

Lentil Disease Management Strategy

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Summary of strategies to minimise disease in lentils

- **Paddock selection.** Aim for a break of at least 3 years between lentil crops and at least 250 m from the previous year's lentil paddock. Avoid sowing adjacent to faba bean, vetch, chickpea or lathyrus stubble.
- **Variety selection.** Select varieties with least susceptibility to the main disease risk for the region. Spread overall risks by sowing more than one variety.
- **Seed source.** Use seed from a paddock where viruses and fungal diseases were not detected. A fungal threshold of less than 1% is acceptable. For viruses, a threshold of <0.1% seed infection is necessary in high risk areas, and <0.5% seed infection for low risk areas.
- **Seed treatment.** Treat seed for sowing with a fungicide seed dressing.
- **Canopy management.** Manipulate variety choice, row spacing, seeding rate and time of sowing to manage crop height, delay time of canopy closure, and prevent lodging to assist in disease management.
- **Wider row spacing** (23-42cm) delays canopy closure, and may reduce disease if lodging does not occur. Standing cereal stubbles, help to keep lentils erect.
- **Sowing rate.** Aim for a plant population of 100-120 plants per square metre.
- **Sowing date.** Sow within the optimum planting window for your district.
- **Hygiene.** Take all necessary precautions to prevent the spread of disease.
- **Foliar fungicide program.** Foliar fungicide applications often commence before canopy closure. Use the SARDI decision support model to assist in making that fungicide application decision. Success depends on monitoring, correct disease identification, timeliness of application and using the correct product.
- **Harvest management.** Early harvest minimises disease infection on seed.

Introduction

With an integrated approach to disease management every year, growers can minimise risk and maximise lentil profits in southern Australia. Seasonal conditions and poor crop management play a significant role in disease outbreaks.

Botrytis grey mould (BGM), caused by the pathogens *Botrytis cinerea* & *Botrytis fabae*, and ascochyta blight, caused by *Ascochyta lentis*, are the two major diseases affecting the production of lentil in southern Australia. Ascochyta blight is favoured by prolonged wet, cool conditions, often before flowering. However, it is most damaging if rain during podding results in pod infection and subsequent downgrading of lentil seed quality due to seed staining.

BGM develops quickly in warm (15 - 25°C), humid conditions (RH over 80%) for 4 – 5 days, particularly at flowering and after canopy closure. Yield losses due to BGM arise from infection of lower stems and leaves, which will spread and lead to stem and plant death, and the eventual formation of dead patches within crops which produced small seed or no seed at all.

This brochure focuses on BGM and ascochyta blight management, but consideration needs also be given to other diseases like viruses and sclerotinia.

Sclerotinia develops under similar conditions as BGM and control strategies for BGM help to reduce this disease.



Photo: Ascochyta blight infection on leaves (DPI Vic)

1. On –farm hygiene (post harvest-pre sowing)

Seed retained on-farm should be from the ‘cleanest’ paddocks, where no disease was detected.

The BGM and ascochyta blight pathogens can carryover from one season to the next on infected lentil seed, stubble and volunteer plants. Botrytis can also carry over on the stubble of alternate hosts such as faba bean, vetch, chickpea or lathyrus as they may be a potential harbour of the same botrytis species (*Botrytis fabae* & *B. cinerea*) that can attack lentils.

Reduce stubble from potential pulse crop hosts where feasible i.e. bury, destroy or burn infected crop residue. Burying stubble can significantly decrease the decomposition time of stubble.

Grazing helps reduce stubble, however, infected stubble can be carried between paddocks by stock. Be aware of grazing restrictions on stubble treated with fungicides.

Infected stubble may also be carried by wind, water or machinery at harvest. Clean all machinery, transport equipment and storage facilities with compressed air before moving to the next paddock.

Control volunteer lentils, faba beans, vetch, lathyrus and chickpeas early to limit the build-up of disease inoculum.

2. Paddock selection

A break of at least 3 years should be observed between lentil crops.

Do not sow adjacent to lentil stubble, particularly downwind. If possible, aim to separate this year’s lentil crop from last year’s lentil stubble by a distance of at least 250 m.

Reduce disease risk by not sowing adjacent or into faba bean, chickpea, vetch or lathyrus stubble. If this is not possible, manage the lentil crop with a high botrytis risk management strategy.

Be aware that early sown faba bean, vetch or lathyrus crops may be a source of botrytis inoculum

Table 1. Disease reaction of lentil varieties^A

DISEASE RATING	ASCOCHYTA		BOTRYTIS GREY MOULD (BGM)
	Foliar ^B	Seed/Pod	
Resistant ^C R	Nipper, Northfield, PBA Blitz, PBA Herald-XT, PBA Jumbo	Nipper, Northfield, PBA Herald-XT, PBA Jumbo	Nipper
Moderately resistant MR	Boomer, Aldinga, Nugget ^B , PBA Bounty	PBA Blitz, PBA Bounty	Boomer ^D , Digger, PBA Blitz, PBA Herald-XT, Nugget ^D
Moderately susceptible MS	PBA Flash ^B Digger ^B	Nugget, PBA Flash ^B Aldinga, Boomer, Digger, Tiara ^(p)	Aldinga, PBA Bounty, PBA Jumbo Tiara ^{D (p)}
Susceptible S	Tiara ^{(p)B}		PBA Flash Northfield

^A National ratings as supplied by Pulse Breeding Australia (PBA) 2012.

^B Note status of PBA Flash, Nugget, Digger and Tiara for ascochyta blight foliar infection was revised in 2011. .

^C No variety with a Resistant (R) rating is immune to disease, and fungicide application may be required under severe disease pressure.

^D Nugget, Boomer and particularly Tiara have a tendency for greater vegetative growth and height, which can predispose them to botrytis.

^(p) = provisional rating

into adjacent, later sown, lentil crops. If this is not possible to avoid, manage the lentil crop with a high botrytis risk management strategy.

Where there is a high risk of sclerotinia, avoid planting lentils after canola or other broadleaf crops which act as alternative hosts to this disease.

Avoid paddocks with high soil nitrogen, as this can lead to greater vegetative growth in lentils, predisposing the crop to disease development.

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



Photo: Ascochyta blight on lentil seed on right (DPI Vic)

3. Varieties

Under high disease pressure, all varieties will require fungicide protection to control disease epidemics. Include a variety that best withstands the main disease risk(s) for your region e.g. PBA Herald-XT, PBA Blitz , PBA Jumbo or Nipper for ascochyta blight resistance; PBA Blitz, PBA herald-XT, Nipper or Boomer for some BGM resistance.

If growing susceptible varieties, spread risks by sowing more than one variety, each with different resistance characteristics. i.e. don’t sow both PBA Flash and Aldinga or both PBA Flash and Northfield if in a BGM prone region.

4. Seed

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

A fungal threshold of less than 1% is acceptable. Definitely avoid using seed with greater than 5% botrytis or 5% ascochyta infection.

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

Seed disease testing services are available from SARDI Diagnostic Services, SA, Ph 08 8303 9360, Agrifood Technology, Vic, Ph 03 9742 0555 or AgWest Laboratories ph 08 9368 3721.

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

5. Seed dressing

Seed should be properly treated with a fungicide to control seedling root rots and most seed infections, including ascochyta blight and BGM.

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

Registered seed treatments to use for lentils are: thiram plus thiabendazole (P-Pickle T[®]); or thiram alone (Thiraflo[®] or Thiragranz[®]). All are registered in lentils for control of ascochyta and seedling root rots, but will control seedling botrytis as well.

Seed dressings may have a deleterious effect upon rhizobia so their contact time must be minimised. Read the label rhizobia label for compatibilities. Apply seed dressing first and then mix inoculum with seed immediately before sowing.

Alternatively granular or liquid inoculants are now available and will prevent inoculum coming in contact with fungicide on seed.

6. Canopy management.

6.1 Sowing rate

Aim for a plant population of 100-120 plants per square metre.

Calculate actual seeding rates (kg/ha) based on seed size because seed sizes vary widely with variety and season. Approximations are 50kg/ha for Nugget or Digger, 60 kg/ha for Aldinga, 40 kg/ha for Nipper or Northfield and 70kg/ha for Boomer.

Higher seeding rates can increase the risk of BGM due to dense canopy growth.

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

Seeding rates below the minimum recommended plant populations can reduce yield.

6.2 Row spacing

Wider row spacing can be part of BGM disease management in lentil by keeping the canopy open and drier for longer, provided lodging does not occur. Precision sowing lentils between standing cereal stubble rows allows trellising and keeps the lentils more erect. Without stubble trellising, row spacing's beyond 23 cm makes the lentil crop susceptible to lodging and increase the risk of disease development. Botrytis can colonise wet cereal straw, but the ability of cereal stubble to act as a multiplier for BGM is still unclear.

6.3. Sowing date

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

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

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

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

Sowing lentils early with wider rows into standing cereal stubble in the belief that it lessens disease risk through delayed canopy closure and less lodging is not proven.

The optimum sowing time for lentils is therefore dependent on location, sowing system used and disease risk:

Early sowing is usually beneficial in medium to low rainfall areas or in areas prone to early, quick finishes to the season. This is provided that weeds, BGM and ascochyta blight are effectively controlled.

Delayed sowing is required in areas where high biomass production occurs in spring, and lodging occurs pre-flowering making effective BGM control more difficult. The ideal is for the lentils to remain standing until flowering has finished.

Spring sowing is desirable in some higher rainfall areas, or areas with a long, late growing season.

In a BGM prone area, sow at the later end of the recommended window for your district and sow varieties like Nipper, Digger or Nugget before varieties like Northfield or Aldinga.

Table 2. Optimum sowing times^A

Region (annual rainfall)	Month	May				June				July			
	Week	1	2	3	4	1	2	3	4	1	2	3	4
350-375 mm													
375-400 mm													
400-450 mm													
450-500 mm													
500-600 mm ^B													
	Marginal areas or low disease risk areas		Preferred planting time							For high disease risk areas ^C			

^A Sowing time may need to vary with the flowering and maturity time of the variety.

^B Preferred sowing time for spring-sown lentils is August-September.

^C Sow later to reduce the disease risk if: a more susceptible variety (eg PBA Flash, Northfield); or in districts with milder winter temperatures where *Botrytis Grey Mould* (BGM) is a regular problem (e.g. Yorke Peninsula, Lower Eyre Peninsula, Upper SE of SA).

7. Lentil viruses

Most lentil crops surveyed in South Australia and Victoria had Cucumber Mosaic Virus (CMV) present, which can occasionally express as a major problem. In unique cases where lentil crops have experienced heavy losses from viral infection, it has been in association with prolonged, high levels of aphids that arrived early. Combinations of CMV, Alfalfa Mosaic Virus (AMV) and Beet Western Yellow Virus (BWYV) were present in plants tested from these crops.

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

- Close proximity to a substantial virus reservoir (eg lucerne, summer weeds, infected lentil seed).
- High summer-autumn rainfall and the subsequent uncontrolled multiplication of aphids on host plants. Early aphid flights to newly emerged crops cause early infection and economic loss as infected plants act as a reservoir for further spread of infection within the crop.

7.1. Virus control

Virus risks can be managed by combining a number of different control measures:

- Suppress the virus source within the crop. Sow seed with less than 0.1% seed infection.
- Control volunteer weeds during summer and autumn where lentils are to be sown.
- Decrease aphid landing rates through having stubble cover. Higher seeding rates and narrow row spacing can help too, but can conflict with other fungal disease management needs.

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



Lentils with CMV & AMV. Note the bare ground (Pulse Australia)

8. Fungicide spraying program

There are three critical periods for fungicide spraying decisions on lentil crops for disease.

First critical period is at 10-14 weeks after emergence (WAE), shortly prior to canopy closure. Early application of fungicide is critical in restricting the early development and spread of BGM. In susceptible varieties, or in districts prone to BGM epidemics, apply a fungicide, irrespective of BGM being present. An application at this stage is the final chance for spray penetration deep into the crop canopy to protect stems. The presence of ascochyta blight at this stage is unlikely to cause significant yield losses in varieties that have moderate resistance to foliar infection by ascochyta. Varieties like PBA Flash and Tiara that are more susceptible may require ascochyta protection at this early stage.

Second critical period is at mid flowering/early pod fill (14-16 WAE). If either BGM or ascochyta blight is present, or weather is conducive to disease, apply a fungicide. The type of fungicide used will be dependent on the variety. Mixtures of foliar fungicides may be required to give control for both diseases in some susceptible lentil varieties. Continued infection by BGM at this stage will impact on yield by causing stem infection under the canopy and subsequent plant death. Infection of pods by ascochyta at this stage will impact on seed quality and yield if seed is aborted.

Third critical period is at the end of flowering/mid pod fill (16-18 WAE). This is the final growth stage where all pods are formed and protection against ascochyta infection ensures good seed quality is achieved.

If ascochyta blight is present during pod formation and filling, seed staining can occur in many older varieties. PBA Herald-XT, PBA Jumbo and Northfield can be the exception because their seed has resistance to ascochyta infection and subsequent staining. However in a wet spring even these may require a spray during podding to prevent seed staining. Severe disease pressure from ascochyta can result in yield loss in some varieties due to seed abortion, except PBA Blitz, PBA Herald-XT, PBA Jumbo, Nipper and Northfield. Botrytis control may be required though if that disease is severe and weather is conducive to spread.

Requirements, all periods: During the critical periods, monitor crops at least once every week and react by spraying ahead of rain events. Fungicide sprays for BGM are likely to be required depending on variety, rainfall and canopy. To assist in making BGM fungicide application decisions, see figure 1 and “disease risk categories – BGM” on this page.

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

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

Take note of grain and grazing withholding periods (WHPs). For crops that are desiccated or windrowed, the WHP is to that date, not actual harvest date.

8.1. Lentil fungicides (Ascochyta blight)

Chlorothalonil is considered a better option than mancozeb when ascochyta persists and its control is most important.

Carbendazim and procymidone products give poor protection against ascochyta.

8.2. Lentil fungicides (Botrytis grey mould)

If botrytis pressure is high or the disease is spreading in the crop, then carbendazim or procymidone are better options than chlorothalonil or mancozeb. Where mancozeb or chlorothalonil is being used primarily for ascochyta control, it has the added benefit of controlling low levels of botrytis.

Registration regulations limit carbendazim and procymidone to a maximum of two consecutive sprays each. Both are systemic fungicides with single site specificity so the probability of resistance increases with regular use. Alternate the carbendazim or

procymidone with a fungicide from a different fungicide group. Procymidone is group 2, carbendazim is group 1. Chlorothalonil is group M5 and mancozeb is group M3.

8.3. Disease risk categories

Ascochyta blight: A lentil crop is considered to be at risk of ascochyta blight if one or more of the following conditions apply:

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

BGM: See Figure 1 to assist in assessing the BGM risk and determining remedial actions. A lentil crop is considered to be at risk of botrytis grey mould if one or more of the following conditions apply:

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

8.4. Fungicide spraying

See figure 1 for assistance in the fungicide spraying decision process for BGM.

Control is based on preventing new infections, not curing old infections.

Stems and lower leaves are not effectively covered by a fungicide applied after canopy closure.

Spraying before the canopy closes achieves better fungicide penetration and is more effective than trying to halt an epidemic after the canopy closes or the crop has lodged.

Any new growth after spraying is not protected.

Spraying ahead of rain prevents fungal infection occurring, rather than waiting until after rain when the disease has already started to spread.

Spray early in the morning as dew will assist in spread of fungicide product over the plant surface.

Spraying in light rain is preferable to waiting till after the end of a rain event.

Depending on the time of year and growth rate of the crop, the period of fungicide protection can vary. In the cooler winter months the period of protection can be for 2-3 weeks when crops growth rates are

generally slower. But in warmer spring conditions this period may be reduced to 7-14 days during rapid crop growth and the emergence of unprotected plant growth.

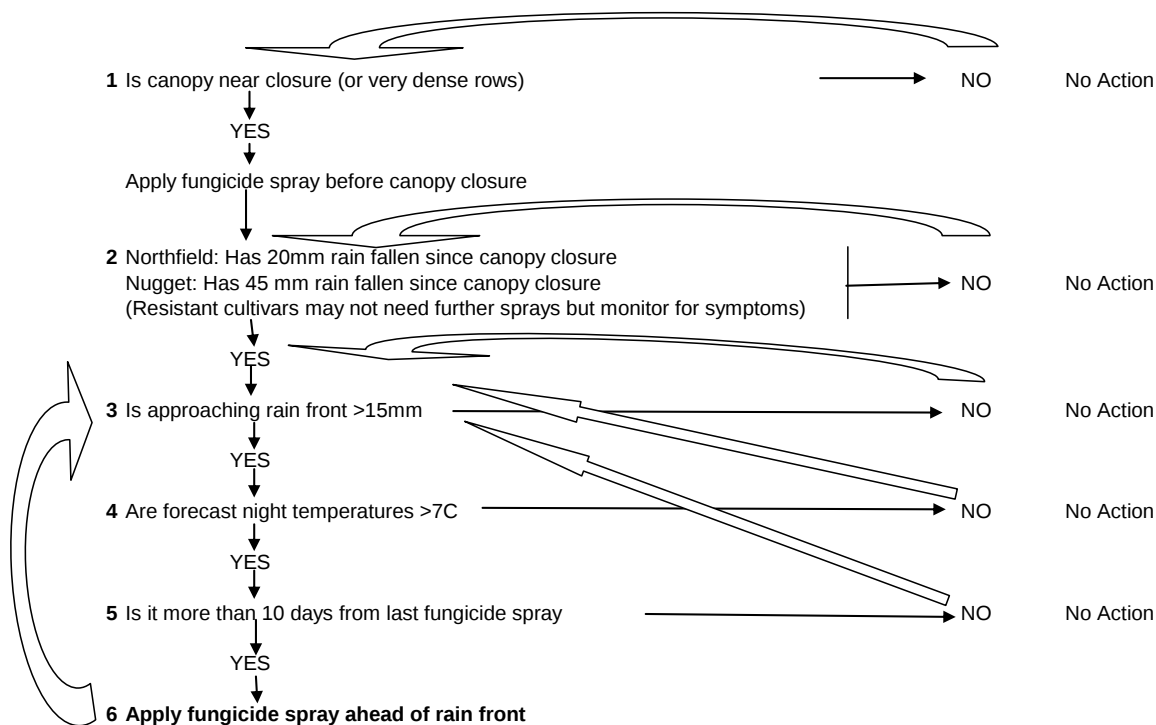
Use high water rates (preferably 100 L/ha by ground or 30 L/ha by air). Flat fan nozzles with a fine/extra

fine droplet spectrum & an operating pressure of 400 kPa is best.

Surfactants (spreaders) improve initial spray deposits and redistribution (refer to fungicide label).

Stickers reduce droplet spread over the leaf surface and are not recommended.

Figure 1. SARDI Decision Support for Fungicide Applications to control BGM in Lentil.



NB: BGM disease can still develop outside the rainfall and temperature guide-lines quoted in the decision model (figure 1).



Photo: *Botrytis* Grey Mould on pods, a condition also referred to as 'fire sack' (DPI Vic)



Photo: *Botrytis* Grey Mould affected crop (DPI Vic)

Table 3. Lentil Foliar Fungicide Registrations^A (APVMA at June 2012)

	Company	Active ingredient and (fungicide group)	Rate ^B	Lentil diseases	
				BGM	Ascochyta
1. Penncozeb 420SC [®]	1.Nufarm	1.Mancozeb 420g/L (M3)	2.5L/ha	-	√
1. Dithane [®] Rainshield Neo Tec 2. Manfil [®] 3. Manzate [®] 4.Penncozeb 750 DF [®] 5. AW Vine 750DF 6. Unizeb 7.Mancoflo 8. Manzeb 9. Masquerade 10. Protectozeb 10. Mancozeb [®]	1.Dow 2.Runge 3.Dupont 4.Nufarm 5. Agri West 6. United Phosphorus 7. Amgrow 8. Farnalinx 9.Axichem 10. Agvantage 11.many	Mancozeb 750 g/kg (M3)	1.0-2.2 kg/ha	√	√
1.Barrack [®] 2.Barrack [®] betterstick 3.Unite 720 [®]	1,2.Crop Care 3.Nufarm	Chlorothalonil 720 g/L (M5)	1.1-2.0L/ha	√	√
Numerous, Including chlorothalonil [®]	1.various	Chlorothalonil 720 g/L, 500 g/L or 900 g/kg (M5)	-	None Registered	None Registered
1. Howzat [®] 2. Spinflo [®] 3. Boomer [®] 4. Carazim [®] 5. Motac 6. Shincar 7. Goldazim 8. Carbendazim	1. Farnoz 2. Nufarm 3. Sipcam 4. Hextar 5. Sumitomo 6. Sinon Aust. 7. Campbell 8. several	Carbendazim 500 g/L (1)	500 mL/ha	√	-
1.Fortress [®] 2.Sumisclex [®] 3.Sumisclex [®] Broadacre 4. Procymidone.	1.CropCare 2,3.Sumitomo 4. Titan	Procymidone 500 g/L (2)	500 ml/ha	√	-
1.Polyram [®] DF	1.Nufarm	Metiram 700 g/kg (M3)			

^A Always read the label before use. ^B = Lower rates to be used on shorter crops or to the commencement of flowering, whichever comes first. Use higher rate for dense crops and if disease severe. **NR** = no registration or permit for this crop. [®]= registered trademark.

Harvest WHP's (days): mancozeb (28), chlorothalonil (14, ESI = 63 days), carbendazim (28), procymidone (21), metiram (42).

9. Early harvest

Harvest as early as possible to minimise botrytis and ascochyta infection on seed. Disease is usually more severe when crops are harvested late. Harvest losses and downgrading in quality can be substantial if lentil harvest is delayed until moisture content is below 12%.

Marketing problems are created if receival standards of 1% poor colour (due to disease, water staining, frost) are exceeded.



Photo: Botrytis Grey Mould on stem (DPI Vic)



Photo: Botrytis Grey Mould on base of stem (DPI Vic)

**Table 4: Fungicide Application Guide^A -
By variety, disease, risk^B, critical period and rainfall (>400mm and <400mm).**

Critical Period	PBA Herald-XT, Nipper	Boomer, Digger, Nugget, PBA Blitz	Aldinga, PBA Bounty, PBA Jumbo, Tiara,	PBA Flash,	Northfield
First (10-14 WAE)	<u>> 400mm only</u> If BGM risk high ^B 1,2,3 or 4 ^A	<u>> 400mm only</u> If BGM risk med/high ^B 1,2,3 or 4 ^A	<u>All rainfalls</u> If BGM risk med/high ^B 1,2,3 or 4 ^A	<u>All rainfalls</u> If BGM risk med/high ^B 1,2,3 or 4 ^A	<u>All rainfalls</u> If BGM risk med/high ^B 1,2,3, or 4 ^A
Second (14-16 WAE)	<u>> 400mm only</u> If BGM risk is very high ^B 1,2,3, or 4	<u>> 400mm</u> If AB present + BGM risk low ^B 3 or 4 If AB present + BGM risk high ^B 5,6,7,8,3 or 4 ^A If AB absent & risk low + BGM risk high 1 or 2 <u>< 400mm</u> If AB risk 3 or 4	<u>> 400mm</u> If AB present + BGM risk low ^B 3 or 4 If AB present + BGM risk med/ high ^B 5,6,7,8,3 or 4 ^A If AB absent & risk low + BGM risk med/high 1,2,3 or 4 <u>< 400mm</u> If AB risk 3 or 4	<u>> 400mm</u> If AB present + BGM risk med/ high ^B 5,6,7,8,3 or 4 If AB absent & risk is low/ medium + BGM risk med/high ^B 5,6,7,8, 3 or 4 ^A Monitor. More than one fungicide application may be required for BGM before end of flowering (critical period 3). <u><400mm</u> If BGM risk med/high 3 or 4	<u>> 400mm</u> If BGM risk med ^B 1,2,3 or 4 If BGM risk high ^B 1 or 2 Monitor. More than one fungicide application may be required for BGM before end of flowering (critical period 3). <u><400mm</u> If BGM risk med/high 1,2,3 or 4
Third (16-18 WAE)	-	<u>> 400mm only</u> If AB present & risk high ^B 3 or 4	<u>> 400mm only</u> If AB present & risk high ^B 3 or 4	<u>> 400mm only</u> If AB present & risk high ^B 3 or 4	<u>> 400mm</u> If BGM risk med ^B 1,2,3,4 If BGM risk high ^B 1 or 2

^A Fungicides: 1= carbendazim, 2 = procymidone, 3 = chlorothalonil, 4 = mancozeb or metiram, 5 = 1+3, 6 = 1+4, 7 = 2+3, 8 = 2+4

^B See AB (ascochyta blight) and BGM (Botrytis Grey Mould) text above for risk determination

Acknowledgements

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