SOUTHERN
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GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

FIELD PEA

SECTION 9

DISEASES

Diseases

Key points

- **Field pea yields can be significantly impacted by diseases.**
- **Field pea requires good disease management to produce a high quality product of a suitable standard for human consumption markets.**
- **The key diseases of field pea in the southern region are caused by fungal pathogens: Ascochyta blight (blackspot), followed by bacterial blight, powdery mildew and downy mildew. Pea seed-borne mosaic virus can also result in significant costs to the industry.**

9.1 Impact and cost of diseases

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

Most field pea (79% of the area sown) is grown in the southern region, with the remainder grown in the western region and, in recent years, the northern region.

Diseases in the Australian field pea industry cause an estimated current average annual loss of $23.7 million, or $78.35/ha. Nationally, these losses were dominated by: Mycosphaerella blackspot, Koolunga blackspot, blackspot complex and Phoma blackspot, which are all part of Ascochyta blight ('blackspot complex').

The 2012 study estimated the potential losses caused by the top five diseases when uncontrolled (Table 1).

Table 1: The potential losses by the top five diseases when uncontrolled.

Disease	$/ha	$million
Mycosphaerella black spot	60.16	18.2
Koolunga black spot	57.11	17.3
Black spot complex	54.20	16.4
Phoma black spot	24.63	7.5
Pea seed-borne mosaic virus	22.48	6.8

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

In Table 1, all diseases except for Pea seed-borne mosaic virus are collectively known as Ascochyta or 'blackspot complex' and are difficult to distinguish in the field. Approximately two-thirds of the national costs are attributed to the southern region.

Most field pea crops in the southern region are treated either with seed or foliar fungicides, costing about $7 million a year or $30/ha.[1]

9.2 Integrated disease management (IDM) strategies

Disease management in pulses is critical and relies on an integrated management approach to variety choice, crop hygiene and strategic use of fungicides. The initial source of the disease (primary inoculum) 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 (secondary inoculum).

A plant disease may be devastating at certain times and yet, under other conditions, it may have little impact. The interaction of host, pathogen and environment are all critical in disease development and can be represented by the two disease triangles (Figure 1 and Figure 2).

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

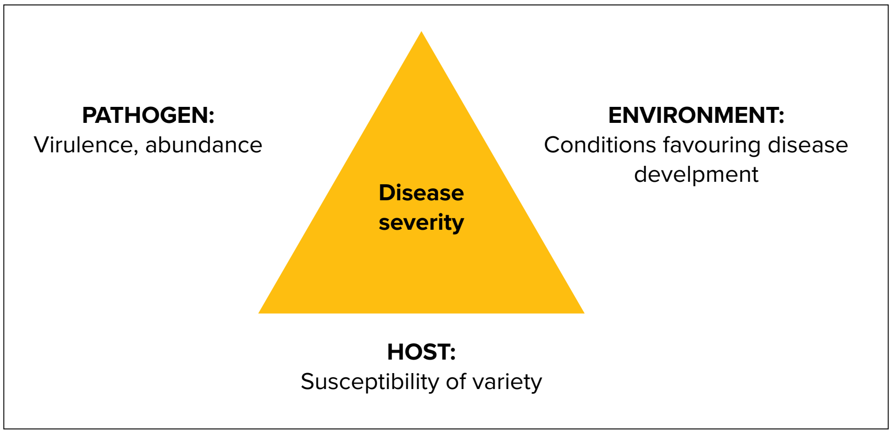

Figure 1: *Fungal disease triangle.*

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

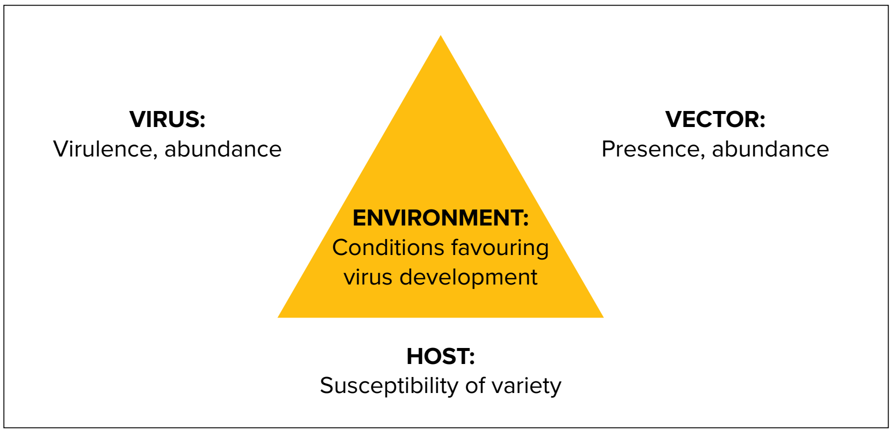

Figure 2: *Viral (and some bacterial) disease triangle.*

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

Disease management should be a consideration when planning any rotation, particularly at the beginning of the season. This is especially important for field pea where the first action of defence against diseases begins with varietal selection. Naturally, other criteria, such as paddock selection, seed quality and treatment, are also vitally important.

Determine which diseases are the highest priorities to control in the pulse crop being grown and, if possible, sow a variety that is resistant to those diseases. Strategic fungicide application combined with paddock selection is also part of an 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.

The key aspects of managing diseases in pulses are detailed in Section 9.3 to Section 9.10 In summary:

- **Varietal resistance** – select a resistant variety
- **Distance** – separate by at least 500 m from stubble of the same pulse from the previous year, if possible. This reduces infection sources for some diseases.
- **Rotation** – aim for at least a 4-year rotation between planting the same pulse crop. A high frequency of crops like lentil, faba bean, vetch, field pea, chickpea, lupin or clover pasture puts pulses at greater risk of multi-host diseases such as Phoma blackspot, Sclerotinia and Botrytis grey mould. Canola can increase the risk of Sclerotinia.

- **Hygiene** – practice good hygiene by reducing last year's pulse stubble, if erosion is not a risk, and removing self-sown pulses before the new crop emerges.
- **Clean seed** – sow seed from crops with no disease or a low level of disease, especially at podding. Avoid using seed where there was a known disease infection, particularly for susceptible varieties. Have seed tested for disease.
- **Fungicide seed dressing** – in high-risk situations seed dressings provide early suppression of diseases like Ascochyta blight (blackspot). Seed dressings containing imidacloprid, used to control aphids, may reduce the chance of virus infection.
- **Sowing date** – do not sow too early, to avoid excessive vegetative growth and early canopy closure. Early crop emergence may coincide with greater inoculum pressure from old crop residues nearby. Aim for the optimum sowing window for the pulse variety and your district. Use 'Blackspot Manager' to help determine the optimum sowing window.
- **Sowing rate** – aim for the optimum plant population (depending on region, sowing time, crop type, variety), as denser canopies can lead to increased disease severity. Adjust the seeding rate according to seed size and germination. See Section 4.3 Sowing rate and plant density.
- **Sowing depth** – sowing deeper than normal any seed lot that is infected with disease will reduce the emergence of infected seedlings. The seeding rate should be adjusted upwards to account for lower emergence and establishment percentage.
- **Foliar fungicide applications** – susceptible varieties require a more intense fungicide program. Success depends on timing, weather conditions that follow and the susceptibility of the variety grown. Monitoring for early detection and correct disease identification is essential. Correct fungicide choice is also critical.
- **Mechanical damage** – physical damage from excessive traffic, wind erosion, frost, hail, post-emergent rolling or herbicide damage can increase the spread of foliar disease in pulses.
- **Control aphids** – integrated pest management (IPM) to reduce the incidence of aphids can reduce the spread of viruses. Spraying insecticide may assist, but is not always effective or economic. Usually virus spread has occurred by the time the aphids are detected.
- **Harvest** – harvest early to minimise disease infection on seed. Consider windrowing or desiccation as a tool to enable earlier harvesting.[2]

2 Pulse Australia (2016). Southern Faba & Broad Bean – Best Management Practices Training Course, module 6-2016. Pulse Australia Limited

9.3 Select a resistant variety

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

The variety resistance ratings are defined as follows:

- Resistant (R) varieties – no economic yield loss is expected under average conditions. Control measures are unlikely to be profitable. Resistant varieties are not immune when conditions are conducive to disease.
- Moderately resistant (MR) varieties are expected to sustain low to moderate yield loss and control measures are likely to be cost effective.
- Moderately resistant to moderately susceptible (MR-MS) varieties are expected to sustain moderate to high losses and control measures are necessary to ensure a profitable crop.
- Moderately susceptible (MS) or worse varieties (susceptible (S) to very susceptible (VS)) will sustain very high to total yield loss and control measures are essential to produce a harvestable crop.[3]

No variety has resistance to all of the field pea diseases. Therefore, it is important to select the correct fungicide and application timing to best manage the target disease in the chosen variety. Control strategies vary according to the variety being grown.[4]

The disease ratings in Table 2 are from early 2016. Always check the updated disease ratings each year in the current Crop Variety Guides for each state or in the NVT Crop Disease Au app.

Table 2: Field pea disease ratings for 2017.

Variety	Blackspot (Ascochyta)	Bacterial blight (Field rating)	Downy mildew		Powdery mildew	PSbMV Pea seed-borne mosaic virus	BLRV Bean leaf roll virus (field rating)	Root-lesion nematodes (*Pratylenchus*)	
			Kaspa strain	Parafiels strain				*P. neglectus*	*P. thornei*
Yellow pea grain type									
PBA Hayman$^{\phi}$	S$_p$	MR$_p$	–	RMR	R	–	–	–	–
PBA Pearl$^{\phi}$	MS	MS	S	R	S	S	R	MRMS	MRMS
Sturt	MS	MS	S	MS	S	S	MS	MS$_p$	MR
Kaspa grain type									
Kaspa$^{\phi}$	MS	S	S	MR	S	S	S	MRMS	MRMS
OZP1101	MS	MRMS$_p$	MS	R	S	S	S	MRMS	MRMS
PBA Gunyah$^{\phi}$	MS	S	S	R	S	S	S	MR	MRMS
PBA Twilight$^{\phi}$	MS	S	S	R	S	S	S	MRMS$_p$	MRMS
PBA Wharton$^{\phi}$	MS	S	S	MS	R	R	R	MRMS$_p$	MR$_p$
Australian dun grain type									
Morgan$^{\phi}$	MS	MS	S	MR	S	S	*Sp*	RMR$_p$	MR$_p$
Parafield	MS	MS	S	S	S	S	S	MRMS	MR$_p$
PBA Coogee$^{\phi}$	S	MRMS$_p$	–	S$_p$	R	–	S$_p$	MRMS$_p$	MR$_p$
PBA Oura$^{\phi}$	MRMS$_p$	MRMS	MRMS	MR	S	S	MR	MRMS$_p$	MRMS$_p$
PBA Percy$^{\phi}$	MS	MR	S	S	S	S	S	MRMS	RMR$_p$

Disease ratings from Pulse Breeding Australia. Resistance order from best to worst: R > RMR > MR > MRMS > MS > MSS > S > SVS > VS. R = resistant, M = moderately, S = susceptible, VS = very susceptible p = provisional ratings – treat with caution

Source: Sigel *et al.* (2016) http://agriculture.vic.gov.au/__data/assets/pdf_file/0008/294893/VIC-Pulse-disease-guide-2017.pdf

3 L Sigel, J Brand, J Fanning (2017) Pulse Diseases Guide 2017. Agriculture Victoria, http://agriculture.vic.gov.au/__data/assets/pdf_file/0008/294893/VIC-Pulse-disease-guide-2017.pdf

4 Pulse Australia (2016) Faba bean: Integrated disease management. Pulse Australia website, http://www.pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/idm-strategies

9.4 Paddock selection

The selection of the most appropriate paddock for growing field pea requires consideration of a number of important factors, many of which are related to the modes of survival and transmission of pathogens such as *Didymella pinodes* (synonym *Mycosphaerella pinodes*), which causes Ascochyta blight (blackspot) on field pea, or *Peronospora viciae*, which causes downy mildew.

Rotational crops and weeds

If possible, allow at least 4 years between growing field pea crops in the same paddock and at least 500 m distance from the previous year's pea crop.

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

Some diseases have potential for cross-infection across more than one pulse crop (Table 3).

Table 3: Field pea diseases and potential for cross-infection from other pulses.

	Field pea	Lentil	Faba bean	Vetch	Chickpea	Lupin
Botrytis grey mould *Botrytis cinerea*	★	★★	★	★★	★★	★
Bacterial blight *Pseudomonas syringae* pv *syringae*	★★	★	★★			
P syringae pv *pisi*	★★					
Blackspot *Mycosphaerella pinodes*	★★	★★				★
Phoma koolunga	★★	★	★	★	★	
Phoma medicaginis var *pinodella*	★★					
Downy mildew *Peronospora viciae*	★★	★	★	★	★	
Powdery mildew *Erysiphe pisi*	★★					
Root rots *Fusarium* sp.	★	★	★	★	★	★
Pythium sp.	★	★			★	★
Rhizoctonia sp.	★★	★★	★★	★★	★	★★
Septoria *Septoria pisi*	★★					
Sclerotinia spp.	★	★	★	★	★	★
Stem nematode *Ditylenchus dipsaci*	★★	★	★★	★	★	
Virus Non-seed-borne (e.g. BLRV)	★★	★	★★	★★	★★	
Seed-borne (e.g. PSbMV)	★★	★★	★★	★★	★★	

★ This disease occurs on this crop but has not caused major damage. ★★ This disease has caused major damage on this crop. Blank indicates plant is not a host. Pythium and Botrytis grey mould is worse (★★) in white peas than in duns (★)

Source: Grain Legume Handbook

The previous occurrence of soil-borne diseases like Sclerotinia stem rot, *Pratylenchus* nematodes or stem nematode can constitutes a risk for subsequent field pea crops for up to 10 years. Sclerotinia can be hosted by canola, other pulses and many broadleaf weed species.

Some of the viruses affecting field pea also have wide host ranges. Weeds, particularly perennial legumes, host viruses and their aphid vectors e.g Cucumber mosaic virus (CMV).

Herbicide interactions

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

To avoid damage ensure the maximum plant-back periods for herbicides are adhered to for triazine, clopyralid, imidazolinone and sulfonylurea herbicides, which are known to predispose plants to disease.

Currently there are no herbicide-tolerant ('XT') field pea varieties available for commercial production.

When diagnosing damage in the field it can be difficult to determine whether the cause of damage is disease or herbicide or a combination of both.[5]

9.5 Good crop hygiene

Pathogens such as Ascochyta blight (blackspot) can be transmitted via infested stubble, soil and seed (Table 4). Soil and stubble movement may occur by machinery, during windy and/or wet weather, and flooding. Therefore, it is essential that headers and sowing equipment be thoroughly cleaned to remove grain, soil and stubble before moving from property to property and, if possible in particularly high-risk disease situations, between individual paddocks. The logistics of actually doing this may be difficult when it comes time to harvest, however growers need to be aware that certain decisions that they or their contractor make may increase the risk of certain diseases in the future.

Table 4: Carryover of major field pea diseases. The relative importance as sources of infection is indicated by the number of stars, with three stars being the most important.

Disease	Stubble	Seed	Soil
Ascochyta blight (blackspot)	★★★	★★	★
Bacterial blight	★★★	★	★
Downy mildew	★★★	★★	★
Powdery mildew	★★★	★	★
Septoria blight	★★★	★★	★

Source: Pulse Australia (2016). Southern/western field pea best management practices training course, module 6-2016 DRAFT.

Control of volunteer field pea during the summer–autumn season and in fallows is vital to reduce the carryover of inoculum of Ascochyta blight (blackspot) and bacterial blight pathogens. Some broadleaf weeds are alternative hosts for one or more of the viruses that affect field pea, and should be removed prior to planting and during crop growth.

Spray rigs should also be cleaned to reduce the risk of disease transmission, particularly if contractors are used. This is especially so with *Ascochyta rabeii* in chickpea, bacterial blight in field pea and anthracnose in lupin. Section 9.13 Ascochyta blight (AB) for further details on field pea.

Floodwaters may also transport disease agents. Floods during January 2011 would have moved field pea stubble infested with Ascochyta blight fungi, as well as soil and weeds harbouring the pathogen.[6]

5 GRDC (2009) Field Peas: The Ute Guide, Southern region. GRDC https://grdc.com.au/resources-and-publications/all-publications/publications/2009/04/field-peas-the-ute-guide

6 Pulse Australia (2016). Southern/western field pea best management practices training course, module 6-2016 Draft. Pulse Australia Limited

9.6 Use clean seed

Use only seed of high quality (purity, germination and vigour). Source seed from a paddock where diseases, particularly those that affect pods, were not detected. A crop known to have been heavily affected by Ascochyta blight (blackspot) or bacterial blight should not be used for seed.

Treatment of seed with a fungicide dressing is recommended to control seed-borne diseases like Ascochyta blight (blackspot) or where damping off, seedling root rots and other soil-borne fungal diseases have been known to cause problems (Table 5).

9.6.1 Seed dressings

Seed dressings registered for use with field pea are shown in Table 5.

Table 5: Seed dressings registered for field pea.

Active ingredient	**Thiram**	**Thiram + thibendazole**
Example trade name	**Thiram**	**P-Pickel® T**
Ascochyta blight (blackspot) *Didymella pinodes* (synonym *Mycosphaerella pinodes*), *Phoma medicaginis* var. *pinodella*, and *Ascochyta pisi.*	NR	R
Downy mildew	NR	NR
Damping off	-	R
Phytopthora root rot	-	-
Seedling root rots (*Pythium* spp. and *Fusarium* spp.)		R
Jurisdiction	All states	All states

R = Registered product label claim. NR = not registered for use in this crop.
Refer to the current product label for complete 'Direction for Use' prior to application.
Prior to the use of any crop protection product, ensure that it is currently registered or that a current permit exists for its use in field pea.
Registered labels and current permits can be found on the APVMA website (www.apvma.gov.au).

Source: Pulse Australia (2016). Southern/western field pea best management practices training course, module 6-2016. Pulse Australia Limited Table 6.2

Do not mix rhizobia inoculant with fungicide seed dressings. Apply the fungicide seed dressing first and then apply the inoculant as a second operation sometime later after the fungicide has dried and immediately prior to seeding.[7]

9.7 Sowing

9.7.1 Sowing date

Plant during the optimum sowing window for your region. The recommended sowing times are in Section 4.2 Table 1 Optimum sowing times for southern Australia.

Avoid sowing too early as earlier planting often leads to excessive vegetative growth, which predisposes crops to Ascochyta blight (blackspot), bacterial blight and frost damage. Use 'Blackspot Manager' to determine the best time to sow.

9.7.2 Sowing rate and row spacing

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

Reduced humidity can be achieved by reducing the sowing rate, increasing the row spacing and by achieving good weed control.[8]

7 Pulse Australia (2016). Southern/western field pea best management practices training course, module 6-2016 Draft. Pulse Australia Limited

8 F Stoddard, A Nicholas, D Rubiales, J Thomas, AM Villegas-Fernandez (2010) Integrated pest management in faba bean. Field Crops Research, 115, 308–318, https://www.researchgate.net/publication/229612261_Integrated_pest_management_in_faba_bean

Optimum plant populations for most field pea varies with field pea type see Section 4.3 Table 3 Suggested plant density and seeding rate for field pea varieties.

For tall field pea varieties' seed (e.g. 13–23 g/100 seeds), optimum plant populations can vary from 30–60 plants/m^2.

For Kaspa$^{\text{(b)}}$ field pea (e.g. 22 g/100 seeds), optimum plant populations can vary from 40–60 plants/m^2.

For medium type with less vigour (e.g. 22 g/100 seeds), optimum plant populations can vary from 40–60 plants/m^2.

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

Row spacing can be varied for field pea, but wider rows are only used if sowing is into standing cereal stubble to minimise lodging at harvest. Medium–wide row spacings (25–36 cm) may allow more air movement between rows in to assist disease control.

To avoid potential 'hotspots' for disease, consider 'tramlining' and controlled-traffic. Physical damage to the crop from machinery travelling over the paddock can be a major cause of disease outbreaks.

Some growers believe that sowing in wide rows in a north–south direction improves podset and disease control.[9]

9.8 Free alert services for diseases

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

South Australian Research and Development Institute (SARDI):

- Crop Watch disease newsletter by email. Subscribe by emailing DK Communications (dvkam@iprimus.com.au).
- Follow the Crop Watch twitter account @CropWatchSA
- Like the @Cropwatch Facebook page

Agriculture Victoria:

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

Southern NSW and northern Victoria:

- NSW DPI and GRDC provide the Crop Disease Bulletin for advisers in southern NSW and northern Victoria. To subscribe contact Kurt Lindbeck (kurt.lindbeck@dpi.nsw.gov.au) or Andrew Milgate (andrew.milgate@dpi.nsw.gov.au).

Australia-wide:

- GrowNotes™ Alert on the latest weed, pest and disease issues in your area delivered via App, SMS, voice, email, social media or web portal (or a combination of preferred methods). Subscribe to this GRDC and Agriculture Victoria service at https://grdc.com.au/resources-and-publications/grownotes/alerts
- For disease issues across Australia follow ExtensionAUS on Twitter @AusCropDiseases or Facebook.

More information about free information services is available at http://extensionhub.com.au

9 GRDC (2009) Field Peas: The Ute Guide, Southern region. GRDC https://grdc.com.au/resources-and-publications/all-publications/publications/2009/04/field-peas-the-ute-guide

9.9 Using fungicides

The legal considerations for using fungicides are the same as for herbicides see Section 7.4 Using herbicides. In particular, watch the withholding periods (period before grazing stubbles, cutting/bailing straw/hay).

9.9.1 Registered products

Managing foliar disease in field pea is all about reducing the risk of infection. Most fungicides are preventative and need to be sprayed before disease is evident. Fungicides protect against new infection, but do not cure existing infection. Getting the timing right is critical.[10]

Unprotected crops can lose over 50% in grain yield. Grain quality can also be affected if seed is discoloured by disease.

Foliar fungicides are important for the management of Ascochyta blight (blackspot) in all varieties.

Monitoring for early detection and correct disease identification is essential. Ensure any disease is correctly identified to make sure the correct fungicide is selected. Controlling disease with fungicides depends on:

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

Fungicides last around 2–3 weeks. Any new growth after fungicide is applied is not protected. In periods of rapid growth and intense rain (50 mm over several days) the protection period will reduce to around 10 days.

The need for and timing of repeat fungicide sprays depends on:

- the amount of unprotected growth;
- rainfall since spraying; and
- the likelihood of a further extended rainy period.[11]

Plan ahead to ensure that fungicides can be applied as soon as a decision is made. Do not compromise a fungicide spray to wait until it can be combined with a herbicide application. Ideally, spray 1–2 days before significant rain is forecast. Don't delay if rain has already started. A light rain of less than 12 mm can increase the efficacy of mancozeb.

Good leaf coverage with lots of fine droplets will maximise the benefit. Use high water rates. For ground application use 100 L water/ha unless a different minimum rate is specified on the label.

The registered fungicides for Ascochyta blight (blackspot) in field pea are mancozeb, metiram, chlorothalonil and copper oxychloride. Some of these fungicides are registered for processing peas and may not be registered in all states. Check pesticide permits and registrations for any changes in use patterns before using fungicides.

Selecting the right fungicide for the specific disease being targeted is important. Check the efficacy of each fungicide against each disease. Some products are broad-spectrum and are effective against more than one disease, for example products containing mancozeb and chlorothalonil. Mancozeb, chlorothalonil, metiram and copper are protectants and have no curative action on existing infections. Newly grown, untreated foliage will not be protected.

10 NSW DPI 2002 Foliar diseases of faba beans: management in southern NSW. Pulse point 16, NSW Department of Primary Industries, http://archive.dpi.nsw.gov.au/__data/assets/pdf_file/0017/157400/pulse-point-16.pdf

11 Pulse Australia (2016). Southern/western field pea best management practices training course, module 6-2016 Draft. Pulse Australia Limited

FEEDBACK

MORE INFORMATION

For details on foliar fungicides and the diseases controlled, please see the Winter Crop Sowing Guide at: http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/winter-crop-variety-sowing-guide

Label regulations limit carbendazim to a maximum of 2 consecutive sprays at 14-day intervals. Carbendazim is a systemic fungicide with single-site specificity so the probability of resistance developing increases with regular use. It is best to alternate carbendazim with either chlorothalonil or mancozeb. Observe the withholding period for grain prior to harvest for carbendazim (4 weeks).[12]

9.9.2 Current minor use permits (MUP)

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

Pulse Australia holds several minor use permits (MUP) on behalf of the pulse industry and is actively involved in the pursuit of new permits and label registrations to meet industry needs.

Check for MUP at Pulse Australia (http://pulseaus.com.au/growing-pulses/crop-protection-products) or APVMA (https://portal.apvma.gov.au/permits) websites.

9.9.3 The critical periods for fungicide use

Monitor crops at least once a week during all critical periods. Be prepared to spray when rain is forecast. Visible lesions will only appear several days after wet conditions.

Fungicide application during critical periods is a standard practice in high-rainfall regions, irrigation districts, in a wet year or in high-disease-risk situations. A crop is at high risk if susceptible varieties are grown, crop rotation is short, if sown adjacent to field pea stubble, infected seed is sown or where all preventative management strategies cannot be followed.

Timelines and fungicide strategies based on the variety and disease being targeted are summarised in Figure 3 and at http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/winter-crop-variety-sowing-guide. The strategy used for each disease is based on the resistance or susceptibility status of the variety. Use variety disease ratings Section 3.3.1 Table 3 Disease resistance characteristics of field pea varieties. to do this. Choose a fungicide or a fungicide mixture to handle the targeted diseases.

12 P Matthews, D McCaffery, L Jenkins (2017) Winter crop variety sowing guide 2017, NSW DPI Management Guide. NSW Department of Primary Industries, https://www.dpi.nsw.gov.au/about-us/media-centre/releases/2017/2017-winter-crop-variety-sowing-guide-now-available

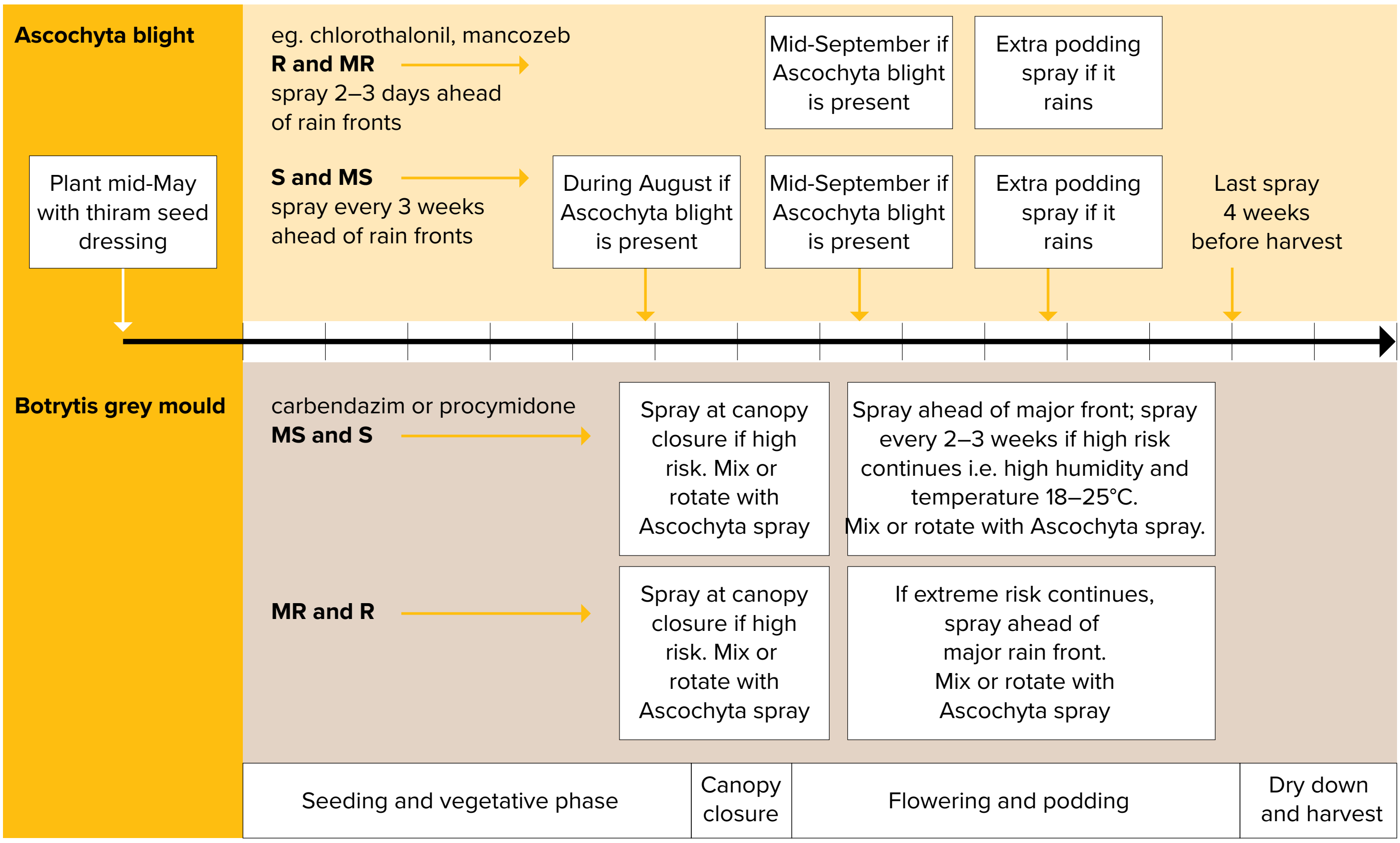

Figure 3: *Fungicide timing of field pea disease control with specific variety choices.**

* Foliar fungicide application times based on variety resistance: Resistant (R) or Moderately Resistant (MR) versus Susceptible (S) or Moderate Susceptible (MS).

Source: Jenny Davidson, SARDI

Registered fungicides to use as seed dressings are listed in Table 5. Registered fungicides to use as foliar fungicides are listed at http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/winter-crop-variety-sowing-guide.

Refer to the current product labels for complete 'Direction for Use' prior to application.

Prior to the use of any crop protection product, ensure that it is currently registered or that a current permit exits for its use in field pea.

Registered labels and current permits can be found on the APVMA website (https://portal.apvma.gov.au/permits).[13]

13 Pulse Australia (2016) Southern Faba & Broad Bean – Best Management Practices Training Course, module 6-2016. Pulse Australia Limited

9.10 Risk assessment

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

There are three steps in risk assessment:

1. Identify factors that determine risk (see Figure 1 & Figure 2)

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, infected seed, aggressiveness of isolate, alternative (weed) hosts prevalent in paddock or nearby, distance from infected stubbles, paddock history.

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

Environment: Time of sowing (early), length of season; likelihood of rain, drought, waterlogging, irrigation; availability of spray equipment and trafficability; paddock characteristics (soil type), residual herbicide history.

Risk management: Has it not yet been considered; a plan is being developed; or is a plan in place?[14]

An example of the key driving factors in managing blackspot is shown in Figure 4.

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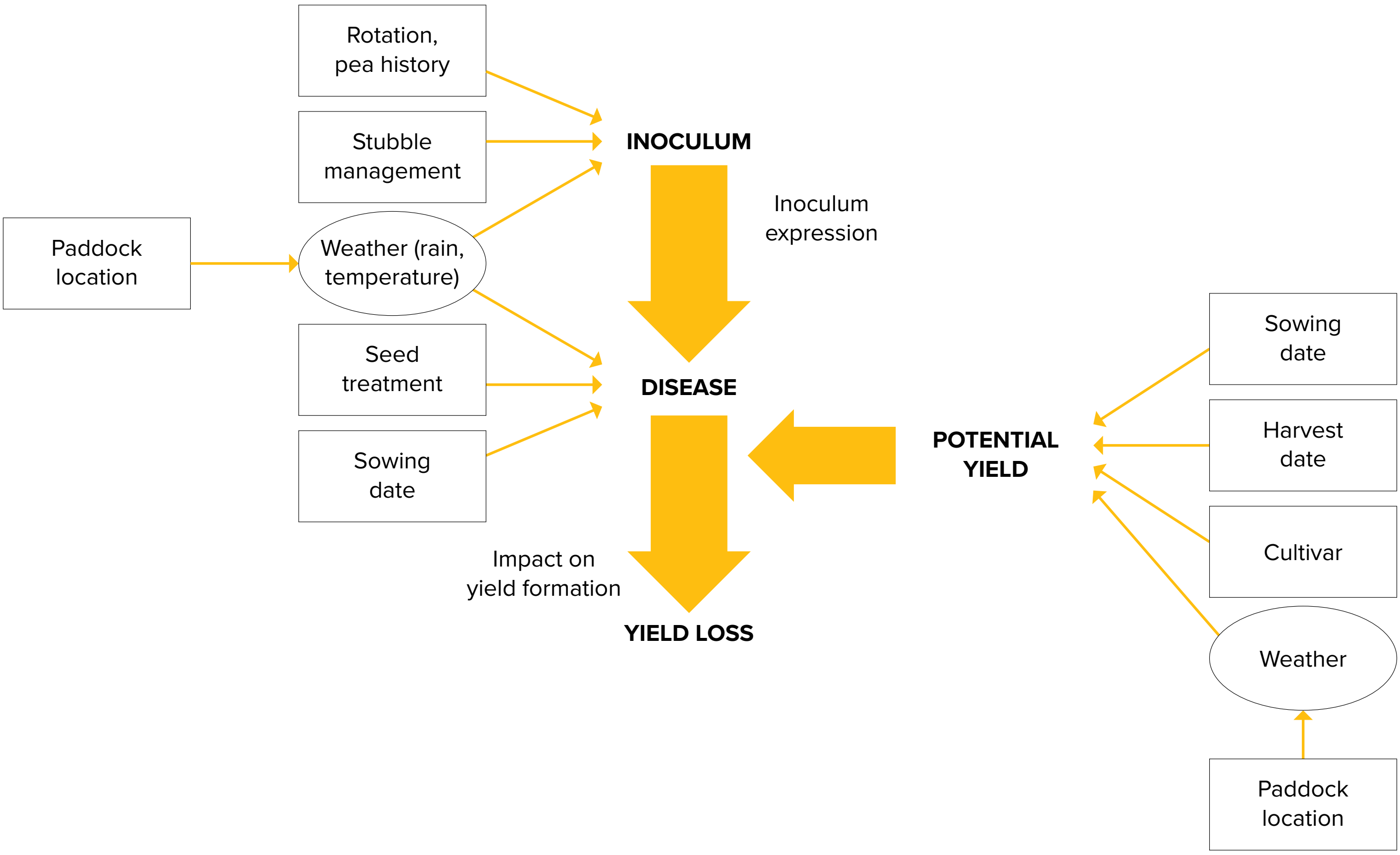

Figure 4: *Key driving factors in blackspot, and the basis for managing the risk and maintaining yield potential. The same principles apply to the management of the other diseases.*

Source: Australian Pulse Bulletin 2012, http://www.pulseaus.com.au/storage/app/media/crops/2012_APB-Fieldpea-disease-management-South-West.pdf

3. What risk level is acceptable?

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

Low: Grower needs cash flow and cannot afford to spend much or lose the crop; failure impacts seriously on farming system.[15]

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9.11 Symptom sorter

This symptom sorter (Table 6) featured in the app Field Pea: The Ute Guide. It can be used to help diagnose diseases from other crop damage causes.

Table 6: Field pea symptom sorter.

Crop affect	Distribution	Plant symptoms	Disorder
Poor emergence	Patches	Seed rotted	Damping off
		Plants chewed	Mice
			Snails
	General	Plants distorted	Trifluralin damage
		Plants stunted	Seed sown too deep
		Ungerminated seed	Poor storage
			Insect damage
Wilting	Scattered plants	Reduced growth – yellow	Fusarium wilt
		Yellow/red	Virus
		Premature death	Root rots
	Patches	Stunted	Herbicide damage
		Premature death	Fusarium wilt
			Waterlogging
			Virus
			Salinity
	General	Plants limp	Herbicide damage
		Leaves/stem distorted	Stem nematode
			Virus
			Downy mildew
			Mites
	Patches	Yellow – death of young leaves	Iron deficiency
			Manganese deficiency
			Sulfonylurea damage
			Broadstrike® damage
		Yellow/red	Damping off (pythium root rot)
			Virus
			Nodulation failure
		General	Herbicide damage (e.g. hormone)
Leaf and stem spotting/discolouration	Scattered plants	Brown	Bacterial blight
		Purplish black spots	Blackspot
		Yellow leaves	Virus
	General	Cream to white blotches	Diflufenican damage
		Yellow/red	Septoria
		Tip death	Triazine damage
			Iron and zinc deficiency
	Leaves	Yellow between veins	Manganese deficiency
Pods discoloured	General	Shrunken – purplish-brown	Blackspot
Fungal growth	Stems and leaves	Grey on underside of leaves	Downy mildew
		White on upper side of leaves	Powdery mildew
			Botrytis grey mould
		May be with a soft slimy rot, may have larger sclerotes	Sclerotinia
Physical damage	Patches	Plants chewed	Mouse damage
			Snail damage
		Pods chewed	Native budworm
			Lucerne seed web moth
	General	Stem, leaves and pods damaged	Mouse damage
			Hail damage
		Stem bent and twisted	Frost

Source: Field peas: The Ute Guide, GRDC (2009), The Ute Guide, Southern region. GRDC Ground Cover Direct page 28 & 29

MORE INFORMATION

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

GRDC Field peas: The Ute Guide
https://grdc.com.au/resources-and-publications/all-publications/publications/2009/04/field-peas-the-ute-guide

9.12 Correctly identifying diseases

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

Symptoms of Ascochyta and bacterial blight, downy mildew powdery mildew, Septoria leaf blotch, Pea seed-borne mosaic virus, Beet western yellows virus and other causes of damage to field pea may be confusing. Correct disease identification is necessary to avoid unnecessary spraying or incorrect fungicide use.

9.12.1 Diagnostic skills

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

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

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

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

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

Follow these steps for an accurate diagnosis:

What is the distribution of the disorder across the district?

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

What is the distribution of the disorder across the paddock?

- Is the pattern linked with a farming operation (past and present)? e.g. cultivation, old fence line, sheep camp, sowing, varieties, spraying, harvesting?
- Does it follow drainage lines or is it confined to low or high parts of the paddock?
- Does it affect individual plants throughout the paddock; individual plants at the edge of the crop or in thin areas.
- Does it occur in patches?

Walk through the crop with your eyes shut sensing changes in soil compaction to establish links between hard zones and symptoms.

- Run your hands across the plants – do they feel stiff and leathery, cool or hot?

What's the weather been like?

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

What's the insect activity been like?

- Aphids on the windscreen, moths in the crop.

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

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

Dig up plants:

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

Finally, if you suspect a plant disease, remember the disease triangle (Figure 1). A crop can only have a serious disease problem if three conditions are met:

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

9.12.2 Sending samples for disease diagnosis

For accurate diagnosis it is imperative that specimens are carefully selected, well presented and submitted with adequate information.

Selection of specimens

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

Preservation

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

DO NOT FREEZE samples.

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

Dried specimens are best when dried rapidly, but again, not in the back of the ute. Place plant parts between sheets of newspaper (with some pressure) and change paper daily for 1 week.

Packaging

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

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

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

Labelling

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

Dispatch

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

MORE INFORMATION

SARDI webpage: Seed and crop testing
http://pir.sa.gov.au/research/services/crop_diagnostics/seed_and_crop_testing

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

AgVic webpage: CropSafe
http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/grain-and-crop-health/cropsafe-program

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

DPIPWE webpage: Plant pathology
http://dpipwe.tas.gov.au/biosecurity/plant-biosecurity/plant-health-laboratories/plant-pathology-laboratory

NSW DPI webpage:
http://www.dpi.nsw.gov.au/content/aboutus/services/das/plant-pests-diseases/sample-preparation

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

Before sending check whether the relevant authority has a submission form.[16]

The information usually required includes:

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

Relevant contacts

South Australia

SARDI Plant Diagnostic Centre

Ph: (08) 8303 9400
Seed and crop testing:
http://pir.sa.gov.au/research/services/crop_diagnostics/seed_and_crop_testing

Post to:

Locked Bag 100,
Glen Osmond, SA, 5064

Courier to:

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

South Australia

SARDI Molecular Diagnostics Group

Ph: (08) 8303 9400
PreDicta® B nematode testing:
http://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b

Post to:

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

Courier to:

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

16 Pulse Australia (2016) Southern Faba & Broad Bean – Best Management Practices Training Course, module 6-2016. Pulse Australia Limited

Victoria

DEDJTR Pulse Pathology,

Ph: (03) 5362 2111

Post to:

Private Bag, Natimuk Rd,
Horsham, VIC 3401

Courier to:

110 Natimuk Rd
Horsham, VIC 3401

Victorian samples may also be submitted via agronomists through the Cropsafe program. The program aims to provide the early detection of exotic diseases.

http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/grain-and-crop-health/cropsafe-program

Tasmania

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

Prices:

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

Western Australia

DPIRD Diagnostic Laboratory Services (DDLS) Seed Testing and Certification

DDLS conduct seed tests for CMV.

Department of Agriculture and Food
Reply Paid 83377
3 Baron Hay Court
South Perth, WA 6151

Ph: 08 9368 3721
Email: DDLS-STAC@agric.wa.gov.au
https://www.agric.wa.gov.au/plant-biosecurity/ddls-seed-testing-and-certification-services

New South Wales

Submission form:

http://www.dpi.nsw.gov.au/content/aboutus/services/das/plant-pests-diseases/sample-preparation

Plant Health Diagnostic Service – Wagga Wagga

Ph: (02) 6938 1608

Post to:

Wagga Wagga Agricultural Institute,
Private Bag, Pine Gully Road,
Wagga Wagga, NSW 2650

Plant Health Diagnostic Service - Tamworth

Ph: (02) 6763 1133

Post to:

Tamworth Agricultural Institute,
RMB 944, 4 Marsden Park Rd,
Calala, NSW 2340

9.13 Ascochyta blight (AB)

Ascochyta blight (synonym: blackspot) is one of the most important diseases affecting field pea. It is caused by four pathogens that occur as a complex in the field and cause a single disease where the symptoms caused by each pathogen are undistinguishable. They can all be found on a single diseased plant. However, the pathogens, *Didymella pinodes* (synonym: *Mycosphaerella pinodes*), *Phoma medicaginis* var. *pinodella*, *Phoma koolunga* and *Ascochyta pisi* are separable in laboratory and glasshouse studies. The disease is widespread in Victoria and South Australia. Field surveys have shown that *Didymella pinodes* predominates in Victoria.

9.13.1 Symptoms

The pathogen infects all above-ground parts of field pea plants, as well as the crown below ground level.[17] Symptoms include purplish-black discolouration and streaking of the lower stem. Severe stem infections may also cause stem or foot-rot, which kills the plant.

Conspicuous spotting of the leaves and pods also occurs. The leaf spots may be either small, irregular, dark-brown and scattered over the leaf, or a few large, circular brown spots. Spots on the pods may coalesce to form large, sunken, purplish-black areas (Photos 1–4).

Infected seeds may be discoloured and appear purplish-brown. Discolouration is usually more pronounced on those areas of the seed coat next to diseased areas on the surface of the pod. Lightly infected seed may appear healthy.[18]

Photo 1: *Blackspot on leaves of pea.*

Photo: Grain legume handbook 2008, module 6, Plate 7.48

17 G Hollaway, F Henry, M Mclean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Identification and management of field crop diseases in Victoria. http://www.croppro.com.au/crop_disease_manual.php

18 H Richardson, F Henry (2013) Ascochyta Blight of Field Peas. AGNote AG0150, Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/ascochyta-blight-of-field-peas

Photo 2: *Blackspot on leaves and stems.*

Photo: Grain Legume Handbook (2008), module 6, Plate 7.49

Photo 3: *Blackspot on lower stems.*

Photo: Grain Legume Handbook (2008), module 6, Plate 7.50

Photo 4: *Blackspot on pods.*

Photo: Grain Legume Handbook (2008), module 6, Plate 7.51

9.13.2 Economic importance

Severity of the disease varies greatly from crop to crop and between seasons. In wet seasons when conditions are conducive, yield losses of up to 60% have been reported within individual crops, but in a dry season crop losses are less.

9.13.3 Disease cycle

The fungi that cause Ascochyta blight (blackspot) may either be seed-borne, soil-borne or survive in pea trash. The disease usually becomes established when sexual ascospores of the fungus (*D. pinodella*), produced in perithecia on old pea stubble, are carried into the new crop by rain and wind causing early infection (primary infection).

Secondary infection occurs when asexual conidia produced in pycnidia (fruiting bodies) infect pea plants. This can occur at any stage of plant growth. Pycnidia and perithecia develop on infected plants throughout the growing season and after harvest on pea stubble and infected volunteer plants. Ascospores are the main source of primary infection, whereas the secondary infection is caused by production of conidia (Figure 5).

Discharge of both types of spores needs rainfall or dew, therefore epidemics are more severe in wetter conditions. Spores produced on infected foliage are transferred onto adjacent healthy plants by wind and rain splash.

The disease can also become established by sowing of infected seed, which is a major concern and up to 90% of seed samples may be infected. The proportion of diseased seedlings arising from any infected seed lot is influenced by seasonal conditions such as high rainfall and soil factors. In a dry year, the planting of infected seed may not produce a diseased crop, but under wet conditions severe disease is likely.

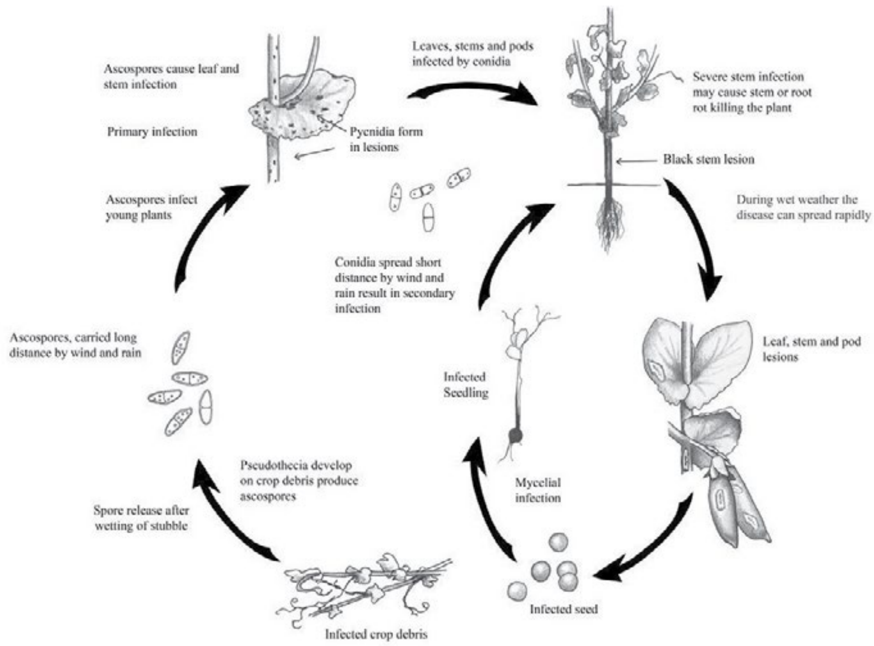

Figure 5: *Disease cycle of Ascochyta blight of field pea.*

Illustration: Kylie Fowler, DEDJTR Source: http://www.croppro.com.au/crop_disease_manual/ch07s02.php

9.13.4 Management options

Ascochyta blight is best managed using an integrated management package approach, involving crop management and hygiene. Control of black spot is the first priority in field pea and sets the basis for controlling the other diseases. Fungicide use is minor in the overall integrated programs.

Summary of recommended strategies to minimise disease in field pea:

- Paddock isolation: (>500 m) from pea stubble is the highest priority.
- Paddock history: aim for a minimum 4-year break between pea crops because soil-borne inoculum is significant.
- Seed source: use seed with minimal disease transmission. Test seed for disease and virus status.
- Fungicide seed dressing: can be effective in high-disease-risk situations.
- Sowing and rainfall: use the 'Blackspot Manager' computer model to assist with sowing date decisions. Do not sow within 2 weeks of the first rains of the season unless in low-rainfall/short-season areas and blackspot risk is low.
- Sowing date: sow within the optimum 'sowing window' for your district, using 'Blackspot Manager' to assist.
- Sowing rate: sow at the recommended plant population for the district, sowing time and variety.
- Variety selection: no variety is resistant to blackspot. Know the other disease susceptibilities of the variety sown.
- Hygiene: take all precautions to avoid disease spread. Spray or remove self-sown pea seedlings and ideally destroy pea stubbles before the new crop emerges.
- Foliar fungicide application: foliar fungicide can effectively control powdery mildew. A fungicide program for controlling blackspot and Septoria in peas is possible, but may not necessarily be economic.
- Mechanical damage: traffic, wind erosion, frost, hail or herbicide damage can spread bacterial blight.
- Harvest management: early harvest helps to minimise disease infection of seed and benefits grain quality.

Despite regional differences, predicting disease risk is possible based on proximity to pea stubbles, paddock history, soil test, rainfall information (timing and amount), stubble management and planned sowing date.

Decision-making tools to use are the 'Blackspot Manager' computer model (SA, WA and Victoria) and the PreDicta™ B soil test (not WA) along with the proximity of the nearest pea stubble (all areas). Plan to manage blackspot in peas first, followed by the other fungal diseases of local importance.[19]

Two of the best management options are isolating the new crop from sources of infection and not sowing too early. Ascochyta blight is best controlled by destroying infected pea trash and self-sown plants. The severity of disease may also be reduced by crop rotation, by the use of disease-free seed, resistant varieties, fungicidal seed dressing and foliar fungicides (in some situations).

Use clean seed

Seed should be tested for disease before sowing. Only use seed if <5% is infected. Using old or damaged seed can reduce seedling vigour and increase susceptibility to infection. Refer to Agriculture Victoria's 'Seed Health Testing in Pulse Crops' (AG1250) (http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/seed-health-testing-in-pulse-crops) or extensionaus.com.au for contacts on where to test seed.

19 Pulse Australia (2012) Field pea Disease Management Strategy, Southern & Western Region. Australian Pulse Bulletin. http://www.pulseaus.com.au/storage/app/media/crops/2012_APB-Fieldpea-disease-management-South-West.pdf

Destroy old crop residues

Destroying pea stubble by grazing and cultivation will reduce disease risk by minimising the number of spores available to infect new crops. However, care should be taken not to expose soil to wind erosion. Self-sown peas must also be controlled to prevent carryover of the disease.

Paddock selection

Avoid planting this season's crop near old field pea stubble. Previous pea crop residues can harbour the Ascochyta blight (blackspot) pathogens. Aim for a separation of at least 500 m from last year's pea paddock.

Crop rotation

The blight fungi can survive in soil and on old pea trash; it is only safe to re-crop an area with pea after all pea debris has decomposed. Pea should not be sown on land planted to pea the previous year nor on land adjacent to pea stubble. Where possible, pea should not be grown in the same paddock more than once in 3 years. If disease occurs, the rotation should be extended to one in 4 or 5 years.

Sowing dates

Follow the recommended sowing rates and sowing dates for your district. Avoid early sowing at high seeding rates as this increases exposure of pea seedlings to the Ascochyta (blackspot) pathogens and produces crops with a large canopy, increased lodging and high humidity, all of which increase the risk of developing disease.

Ascochyta spore forecasting model

'Blackspot Manager' is a forecasting model for Ascochyta blight (blackspot) of field pea. It can be used by agronomists and growers to help identify the best sowing dates that minimise the risk of Ascochyta blight without delaying sowing longer than necessary. The sowing dates are developed for different rainfall regions after first autumn rains. Blackspot Manager is produced by the Department of Primary Industries and Regional Development (DPIRD, formerly Department of Agriculture and Food, Western Australia (DPIRD)) and predictions are made for field pea crops in New South Wales, South Australia, Victoria and Western Australia.

Chemical control

Fungicidal seed dressings registered for use on Ascochyta blight of field pea, when applied correctly, will control seed-borne disease and protect young plants from early infection. It is recommended that all pea seed be treated with a fungicide. Where seed is to be inoculated apply the fungicide first and allow to dry. Apply the inoculum immediately prior to sowing. Fungicides and inoculant should never be mixed together. If the potential yield is over 2 t/ha, then use P-Pickel T® and seed dressing and apply mancozeb (2 kg/ha) at 9th node stage and again at early flowering.

Fungicide application for Ascochyta blight (blackspot) control has generally proven to be uneconomic for field pea that yield <2 t/ha. In some situations, applying mancozeb at 2 kg/ha, at strategic timings (9th node and again at early flowering prior to significant rain fronts) can lead to economic disease control in high-yielding pea crops. If field peas are sown according to recomendations of Blackspot Manager, ie after 50% of spores have been released, then blackspot disease is unlikely to reach severe levels. If the peas are sown before the peak spore release -- that is the spores are released in late May or June and peas re sown mid-May, then foliar fungicides are warranted for disease control. Trials in previous years have shown that potential yield needs to be at least 2t/ha for foliar fungicides to be economic in field peas even when blackspot is severe. While yields were high in 2011, blackpot severity was generally low, and application of fungicides was not economic in 2011. (see Field pea disease management strategy, http://www.pulseaus.com.au/storage/app/media/crops/2012_APB-Fieldpea-disease-management-South-West.pdf).

SARDI trial data 2016: re-thinking Ascochyta blight control strategy in field pea

Key findings:

In low-rainfall zones delayed sowing to manage Ascochyta blight risk often leads to yield loss.

Earlier sowing can be achieved with the use of foliar fungicides.

Research conducted in 2015 to test the efficacy of alternative fungicides alongside the current industry practice has improved Ascochyta blight disease control together with a yield benefit of up to 15% over the current industry practice.

See summary of trial below or full details: http://www.farmtrials.com.au/trial/18345

SARDI trial data 2016

The existing industry practice for Ascochyta blight control in field pea was developed by SARDI (McMurray *et al.*) and includes the use of a fungicide application strategy of P-Pickel T® seed dressing followed by two foliar applications of mancozeb (2 kg/ha at 9th node and early flowering). This strategy, developed in 2011, has been shown to suppress Ascochyta blight and is generally a viable economical option for crops yielding 1.5 t/ha or greater.

Research conducted in 2015 to test the efficacy of alternative fungicides alongside the current industry practice has indicated improved Ascochyta blight disease control together with a yield benefit of up to 15% over the current industry practice. This research also identified that the severity of disease onset was higher at an earlier growth stage in low-rainfall environments, such as Minnipa, SA. As such, the timing of the first foliar fungicide, at 8 weeks after sowing (WAS) was thought to be too late for effective control of Ascochyta blight in these environments. Further, in medium-rainfall environments, more favourable spring conditions often extend late season disease progression and therefore sprays towards the back-end of the growing season may be required.

The aim of the 2016 trials was to further assess these new experimental fungicides alongside the current strategy and also include variations in fungicide application timings to improve disease control efficacy.

Key findings

- The recommended industry practice of P-Pickel T® seed treatment and two foliar fungicides of mancozeb failed to significantly reduce disease infection levels or increase grain yield over untreated control treatments under high blackspot disease pressure in 2016.
- Early disease control applications (4 weeks after sowing) were important for reducing initial blackspot infection levels at Minnipa; conversely, later spring application were important at the higher-rainfall site of Hart.
- Over 2 consecutive years, a yield benefit of at least 15% has been obtained from application of new experimental fungicide actives over the current industry practice treatment.

Further research is required to understand the interaction in efficacy between fungicides and timing of disease infection, together with the drivers of Ascochyta blight control and progression in different field pea growing environments.[20]

MORE INFORMATION

CropPro webpage: Ascochyta blight (blackspot) of field peas, http://www.croppro.com.au/crop_disease_manual/ch07s02.php

Blackspot Manager, https://extensionhub.com.au/web/field-crop-diseases/-/blackspot-manager-for-field-peas

Field pea disease management strategy for Southern and Western regions, http://www.pulseaus.com.au/storage/app/media/crops/2012_APB-Fieldpea-disease-management-South-West.pdf

20 C Walela, L McMurray, J Davidson, L Davis (2016) Re-thinking the current ascochyta blight control strategy in field peas, Hart Trial Results 2016. http://www.hartfieldsite.org.au/media/2016%20Trial%20Results/Hart_Trial_Results_2016_Re-thinking_the_current_ascochyta_blight_control_strategy_in_field_peas.pdf

9.14 Bacterial blight of field pea

This disease, caused by the bacteria *Pseudomonas syringae* pv. *pisi* and *P. syringae* pv. *syringae*, is a serious disease of pea. Recently, the pathogen *P. syringae* pv. *syringae* has been considered the main cause of the disease in pea crops. Bacterial blight is widespread in field pea in southern New South Wales and Victoria, but its severity varies greatly from crop to crop and between seasons. The disease is seed-borne and is more prevalent after frost events; multiple frosts can cause epidemics resulting in significant yield loss.

9.14.1 Symptoms

The disease first becomes evident as small, dark-green, water-soaked lesions on leaves and stipules. The lesions may enlarge and coalesce, but are nearly always delimited by the veins and develop a characteristic fan shape. The lesions on the leaflets turn yellowish and later brown and papery; lesions on the pods are sunken and turn olive-brown (Photos 5 and 6).

Lesions may also develop on stems near ground level. These begin as water-soaked areas, which later turn olive-green to dark brown. Stem lesions may coalesce, causing the stem to shrivel and die. Stem infection may spread upwards to the stipules and leaflets.

Pre-emergence and post-emergence damping-off may occur, and even advanced plants may be killed. Heavily infected seed may be discoloured, but light infection has no visible effect on seed.

The symptoms of bacterial blight caused by *P. syringae* pv. *pisi* or *P.syringae* pv. *syringae* are indistinguishable from each other on the pea plant.[21]

Photo 5: *Water-soaked lesions, caused by bacterial blight, spreading in a fan-shaped pattern into the leaf from the base.*

Photo: P Baker, Rural Directions, Field peas: The Ute Guide Page 41

Photo 6: *Olive-brown bacterial blight lesions on pea pods.*

Photo: J Wilson, Elders

21 G Hollaway, F Henry, M Mclean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Identification and management of field crop diseases in Victoria. http://www.croppro.com.au/crop_disease_manual.php

Photo 7: *Paddock affected by bacterial blight.*

Photo: W. Hawthorne, formerly Pulse Australia

9.14.2 Economic importance

Bacterial blight is widespread in field pea in Victoria, but its severity varies greatly from crop to crop and between seasons. Severe epidemics can result in crop failure, however, losses are usually less than 20%.[22]

9.14.3 Disease cycle of bacterial blight in field pea

Bacterial blight commonly becomes established within a field by sowing infected seed or from infected pea trash that is nearby. During wet weather, bacteria spread from infected to healthy plants by rain splash and in wind-borne water droplets (Figure 6).

Infection may occur at any stage of plant growth. The pathogens can remain on the surface of plants without causing symptoms. However, following rain, heavy dew, frost or other forms of damage to plant tissues, symptoms can develop. Damage to field pea enables entry of bacteria into the plant tissue. Early infections may lead to epidemics but later infection can also cause yield losses. Because the disease depends on wet conditions, bacterial blight is most severe in wet seasons. A combination of excessive rainfall and strong winds provides the most favourable conditions for spread of the disease within crops.

P. syringae pv. *pisi* is largely restricted to field peas but *P. syringae* pv. *syringae* has a wide host range including clover, common bean, faba bean, lentil, chickpea and vetch, which act as alternate hosts.

22 H Richardson (2012) Bacterial Blight of Field Peas. AGNote AG0148, Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/bacterial-blight-of-field-peas

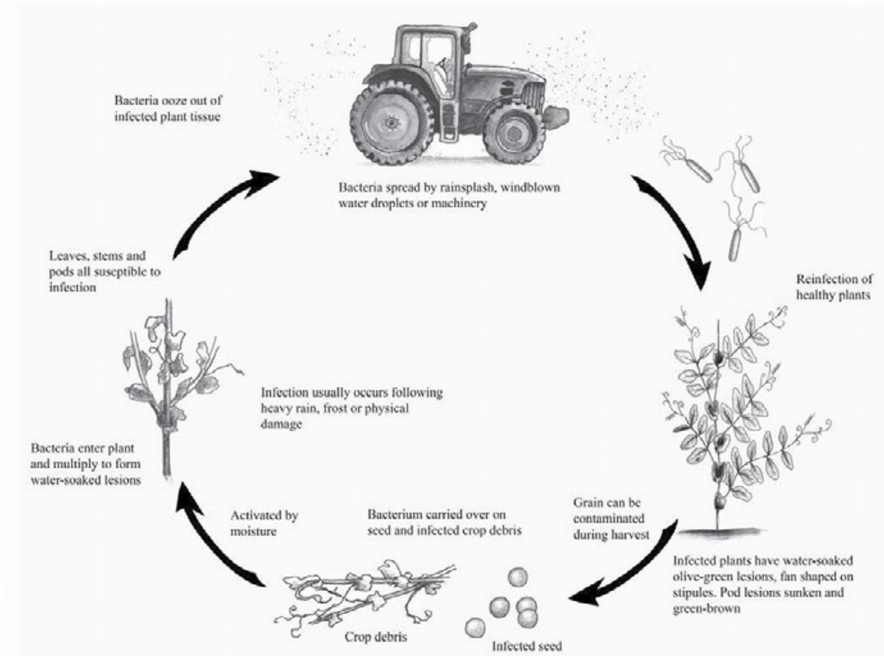

Figure 6: *Disease cycle of bacterial blight in field pea.*

Illustration: Kylie Fowler, DEDJTR Source: CropPro http://www.croppro.com.au/crop_disease_manual/ch07s03.php

9.14.4 Management options

Bacterial blight can be avoided by using an integrated approach to management that encompasses planting disease-free seed, crop rotation, variety selection and avoiding early sowing.

Use of disease-free seed

This is the main control measure recommended. The use of clean seed will minimise the possibility of disease, provided the land has not been cropped to pea for several years. Do not use seed from crops identified with bacterial blight during field inspections. A field inspection should occur at mid to late pod-fill. Bacteria remain viable on seed for at least 2 years. Seed testing for bacterial blight is available from:

DPIRD Diagnostic Laboratory Services (DDLS) Seed Testing and Certification

Department of Primary Industries and Regional Development
Reply Paid 83377
3 Baron Hay Court
South Perth, WA 6151

Ph: 08 9368 3721
Email: DDLS-STAC@agric.wa.gov.au
https://www.agric.wa.gov.au/plant-biosecurity/ddls-seed-testing-and-certification-services

AsureQuality

3-5 Lillee Crescent (PO Box 1335)
Tullamarine
Victora 3043

Ph: 03 8318 9000
Fax: 03 8318 9001
https://www.asurequality.com

For information on virus testing, please see: Section 9.20.6 Virus testing

Rotations

To obtain a blight-free crop, pea should not be sown on land sown to pea in the previous year or adjacent to pea stubble. Where possible, pea should not be grown on the same land more than once in 3 years. If disease occurs the rotation should be extended to once in 4 years.

Stubble can be a significant source of inoculum. Destroy by burying, baling or burning infected stubble. The survival time of inoculum is significantly reduced by burying pea trash 10 cm below the soil surface.

Time of sowing

Early-sown crops are more vulnerable to bacterial blight infection than late-sown crops; never sow earlier than recommended for your district. In areas prone to bacterial blight avoid early sowing.

Crop damage

Bacterial blight is often associated with physical crop damage such as hail, frost, strong winds, sand blasting or machinery damage. Physical damage enables bacteria to enter plant tissue. Minimise the use of post-emergence herbicide sprays, if possible, as the severity of bacterial blight can increase if plant tissue is damaged. Avoid paddocks where sulfonylurea residues may be present and the more frost-prone paddocks.

Varieties

All varieties are susceptible to *P. syringae* pv. *pisi*, but the frequency of bacterial blight can be reduced by avoiding varieties susceptible to *P. syringae* pv. *syringae* (Table 8).

Table 7: Reaction of varieties to bacterial blight caused by *Pseduomonas syringae* pv. *Syringae*.

Variety	Reaction
Bundi	Susceptible
SW Celine	Susceptible
Dundale	Resistant
Dunwa	Resistant
Excell	Susceptible
Helena	Resistant
Kaspa⫽	Susceptible
Maki	Susceptible
Moonlight	Very Susceptible
Morgan⫽	Moderately Susceptible
PBA Gunyah⫽	Susceptible
PBA Oura⫽	Moderately Resistant
PBA Percy⫽	Resistant
PBA Twilight⫽	Susceptible
Parafield	Moderately Resistant – Moderately Susceptible
Snowpeak	Very Susceptible
Sturt	Moderately Resistant – Moderately Susceptible
Yarrum	Susceptible

Source: Richardson (2012) Bacterial Blight of Field Peas. AgNote AG0148, Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/bacterial-blight-of-field-peas

Farm hygiene

When bacterial blight is detected, steps should be taken to prevent the spread of disease. Where possible, harvest infected crops last to avoid contaminating healthy crops, and machinery used in an infected crop should be cleaned thoroughly and washed with disinfectant after use. Likewise, machine operators and farm workers should only move from crop to crop after taking precautions against the spread of bacteria. This is best achieved by wearing rubber boots and waterproof trousers that are washed with disinfectant immediately after leaving an infected field. Crops should never be inspected when they are wet as this increases the chance of spreading disease.

MORE INFORMATION

CropPro webpage: Bacterial Blight of Field Peas

http://www.croppro.com.au/crop_disease_manual/ch07s03.php

Chemical control

Fungicides and seed treatments are designed to be active against fungal diseases and are ineffective in the control of bacterial diseases. There are copper-based compounds, registered for use in field pea against bacterial blight, but evidence for their effectiveness in Australian field pea crops is limited and inconclusive.[23]

9.15 Downy mildew of field pea

Downy mildew, caused by the pathogen *Peronospora* viciae, is a common disease of pea in Victoria, South Australia and Tasmania. Downy mildew is favoured by wet, cool seasons. Night temperatures below 10°C and morning dew promotes the disease. The disease also impairs wax formation on the leaves and makes plants susceptible to herbicide damage. Systemic infection can lead to the appearance of the disease late in the season if conditions are conducive, but yield losses due to downy mildew arise from the stunting of plants early in their growth, or from complete loss of seedlings. Substantial losses are likely to occur in cooler districts.[24]

9.15.1 Symptoms

This disease is most common soon after seedling emergence, but it may affect plants at any stage of growth especially during periods of moist, cool weather.

Plants grown from infected seed are severely stunted and distorted, and have a sickly yellowish-green appearance. The undersides of the leaflets, in particular, are covered with a fluffy mouse-grey spore mass (Photo 8). Infected plants may turn yellow-while producing an abundant source of spores, which cause secondary infections.

Secondary infection results in the appearance of isolated greenish yellow to brown blotches on the upper surface of leaves (Photo 9), while on the underside of the leaf, masses of mouse-grey- coloured spores are produced.

The fungus usually affects the lowest leaves and then progresses up the plant, sometimes infecting flowers and pods. Infected pods are deformed and covered with yellow to brownish areas and superficial blistering.

23 G Hollaway, F Henry, M Mclean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Identification and management of field crop diseases in Victoria. http://www.croppro.com.au/crop_disease_manual.php

24 G Hollaway, F Henry, M Mclean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Identification and management of field crop diseases in Victoria. http://www.croppro.com.au/crop_disease_manual.php

Photo 8: *Downy mildew can be identified by the pale grey fungus underneath the leaves.*

Photo: Grain Legume Handbook, chapter 7, Plate 7.52

Photo 9: *Downy mildew on pea with greenish-yellow to brown blotches on the upper surface of leaves, and grey fungal growth on the underside.*

Photo: Grain Legume Handbook (2008), chapter 7, Plate 7.53

9.15.2 Economic importance

Downy mildew causes most damage by stunting plants early in their growth or by killing seedlings in more extreme instances. Generally, plants will grow away from the disease as temperatures increase in late winter/early spring without significant yield loss.

The disease also impairs formation of wax on the leaves, which makes plants very susceptible to damage by herbicides. Substantial losses can occur in cooler districts.[25]

9.15.3 Disease cycle

The fungus that causes downy mildew survives in the soil and on pea trash and can be seed-borne.

Infected seed can act as a primary source for systemic and local infections. The disease can develop quickly when conditions are cold (5–15°C) and humidity >90% for 4–5 days, often when seedlings are in the early vegetative stage. Individual

25 T Bretag, H Richardson, F Henry (2013) Down Mildew of Field Peas. AGNote 0149, Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/downy-mildew-of-field-peas

seedlings become infected and act as foci of infection from which the disease spreads. Rain is the major means of spore dispersal and infection. Heavy dew will promote sporulation. Dry, warm weather is unfavourable for the disease. Systemic infection of plants can lead to the disease developing late in the season if conditions are favourable (Figure 7).

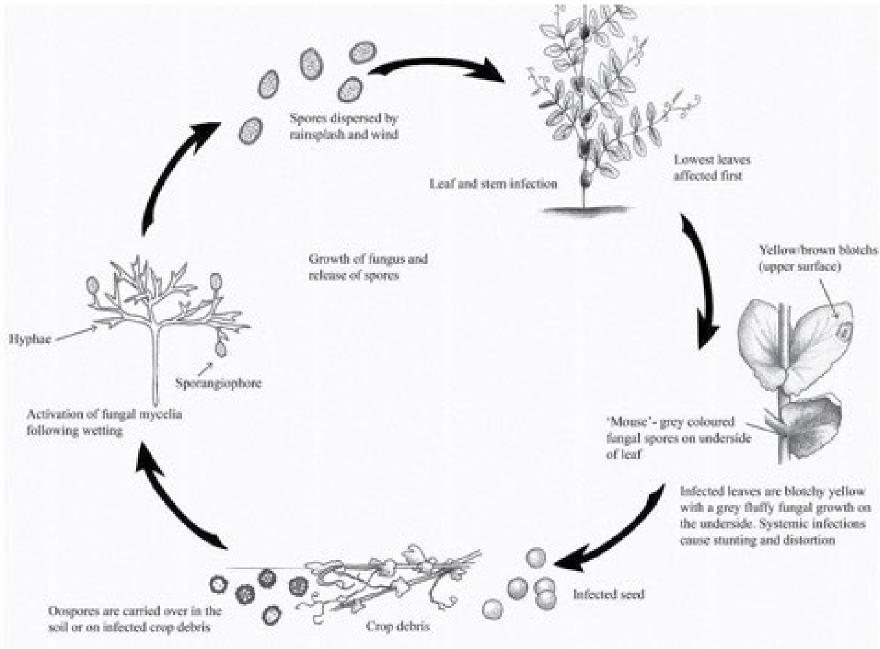

Figure 7: *Disease cycle of downy mildew on field pea.*

Illustration: Kylie Fowler, DEDJTR

9.15.4 Management options

Varietal selection

Growing a resistant variety is the most effective means of controlling downy mildew in districts prone to this disease. There are two strains of the downy mildew fungus. The Parafield strain, which is considered a non-virulent strain, infects all conventional-type tall field peas such as Parafield and Alma. Whereas the new Kaspa$^{\text{⊕}}$ strain is more virulent and can infect both conventional-type, older field pea varieties as well as newer semi-leafless varieties such as Kaspa$^{\text{⊕}}$ and PBA Oura$^{\text{⊕}}$.

There are no commercial varieties with resistance to both strains of the fungus.[26] The resistance of current field pea varieties to both strains of downy mildew is shown in Table 8.

26 G Hollaway, F Henry, M Mclean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Identification and management of field crop diseases in Victoria, http://www.croppro.com.au/crop_disease_manual.php

Table 8: Reaction of field pea varieties to the strains of downy mildew caused by *Peronospora viciae*.

Variety	Reaction to Parafield strain	Reaction to Kaspa⁽ᵈ⁾ strain
Bundi	Resistant	Moderately Susceptible
SW Celine	Susceptible	Susceptible
Excell	Moderately Resistant	Susceptible
Kaspa⁽ᵈ⁾	Moderately Resistant	Susceptible
Maki	Susceptible	Susceptible
Morgan⁽ᵈ⁾	Resistant	Susceptible
PBA Gunyah⁽ᵈ⁾	Resistant	Susceptible
PBA Oura⁽ᵈ⁾	Moderately Resistant	Moderately Susceptible
PBA Percy⁽ᵈ⁾	Susceptible	Susceptible
PBA Twilight⁽ᵈ⁾	Resistant	Susceptible
Parafield	Susceptible	Susceptible
Sturt	Moderately Susceptible	Susceptible
Yarrum	Susceptible	Susceptible

Source: T Bretag, H Richardson, F Henry (2013) Down Mildew of Field Peas. AGNote 0149, Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/downy-mildew-of-field-peas

Chemical control

Seed dressing with metalaxyl or oxadixyl (Group 4 systemic phenylamide fungicides) can be effective. Seed treatments reduce the number of seedlings with primary infection, thereby reducing the amount of air-borne spores that cause secondary infection in the surrounding crop. Seed treatments are recommended for districts where downy mildew occurs in most years. Not all fungicide seed dressings have activity against downy mildew. For more information on seed treatments, see Pulse Australia's Pulse Seed Treatments and Foliar Fungicides. http://pulseaus.com.au/storage/app/media/crops/2011_APB-Pulse-seed-treatments-foliar-fungicides.pdf

Crop rotation

Extended crop rotations and destruction of infected pea trash will minimise the risk of serious disease. Extended crop rotations allow spore numbers in the soil to decline before sowing again to field pea. A break of at least 3 years between field pea crops is recommended. Avoid sowing pea crops adjacent to last season's stubble.[27]

MORE INFORMATION

CropPro webpage: Downy Mildew of Field Peas

http://www.croppro.com.au/crop_disease_manual/ch07s04.php

9.16 Powdery mildew of field peas

Powdery mildew, caused by the pathogen *Erysiphe pisi*, can be a serious disease of pea in South Australia and Victoria. Severe infections can significantly reduce yield in susceptible varieties. Powdery mildew is most prevalent late in the season when warm days and cool nights result in dew formation.

Note: Downy mildew is caused by *Peronospora viciae,* a different fungus from that which causes powdery mildew.

9.16.1 Symptoms

Infected plants are covered with a white powdery film. Severely infected foliage turns blue-white in colour; tissue below these infected areas may turn purple (Photos 10 and 11). Symptoms first appear on the upper surfaces of the oldest leaves. Leaves, stems and pods may all become infected, resulting in withering of the whole plant.

27 G Hollaway, F Henry, M Mclean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Identification and management of field crop diseases in Victoria, http://www.croppro.com.au/crop_disease_manual.php

Severe pod infection can cause a grey-brown discolouration of the seeds. These seeds have an objectionable flavour that lowers the quality of the grain.[28]

Photo 10: *Typical white powdery mildew growth on an infected plant.*

Photo: Pulse Australia (2016). Southern/western field pea best management practices training course, module 6-2016. Pulse Australia Limited, Figure 7.12

Photo 11: *Powdery mildew infects all parts of the plant including pods.*

Photo: Pulse Australia (2016). Southern/western field pea best management practices training course, module 6-2016. Pulse Australia Limited, Figure 7.12

9.16.2 Economic importance

Severe infections can reduce yield by 10–20%. Powdery mildew is most prevalent late in the season.

Crops sown late are more likely to be affected by powdery mildew than early-sown crops. Severe pod infection can lead to poor seed quality.[29]

28 G Hollaway, F Henry, M Mclean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Identification and management of field crop diseases in Victoria, http://www.croppro.com.au/crop_disease_manual.php

29 T Bretag, H Richardson, F Henry (2012) Powdery Mildew of Field Peas. AGNote 0147, Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/powdery-mildew-of-field-peas

9.16.3 Disease cycle

The fungus over-winters on infected pea trash and produces spores, which are blown by wind into new crops (Figure 8). Under favourable conditions the disease may completely colonise a plant in 5–6 days and once a few plants become infected it rapidly spreads to adjacent areas.

Warm (15–25°C), humid (>70%) conditions for 4–5 days late in the growing season during flowering and pod-fill are favourable for disease development. Rainfall is not favourable for the disease, as it will actually wash spores off plants. Dewy nights are sufficient for disease development.

The disease may also be seed-borne, but this source of infection appears less important.

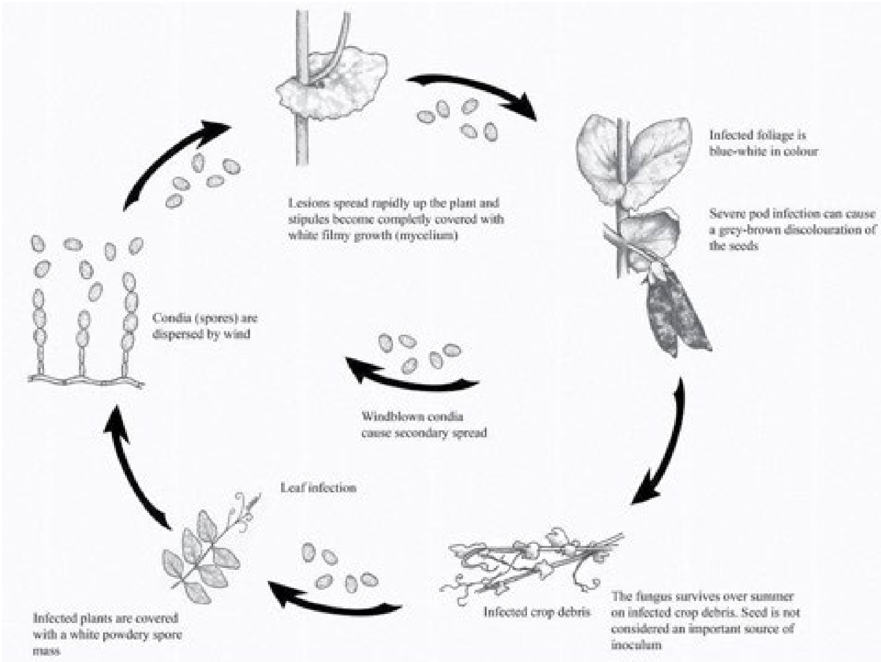

Figure 8: *Disease cycle of powdery mildew of field peas.*

Illustration: Kylie Fowler, DEDJTR

9.16.4 Management

Varietal selection

Growing a resistant variety is the most effective means of controlling powdery mildew. Maki and Yarrum are the resistant varieties currently available. For further information on disease ratings refer to the Victorian Pulse Disease Guide.

Crop rotation for powdery mildew control

Leave a 4-year break between growing field pea crops in the same paddock. Control volunteer field pea, which can harbour disease. Avoid sowing field pea crops adjacent to last season's stubble. Incorporate or burn infected pea stubble soon after harvest where practicable.

Seed treatment of powdery mildew

Seed treatments can be beneficial and are recommended for districts where powdery mildew frequently occurs. For more information on seed treatments, see Pulse Australia's Pulse Seed Treatments and Foliar Fungicides (http://pulseaus.com.au/storage/app/media/crops/2011_APB-Pulse-seed-treatments-foliar-fungicides.pdf).

FEEDBACK

MORE INFORMATION

CropPro webpage: Powdery Mildew of Field Peas

http://www.croppro.com.au/crop_disease_manual/ch07s05.php

Powdery mildew foliar fungicides

Monitor crops from flowering onwards for signs of powdery mildew. If the disease is present the application of a foliar spray may be warranted. Fungicides need to be applied prior to disease development to be most effective. Fungicides for powdery mildew have limited systemic activity and will not protect the new growth following spraying. Good plant coverage with the fungicides is essential. Depending on disease pressure, foliage is protected for about 14 days.

Before using any chemicals check that they are currently registered for use. Refer to Pulse Australia's Pulse Seed Treatments and Foliar Fungicides for more information on foliar fungicides.[30]

9.17 Septoria blight of field pea

Septoria blight is caused by the fungus *Septoria pisi*. Septoria blight is a minor disease and appears to have little effect on the yield of most pea varieties. The disease has been particularly noted in NSW but occurs sporadically in Victoria and South Australia. The disease is often seen on old foliage, pods and stems late in the growing season.

9.17.1 Symptoms

Septoria blight of field pea is found mainly on the lower, senescing parts of the plant and the pods. The disease is characterised by yellow blotches on plant tissue, which become necrotic and covered in numerous brown spots. Lesions vary in size, are roughly circular and have no distinct margin. First they appear yellow, later becoming straw-coloured. Several such blotches may join to cover the entire leaf. As the blotches dry out many pinpoint-sized black pycnidia (fungus fruiting bodies) may be seen scattered widely on infected plant parts, including pods, (Photo 12). Diseased tissues may dry off prematurely.[31]

Photo 12: *Typical leaf and pod lesions caused by Septoria infection. These blotches are brown and angular, containing very small brown to black spots.*

Photo: Mary Burrows, Montana State University, www.Bugwood.org, Pulse Australia (2016). Southern/western field pea best management practices training course, module 6-2016. Pulse Australia Limited, Figure 7.12

30 G Hollaway, F Henry, M Mclean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Identification and management of field crop diseases in Victoria, http://www.croppro.com.au/crop_disease_manual.php

31 G Hollaway, F Henry, M Mclean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Identification and management of field crop diseases in Victoria, http://www.croppro.com.au/crop_disease_manual.php

9.17.2 Economic importance

This disease occurs sporadically and seldom causes significant yield losses. However, losses of up to 40% have been reported in some susceptible pea varieties.[32]

9.17.3 Disease cycle

The fungus over-winters on infected pea trash and seed. Spores of the fungus are carried by wind from infected trash into the new crop (Figure 9). Infection is found on the lower foliage where the humidity is high following rain or heavy dews. Disease development favours prolonged high humidity (at least 24 hours) and moderately warm temperatures of 21–27°C. Splattering of water assists in spreading the disease within a field. While seed-borne transmission can occur it is less important.

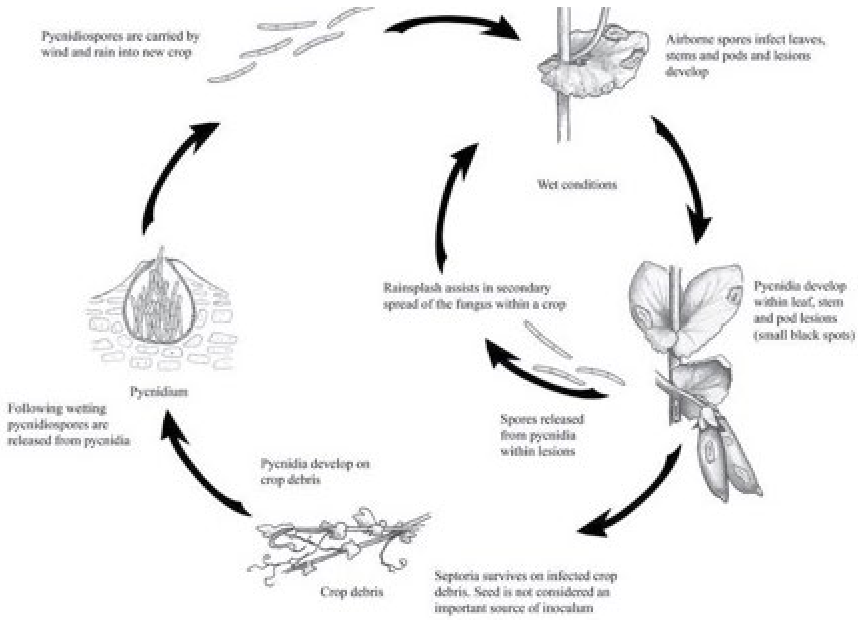

Figure 9: *Disease cycle of Septoria of field pea.*

Illustration: Kylie Fowler, DEDJTR

9.17.4 Management

Septoria can be managed by using an integrated approach that encompasses crop rotation, stubble management and fungicides. The Septoria blotch fungus survives in soil and on old pea trash. It is only safe to re-crop an area with pea after all pea debris has decomposed. Destroying pea stubble by grazing, burning and cultivation will help in reducing the pea debris more quickly.[33]

MORE INFORMATION

CropPro webpage: Septoria Blight of Field Peas
http://www.croppro.com.au/crop_disease_manual/ch07s06.php

To identify symptoms and management of field pea diseases:

GRDC App Field Peas: The Ute Guide, southern, for android and iOS, found at App Store

32 T Bretag, H Richardson, F Henry (2013) Septoria Blotch of Field Pea. AGNote AG1164, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/septoria-blotch-of-field-pea

33 G Hollaway, F Henry, M Mclean, P Kant, H Li, S Marcroft, M Rodda, M Aftab, P Trebicki, J Fanning, A Van de Wouw, H Richardson, L Hamilton (2015) Identification and management of field crop diseases in Victoria, http://www.croppro.com.au/crop_disease_manual.php

9.18 Stem nematode

Stem nematode (*Ditylenchus dipsaci*) is a soil-borne pest of pulses, oat and some pasture crops. The oat, lucerne and clover races of this nematode occur in South Australia and Victoria. The oat race infects oat, faba bean, field pea and wild oat, and has also been recorded on canola, lentil and chickpea seedlings. It can also be highly damaging to some horticultural, ornamental and nursery plants.[34]

9.18.1 Symptoms

Heavy infections cause poor germination and patches of stunted malformed plants. Peas will often turn yellow-green. In many instances the symptoms – leaves curling and showing water-soaked areas – are confused with herbicide damage. Sometimes the stem will die back but this occurs more frequently in bean than in pea crops.[35]

Photo 13: *Stem nematode in field pea causes plants to become severely stunted and distorted.*

Photo: Grain Legume Handbook (2008), chapter 7, Plate 7.62

9.18.2 Economic importance

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

Access to some international and domestic markets requires seed to be tested and found free of stem nematode.[36]

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

9.18.3 Disease cycle

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

34 Pulse Australia (2016) Southern/western field pea best management practices training course, module 6-2016. Pulse Australia Limited

35 J Lamb, A Podder (2008) Grain Legume Handbook for the Pulse Industry. Grain Legume Hand Book Committee, https://grdc.com.au/grainlegumehandbook

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

MORE INFORMATION

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

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

It infects above-ground parts of plants and can multiply many times during the growing season. Disease build-up is worse in wetter situations and at temperatures less than 15°C.[37]

It is more common in high-rainfall areas on clay soil.[38]

9.18.4 Management options

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

Rotate with non-host crops such as wheat and barley to reduce nematode numbers. Soil-borne disease risk can be assessed through the SARDI PreDicta® B soil test.

9.19 Root-lesion nematodes (RLN) (*Pratylenchus neglectus* and *P. thornei*)

Field pea is grown as a rotational crop to reduce the population of root-lesion nematodes (RLNs) in the soil.

9.19.1 Symptoms

In the field, symptoms are difficult to detect but RLNs cause stunted growth, uneven patches or waviness across the paddock.

RLNs invade the root tissue, resulting in light browning of the roots or localised deep brown lesions in the root cortex, not the stele. However, these lesions can be difficult to see on roots. The damage to the roots and the appearance of the lesions can be made worse by fungi and bacteria also entering the wounded roots.[39]

Diagnosis can be difficult and can only be confirmed with a SARDI PreDicta® B test to identify the particular RLN species. PreDicta® B (B = broadacre) is a DNA-based soil-testing service that identifies soil-borne pathogens, including RLN, that pose a significant risk to broadacre crops prior to seeding.

9.19.2 Economic importance

Most field pea cultivars are resistant to *P. thornei* and *P. neglectus*, with minimal yield loss. However, some of the newer cultivars of field pea are moderately susceptible to *P. thornei*. Rotations that include resistant crops will reduce the RLN population in the soil.

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

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

P. teres and *P. penetrans* are found in the western region.[40]

More than one RLN species can be found in the roots of an individual crop, although one species usually dominates. Identification is important as different crops have

37 Pulse Australia (2016). Southern/western field pea best management practices training course, module 6-2016 Draft. Pulse Australia Limited

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

39 J Thompson, K Owen, T Clewett, J Sheedy, R Reen (2009) Root-lesion nematodes: Management of root-lesion nematodes in the northern grain region, https://www.daf.qld.gov.au/__data/assets/pdf_file/0010/58870/Root-Lesion-Nematode-Brochure.pdf

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

different resistance or susceptibility depending on the *Pratylenchus* type. All species of *Pratylenchus* have a wide host range.[41]

9.19.3 Life cycle

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

There may be 3–5 generations of nematodes within a growing season. Nematodes are likely to multiply under a range of host crops, such as wheat and chickpeas. Barley is only moderately susceptible. Many grass weeds and legumes can also host nematodes.

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

Nematodes will not move great distances unless they are spread by surface water, soil on farm machinery or wind-blown soil in summer.[42]

9.19.4 Management options

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

Resistant crops reduce the population of nematodes in the soil. Tolerant crops do not reduce the population, but are less vulnerable to damage from nematodes.[43]

Resistant crop species can reduce nematode populations by up to 50% per year. A 2-year, or longer, break from susceptible crops may be necessary to minimise yield loss if nematode numbers are high.[44] Resistant varieties of susceptible crop species should be grown in the following years.

With the exception of chickpea, pulses tend to have good resistance to *P. neglectus* and *P. thornei*, so can reduce nematode populations in cropping rotations (Table 10).[45]

Resistant crops may differ in their capacity to host *P. neglectus* or *P. thornei* so tailor rotations to manage the predominant species.[46] Crops such as field pea and lentil provide some control for *P. thornei*, while faba bean, field pea and lentil provide control for *P. neglectus*.

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

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

Reducing the nematode population can lead to higher yield in subsequent cereal crops. Yield loss in south-eastern Australia from RLN is lower than in northern Australia.[47]

41 GRDC (2010) Plant parasitic nematodes Fact Sheet. GRDC, Southern and Western Regions, October 2010, http://www.grdc.com.au/GRDC-FS-Plant-Parasitic-Nematodes-SW

42 Pulse Australia (2016) Southern Faba & Broad Bean – Best Management Practices Training Course, module 6-2016. Pulse Australia Limited

43 GRDC (2010) Plant parasitic nematodes Fact Sheet. GRDC, Southern and Western Regions, October 2010, http://www.grdc.com.au/GRDC-FS-Plant-Parasitic-Nematodes-SW

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

45 GRDC (2010) Plant parasitic nematodes Fact Sheet. GRDC, Southern and Western Regions, October 2010, http://www.grdc.com.au/GRDC-FS-Plant-Parasitic-Nematodes-SW

46 V Vanstone G Hollaway, G Stirling (2008) Managing nematode pests in the southern and western regions of the Australian cereal industry: continuing progress in a challenging environment. *Australasian Plant Pathology*, 37, 220-234

47 G Hollaway, J Fanning, F Henry and A McKay (2015) Cereal root disease management in Victoria. GRDC Update Papers, 24 February 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02/Cereal-root-disease-management-in-Victoria

FEEDBACK

MORE INFORMATION

Root-lesion nematodes Tips and Tactics
www.grdc.com.au/TT-RootLesionNematodes

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

Soil Quality Fact Sheet: Root lesion nematode
http://soilquality.org.au/factsheets/root-lesion-nematode

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

VIDEO

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

VIDEO

How to diagnose Root Lesion Nematode
https://youtu.be/ttFltE-B4qA

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

Table 9: Resistance and tolerance of pulses to the major *Pratylenchus* species.

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

* Chickpea varieties have a range of resistances and tolerances to *Pratylenchus* species. Source: Pulse Australia (2016)

9.20 Viruses

Field pea crops can be affected by a number of virus diseases (Table 10). Some are seed-borne, but all require aphids to move between plants. Most require a 'green bridge' to survive between seasons.

Major viruses that are known to infect field pea in Australia include:

- Cucumber mosaic virus (CMV)
- Alfalfa mosaic virus (AMV)
- Bean yellow mosaic virus (BYMV)
- Pea seed-borne mosaic virus (PSbMV)
- Bean leaf roll virus (BLRV)
- Subterranean clover stunt virus (SCSV)
- Turnip yellows virus (TuYV) (synonym: Beet western yellows virus (BWYV)).

Less common viruses that occur in Australia are:

- Soybean dwarf virus (SBDV) (synonym: Subterranean clover red leaf virus (SCRLV))
- Clover yellow vein virus (ClYVV)
- Tomato spotted wilt virus (TSWV)
- Broad bean wilt virus (BBWV).

9.20.1 How viruses spread

Viruses need aphid vectors to spread from infected to healthy plants. The exception is Tomato spotted wilt virus (TSWV), which is transmitted by specific thrip species. Some viruses such as Pea seed-borne mosaic virus (PSbMV) are introduced by sowing infected seed.

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

- Infected seed or close proximity to a substantial virus reservoir (e.g. lucerne, summer weeds).
- A wetter than average summer–autumn with green plant material that allows uncontrolled multiplication of aphids during the time when numbers are usually

low. When aphids are present early in the season epidemics are more likely to occur and the level of damage will be higher.[48]

While field pea seed infected with PSbMV may infect seedlings at a rate of 100%, the rate of transmission for faba bean is thought to be much lower (<1%).[49] Viruses can be classified by the manner in which they are transmitted by insect vectors: persistent or non-persistent.

Persistent transmission

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

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

Insecticides that kill aphids can work in suppressing the spread of this type of virus as transmission rates increase dramatically when the aphids fly.

Non-persistent transmission

Aphids transfer non-persistent viruses on their mouth parts directly by carrying the virus from an infected plant to a healthy one. The aphid can only infect one or two more plants at a time. Many aphid species are vectors of this type of virus including ones that do not colonise legumes but just land and probe while searching for their preferred hosts (e.g. oat and turnip aphids). Non-persistent viruses include PSbMV, AMV, CMV and BYMV.

Insecticides are less effective at suppressing this type of virus as they do not act fast enough. They may make the situation worse as the insecticide can agitate aphids and increase virus spread.[50]

48 B Coutts, R Jones, P Umina, J Davidson, G Baker and M Aftab (2015) Beet western yellows virus (synonym: Turnip yellows virus) and green peach aphid in canola. GRDC Updates Paper, 10 February 2015

49 J Davidson, R Kimber, L McMurray, M Lines, J Paull, A Ware and K Hobson (2014) Diseases in pulse crops during 2013. GRDC Update Papers, 25 February 2014, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/02/Diseases-in-pulse-crops-during-2013

50 Pulse Australia (2016) Southern/western field pea best management practices training course, module 6-2016 Draft. Pulse Australia Limited

Table 10: Virus categories and general symptoms.

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

* Seed transmission in field pea is minimal for most viruses except PSbMV, but of no epidemiological significance. However, it is important for quarantine to keep foreign virus strains out of Australia

Source: Pulse Australia (2016).

In 2014, a year where TuYV (synonym: BWYV) was widespread in canola crops across SA, Victoria and NSW, the South Australian Research and Development Institute (SARDI) found relatively low virus infection rates in field pea in SA and it was only detected at a high infection rate in one crop in SA late in the season (Table 11).

Table 11: Results of virus testing in South Australia in 2014.

Crop type	Number of crops or trials tested	Test period	Number of crops with positive virus tests (average % infection rate in brackets)					
			TuMV (syn. BWYV)	PSbMV	CMV	AMV	BLRV	BYMV
Field pea	9	Jul–Aug	8 (20.1%)	7 (6.1%)	1 (2%)	0	0	0
	6	Sep–Oct	4 (3%)	4 (20.5%)	0	0	0	0

Source: J Davidson, R Kimber, L McMurray, M Lines, J Paull, A Ware and K Hobson (2014) Diseases in pulse crops during 2013. GRDC Update Papers, 25 February 2014, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/02/Diseases-in-pulse-crops-during-2013

9.20.2 Symptoms

It can be difficult to distinguish plant disease symptoms caused by viruses in pea plants, as viral foliage symptoms are often similar to those caused by nutritional deficiencies, herbicide damage or waterlogging.[51]

Paddock symptoms

Seed-borne virus infection causes stunted plants that are scattered throughout the crop and act as foci for virus spread by aphids.

When the virus source is external to the crop, plants often become infected first in greatest numbers close to the paddocks edges or around thin or bare areas, particularly on the paddock's windward side.

Pea seed-borne mosaic virus (PSbMV)

PSbMV is the only seed-borne virus of importance in field pea in Australia. It is non-persistently aphid-borne. Plant symptoms are usually very mild and difficult to detect:

- plants may be infected without showing symptoms;
- margins of young leaves roll downwards, there is mild chlorosis and mosaics, mild vein clearing may develop (Photo 14);
- terminal leaves are often reduced in size and tendrils excessively curled;
- infection at later growth stages may result in top leaves turning pale; and
- infected plants may also produce distorted flowers, which give rise to small distorted pods and fewer seeds. The seed coats may split as the seeds mature, and dark brown rings and tan spots develop.

51 GRDC (2009) Field Peas: The Ute Guide, Southern region. GRDC Ground Cover Direct

Photo 14: *Mild chlorosis, mosaic vein clearings, excessive curled tendrils on field pea infected with PSbMV.*

Photo: Rohan Prince, DPIRD (formerly WADA)

Photo 15: *Brown rings, tan sports and cracking of seed indicate PSbMV.*

Photo: Trevor Bretag, DEDJTR

Alfalfa mosaic virus (AMV), Bean yellow mosaic virus (BYMV) and Cucumber mosaic virus (CMV)

These viruses are generally of minor economic importance. They are non-persistently aphid-borne and develop low rates of seed transmission in peas. General symptoms can include mosaic mottling and yellowing.

Alfalfa mosaic virus (AMV)

- Chlorosis and necrosis of new shoots. Necrotic spots or streaking of older leaves.
- Pods may be malformed and fail to develop seed.

Bean yellow mosaic virus (BYMV)

- Variable symptoms, but plants sometimes become infected while symptomless.
- When foliage symptoms develop, these consist of vein clearing and mottles and mosaics especially on young leaves.
- Necrosis sometimes develops in stems and veins.

Cucumber mosaic virus (CMV)

- Foliage symptoms are mild and difficult to observe.
- Possible leaf chlorosis and slight stunting (Photo 16).[52]

Photo 16: *CMV-infected pea plant (right) and healthy plant (left).*

Photo: Crop Pro, Field pea viruses, http://www.croppro.com.au/crop_disease_manual/ch10s04.php

Turnip yellows virus (TuYV) (synonym: Beet western yellows virus (BWYV))

TuMV (synonym: BWYV) is persistently aphid-borne; no seed transmission. Symptoms include stunting and yellowing of plants (Photo 17).

Photo 17: *TuMV (synonym: BWYV) infected field pea plant (right) and healthy plant (left).*

Photo: Crop Pro, Field pea viruses, http://www.croppro.com.au/crop_disease_manual/ch10s04.php

52 B Coutts (2015) Diagnosing virus damage in field peas. Department of Agriculture and Food, Western Australia, https://www.agric.wa.gov.au/mycrop/diagnosing-virus-damage-field-peas

Bean leaf roll virus (BLRV)

BLRV is persistently aphid-borne; no seed transmission. Symptoms include stunting and yellowing of plants. BLRV is the most important virus in northern field pea areas (Photos 18 and 19).

Photo 18: *The three plants on the right are stunted and yellow from Bean leaf roll virus infection.*

Photo: Grain Legume Handbook (2008), Grain Legume Handbook or Field Peas: The Ute Guide page 38

Photo 19: *Premature death of field pea lines infected with Bean leaf roll virus.*

Photo: M Schwinghamer, NSW DPI, Field Peas: The Ute Guide page 38

9.20.3 Economic importance

Viruses are not considered a major problem of field pea in the southern region, but should not be ignored (Table 13). Infection can reduce yield and seed quality.[53]

Table 12: Incidence and field pea crop area affected by virus.

Virus	Incidence (%)	Area of crop (%)
Alfalfa mosaic virus	5.6	0.3
Bean leaf roll virus	17.1	8.8
Bean yellow mosaic virus	8.8	8.3
Beet western yellows virus	12.5	9.7
Cucumber mosaic virus	8.8	8.8
Pea seed-borne mosaic virus	49.4	34.2

Incidence as a proportion of years when the disease occurs and area as a percentage of crop area affected when the disease develops.

Source: Murray and Brennan (2012)

Many field pea crops surveyed in Australia had Pea seed-borne mosaic virus (PSbMV) present, which is a seed-transmitted virus that can occasionally express as a major problem.

Other viruses like Bean leaf roll virus (BLRV) and Turnip yellows virus (TuYV) (synonym: Beet western yellows virus (BWYV)) have also been detected, but are not seed-transmitted.

In unique cases where field pea crops have experienced heavy losses from viral infection, it has been in association with prolonged, high levels of aphids that arrived early.[54]

9.20.4 Disease cycle

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

CMV and AMV are non-persistently transmitted by a range of aphid species including lucerne blue green aphid (*Acyrthosiphon kondoi*), cowpea aphid (*Aphis craccivora*), foxglove aphid (*Aulacorthum solani*), ornate aphid (*Myzus ornatus*) and green peach aphid (*Myzus persicae*). The luteoviruses are persistently aphid-transmitted, but are more vector specific. Correct identification of the aphid is important for effective management.

TSWV is spread by thrips.

Probing and feeding needs to be prolonged for persistently transmitted viruses (0.1–4.0 hours for luteoviruses), but only needs to be brief for non-persistently transmitted viruses. Eventually aphids colonise the field pea plant and become very visible in the crop.

Crop loss depends on the growth stage at infection and the number of plants infected. Early and widespread infections lead to the greatest losses.[55]

Aphid activity is influenced by seasonal conditions and will require early monitoring in nearby crops and pastures. See Section 8.6 Aphids and viruses for more information on monitoring and managing aphids.

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

54 W Hawthorne, J Davidson, L McMurray, E Armstrong, B McLeod, H Richardson (2012) Field Pea Disease Management Strategy, Southern & Western Region. Australian Pulse Bulletin, No. 6, http://www.pulseaus.com.au/storage/app/media/crops/2012_APB-Fieldpea-disease-management-South-West.pdf

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

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MORE INFORMATION

GRDC Fact Sheet: Aphids and viruses in pulse crops
http://www.grdc.com.au/GRDC-FS-AphidsandVirusesinPulses

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

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

9.20.5 Control

There are no proven methods for controlling viruses. Breeding resistant varieties is the most economical and sustainable way to control viruses.

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

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

Management options at the planning stage are:

- Suppress the virus source within the crop by purchasing virus-tested seed. Only retain seed from crops with no visible symptoms.
- Grade out smaller grain, which is more likely to be infected. PSbMV, CMV, BYMV and AMV survive through seed transmission. A threshold of 0.1% seed infection is recommended for sowing in high-risk areas, and <0.5% for low-risk areas.
- Distance crops from lucerne, weeds or other species that act as a reservoir for viruses, diseases and aphids.
- Control volunteer weeds and self-sown pulses that are a 'green bridge' host for viruses and a refuge for aphids and their multiplication during summer and autumn.
- Rotate pulse crops with cereals to reduce virus and vector sources (aphids or other insects) and where possible avoid close proximity to perennial pastures (e.g. lucerne) or other crops that host viruses and aphid vectors.[56]

Management options at sowing and in-crop:

- Suppress the virus source within the crop. Sow seed with <0.1% seed infection.
- Use a seed treatment like Gaucho 350SD® (imidacloprid) or Cruiser Opti® (thiamethoxam), which are registered for early aphid protection to control persistently transmitted viruses.
- Retain cereal stubble as aphids are less likely to land in stubble.
- Sow at recommended times to avoid autumn aphid flights.
- Sow at recommended plant densities to achieve early closure of the crop canopy. Closed canopies deter aphids.
- Note that high seeding rates and narrow row spacing to provide early canopy closure assists in aphid control, but conflicts with management of fungal diseases.
- Manage crops to minimise seedling stress through disease, herbicide damage and poor nutrition. Stressed crops are more attractive to aphids.
- Insecticides after emergence may be effective for persistently transmitted viruses. However, they may not be effective for non-persistently transmitted viruses as the insecticide can agitate aphids and increase virus spread.
- Monitor field pea and nearby crops and pastures for aphids. Be prepared to use insecticide when there may be localised flights.
- Consider the effect of insecticide on beneficial insects.

Growers should only consider applying insecticide to control aphids and prevent the spread of viruses if they consider their crops to be at high risk. Insecticides aimed at controlling damage from aphid feeding are normally too late to control virus spread and damage.[57]

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

57 W Hawthorne, J Davidson, L McMurray, E Armstrong, B McLeod, H Richardson (2012) Field Pea Disease Management Strategy, Southern & Western Region. Australian Pulse Bulletin, No. 6, http://www.pulseaus.com.au/storage/app/media/crops/2012_APB-Fieldpea-disease-management-South-West.pdf

9.20.6 Virus testing

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

Detection of virus in 1 or 2 plants is not proof that the virus is causing a problem. It is important to check for a range of viruses, as the one detected by a test may not be the virus actually causing symptoms.

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

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

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

DPIRD Diagnostic Laboratory Services (DDLS) Seed Testing and Certification

DDLS conduct seed tests for CMV.

Department of Agriculture and Food
Reply Paid 83377
3 Baron Hay Court
South Perth, WA 6151

Ph: 08 9368 3721
Email: DDLS-STAC@agric.wa.gov.au
https://www.agric.wa.gov.au/plant-biosecurity/ddls-seed-testing-and-certification-services

TASAG

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

Contact: Peter Cross

New Town Laboratories
13 St John's Ave
New Town, Tasmania, 7008

Ph: 03 6165 3252
Email: peter.cross@dpipwe.tas.gov.au
http://dpipwe.tas.gov.au/biosecurity/plant-biosecurity/plant-health-laboratories/tasag-elisa-testing

Agrifood Technology

Agrifood conduct testing for CMV and AMV.

Contact: Robert Rantino or Doreen Fernandez

260 Princes Highway,
Werribee, VIC 3030, Australia

Postal: PO Box 728,
Werribee, VIC 3030, Australia

Phone: 1800 801 312
http://www.agrifood.com.au/index.php/services/food-safety

MORE INFORMATION

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

DPIRD webpage:
https://www.agric.wa.gov.au/plant-biosecurity/ddls-seed-testing-and-certification-services

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

Agrifood Technology webpage:
http://www.agrifood.com.au/index.php/services/food-safety

For more information, please see:
Section 3.5.2 Seed testing for disease

9.21 Research of interest

J Davidson, C Wilmshurst, E Scott & M Salam (2013). Relationship between ascochyta blight on field pea (*Pisum sativum*) and spore release patterns of *Didymella pinodes* and other causal agents of ascochyta blight.