BWYV) sometimes found in canola, consider growing chickpeas (and other pulse crops) away from canola. [64]

63 M Sharman, K Moore, J van Leur, M Aftab, A Verrell (2014) Viral diseases in chickpeas—impact and management. GRDC Update Papers 4 March 2014, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Viral-diseases-in-chickpeas-impact-and-management

64 K Moore, M Ryley, M Sharman, J van Leur, L Jenkins, R Brill (2013) Developing a plan for chickpeas 2013. GRDC Update Papers 26 Feb 2013, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Developing-a-plan-for-chickpeas-2013

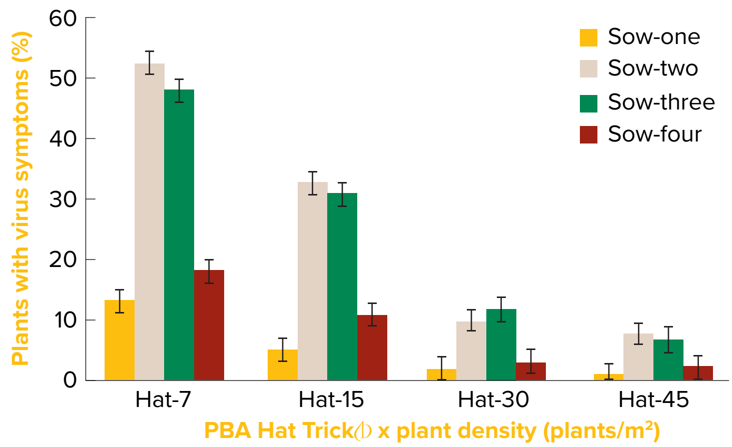

Figure 27: *Proportion of plants with virus symptoms for sowing date by plant density for PBA HatTrick⊅.*

Source: A Verrell (2013) Virus in chickpea in northern NSW 2012. GRDC Update Papers. 26 Feb 2013

Row spacing and incidence of plants with virus symptoms

Row spacing had a significant effect on incidence of plants with virus symptoms in a 2013 trial. On 11 October 2013, there were more than twice as many symptomatic plants/m^2 in plots with 40 cm rows compared to those with 80 cm rows (Figure 28). Both row configurations were sown at 30 plants/m^2 so plant density per unit area cannot account for the difference. Rather, plant density within each row appears to be responsible (12 plants/m row at 40 cm and 24 pl/m row at 80 cm).

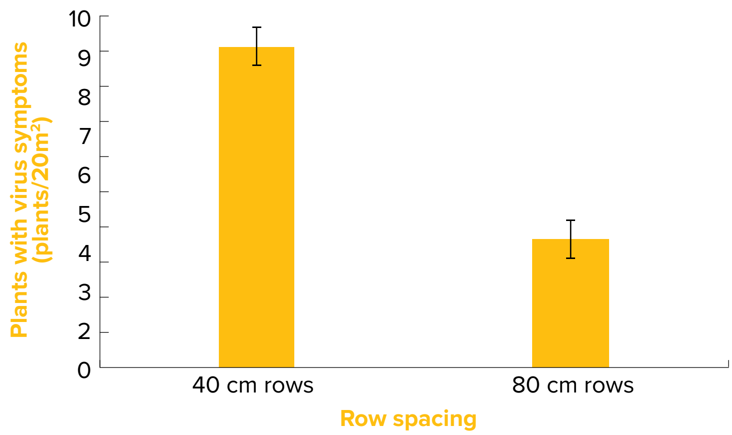

Figure 28: *Effect of row spacing on incidence of chickpea plants with virus symptoms.*

Source: GRDC

Stubble management and incidence of plants with virus symptoms

Planting into standing cereal stubble is known to help reduce risk of virus in lupin crops. Retaining standing cereal is believed to be useful in reducing risk of virus in chickpea crops, though research providing such evidence is limited.

Two trials were conducted in 2013 to compare standing versus flat (slashed) wheat stubble on incidence of plants with virus symptoms. One trial was sown at 80 cm row spacing; the other at 40 cm spacing; both were sown with PBA HATTRICK chickpea at 30 plants/m^2. The 80 cm trial was assessed on 11 October and the 40 cm trial was assessed on 9 October and again on 16 October. In both trials, incidence of plants with virus symptoms was lower where the chickpeas had been sown into standing stubble (Figure 29). Individual plots in these trials were small, 2 m × 10 m for the 80 cm trial and 4 m × 10 m in the 40 cm trial. [65]

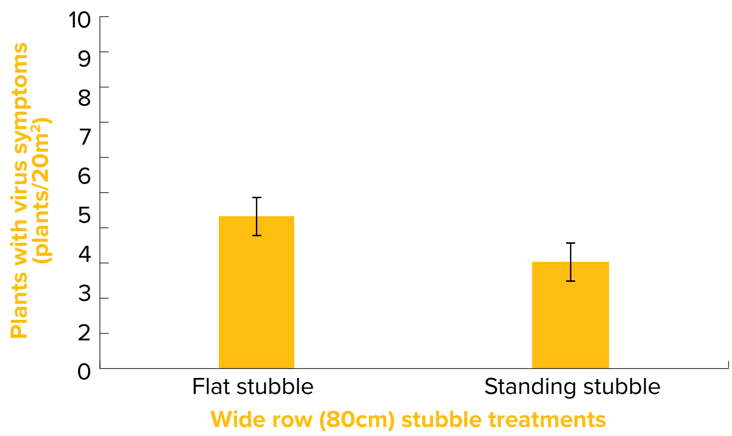

Figure 29: *Effect of stubble management (flat v. standing) on incidence of chickpea plants with virus symptoms.*

Source: GRDC

Non-persistently transmitted viruses

With non-persistently transmitted viruses (e.g. CMV, BYMV, AMV, and PSbMV) the initial and main source of infection is contaminated seed, with further transmission in-crop by aphids.

Management steps include:

- Source healthy seed that has been tested free of CMV, BYMV, AMV and PSbMV virus. Tested seed should have less than 0.1% virus infection and field peas should have less than 0.5% for PSbMV.
- Farmer-retained seed should only come from crops with no visible virus symptoms and seed testing should be a priority.
- Some cultivars have virus resistance such as CMV in many new lupin varieties and in Jenabillup (available in 2011). Yarrum field pea has resistance to BLRV and PSbMV. Increased emphasis on virus resistance is a priority of Pulse Breeding Australia.
- Controlling aphids in-crop is not an effective means of controlling non-persistently transmitted types of viruses.
- Sow direct into retained cereal stubble and preferably standing, as some aphid species are attracted to bare earth. This has been effective in minimising CMV spread in lupins.

Persistently transmitted viruses

Persistently transmitted viruses (e.g. BLRV, BWYV, SCSV) are not seed-borne. The virus is transmitted from live infected plants to healthy plants primarily by aphids or other insect vectors.

65 K Moore K, A Verrell, M Aftab (2014) Reducing risk of virus disease in chickpeas through management of plant density, row spacing and stubble. GRDC Update Papers 04 March 2014, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Reducing-risk-of-virus-disease-in-chickpeas

An integrated management strategy involves the use of both cultural and chemical measures that aim to eliminate any virus sources, minimise aphids and deter aphids from entering the crop. Often by the time aphids are detected, the virus spread has already occurred.

Management steps include:

- Minimise the 'green bridge' for virus and aphid survival over summer. Control volunteer pulses, legumes and weeds well before sowing and early crop weeds that may carry viruses and aphids.
- Minimise bare earth through sowing into previous cereal stubbles and early sowing with adequate plant population (germ and vigour test seed). Use narrow rows in the absence of stubble to minimise exposed bare soil to deter aphids entering the crop.
- Avoid crop stress through good paddock selection (soil type, no hard pan, low weed burden) adequate nutrition, no herbicide stresses and good inoculation.
- Avoid sowing pulses close to each other and broadleaf crops such as canola, and be aware of proximity to perennials (e.g. lucerne).
- Monitor crops and neighbouring areas using a sweep net or beat sheet. Yellow sticky traps on crop perimeters can also be a handy check for aphid presence. Identify the species present and be prepared to use a 'soft' insecticide such as pirimicarb if there is a chance of localised flights.
- Use of 'soft' insecticides soon after emergence has been shown to help control persistently transmitted viruses only. Use of an SP is controversial as while it prevents early colonisation due to 'anti feed' properties, it can also agitate aphids not controlled and increase virus spread. It should not be used when green peach aphid is present as this major vector for BWYV has resistant populations. Impact on natural beneficials could also lead to higher aphid build-up. [66]

MORE INFORMATION

Impact and management of viral diseases in chickpeas

Virus control in chickpea – special considerations

Managing viral diseases in chickpeas through agronomic practices

66 Pulse Australia Ltd (2015) Australian Pulse Bulletin: Managing viruses in pulses. http://www.pulseaus.com.au/growing-pulses/publications/manage-viruses