Management of field peas to reduce Ascochyta blight and maximise yield

Sarita Jane Bennett, Robert C. Lee, Anjana Sharma

Centre for Crop and Disease Management, School of Molecular and Life Sciences, Curtin University, Bentley, WA 6102, http://ccdm.com.au, sarita.bennett@curtin.edu.au

Abstract

The legume field pea can be a valuable component of crop rotations to reduce cereal disease carryover and increase soil nitrogen. However, it is frequently affected by Ascochyta blight which reduces yield. Fungicides are used to control the impact of the disease with mixed success, but effective management relies on a combination of strategies. To determine the efficacy of management strategies for disease suppression, field trials were run investigating;

- The interaction between time-of-sowing and fungicide treatment at three locations in Western Australia in 2016, with four fungicide treatments applied either once or twice after sowing.
- The impact of using wheat stubble from the preceding crop to trellis the field peas, reducing crop lodging, and potentially disease spread.

Results showed that time of sowing had a greater impact on yield than repeated application of fungicide. Stubble-trellising using the previous year's cereal stubble significantly reduced disease in the crop and increased yield.

Key Words

Black spot, *Pyronellaea*, *Mycosphaerella pinodes*, *Phoma pinodella, Phoma koolunga*

Introduction

Field peas (*Pisum sativum*) are grown in Australia for both domestic use and for export. In 2016-17 field peas were sown over 230,000 ha with a total production of 415 kt (ABARES 2018). The largest area sown is in South Australia, and in 2016-17 65% of total production was exported (ABARES 2018).The main constraint to field pea production is disease development and yields can be significantly reduced. The annual loss due to disease in field peas in Australia has been estimated to be $23.7M, which equates to $73.35/ha (GRDC 2017). Ascochyta blight or black spot is the major contributor to this loss and can be as high as 100% of the crop, although this is rare. It is caused by a disease complex of four pathogens; *Mycosphaerella pinodes* (Berk. & Blox.) Vestergr (Syn: *Peyronellaea pinodes*), *Phoma pinodella* (L.K. Jones) (Syn: *Peyronellaea pinodella*), *Phoma koolunga* (sp. Nov.) and *Ascochyta pisi* Lib. (Davidson, Hartley et al. 2009) which affect green leaf area, plant stem strength and seed production. The later occurs rarely in Australia.

Ascochyta blight occurs when conditions are cool, wet and humid. Disease symptoms first appear as small dark coloured flecks on the lower leaves and stems, progressing up the stem and onto the pods as the season progresses. Under conditions which favour the disease, integrated disease management is recommended, comprising the following components; variety selection, strategic use of fungicides and crop rotation. Time of sowing is also an important strategy, to allow for the first flush of spores to be released from old pea stubble at the commencement of the season before the crop is sown and emerges.

The aim of this research was to investigate disease management practices on Ascochyta blight infection of field pea and subsequent yield. Field trials were established in which time of sowing and fungicide efficacy were determined. The impact of cereal stubble management was assessed in a separate trial.

Methods

Experiment 1: Interaction of fungicide efficacy with time of sowing

Field trials were sown in 2016 at three locations in Western Australia; Muresk near Northam, Nyabing and Wittenoom Hills, north of Esperance to investigate the impact of time of sowing (TOS) and fungicide treatment on Ascochyta blight in field pea cv. PBA Wharton. Field trials were sown as a three-block split plot design with ten fungicide and timing treatments and two TOS 4-weeks apart; 1 May and 1 June 2016. Table 1 details the fungicide treatments for each site. Fungicide treatments 1 to 4 were single applications of fungicide at 4 weeks after sowing (WAS), treatment 5 was an untreated control, treatments 6 to 9 were two applications of the fungicide at 4 and 8 WAS, and treatment 10 was four applications of a different fungicide each application at 4, 8, 12 and 16 WAS at Muresk and Nyabing, and at 4, 8, 11 and 14 WAS at Wittenoom

Hills. Seeds were treated with P-Pickel T prior to sowing according to standard recommenced practice, sown at 120 kg/ha and inoculated with Group E/F ALOSCA rhizobia. Plots were 6 rows by 10 m, with lentils sown as a buffer between blocks.

Trials were scored three times over the season (early July, August and September). Each plot was given a disease score from 0 to 5 (0 is no disease). Plant height (mm) and growth stage were scored on five plants within each plot, along with a disease percentage on the lower, middle and upper section of each plant at Muresk and Nyabing, and the lower and upper half at Wittenoom Hills, plus a total disease rating across the plot from 0 to 5, where 5 is complete infection. Plots were harvested at the end of the season to record final yield, and a sample of seeds was scored for disease damage.

Table 1: Field pea -Ascochyta blight field trials at Muresk, Nyabing and Wittenoom Hills in 2016 showing fungicide treatments and application rates

Treatments	Fungicide	Active ingredients	Rate (L/ha)
1 & 6	Amistar Xtra	200 g/L Azoxystrobin + 80 g/L Cyproconazole	0.6
2 & 7	Unite	720 g/L Chlorathalonil	1.5
3 & 8	Prosaro	210 g/L Prothioconazole + 210 g/L Tebuconazole	0.3
4 & 9	Tilt	250 g/L Proprioconazole	0.5
5	Untreated control		
10	Amistar Xtra	200 g/L Azoxystrobin + 80 g/L Cyproconazole	0.6
10	Folicur SC	430 g/L Tebuconazole	0.3
10	Tilt	250 g/L Proprioconazole	0.5
10	Opera	85 g/L Pyraclostrobin + 62.5 g/L Epoxiconazole	0.5

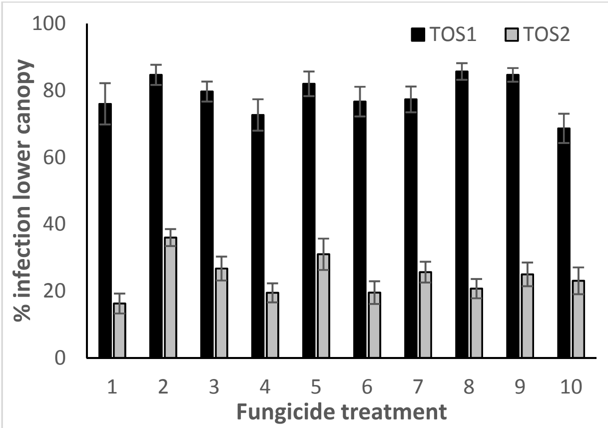
Experiment 2: Stubble management by time of sowing trial
Following a wheat crop in 2017, two blocks were set up at Curtin University, Perth, Western Australia, each with two plots (6 rows by 4 m) of retained or flattened wheat stubble and two times of sowing (TOS) ; 21 May and 21 June as a randomised design with blocks. The trial was sown with field pea cv Kaspa and inoculated with Group E/F ALOSCA rhizobia. Plots were scored for canopy height (mm) and given a lodging score from 0-5 (0 is no lodging) on 11 Aug, 22 Aug and 13 Sep. On the same dates four individual plants were scored for disease on the lower, middle and upper parts of the plant in each plot, as described above. Final yield was recorded at the end of the season.

Following tests for normality and homogeneity of variance, data for both experiments were transformed where required and analysed using Genstat v.18.2 (VSN International Ltd) and R Software packages with statistical methods as noted in the results section. Temperature and rainfall data were recorded at all trial sites over the growing season in both experiments.

Results

Fungicide management by time of sowing trial
Environmental conditions in 2016 imposed additional pressures on the trials with Muresk being impacted by frost (on 34 nights the minimum temperature was below 2°C), and waterlogging in some plots, and Nyabing also being impacted by frost (on 46 nights the minimum temperature was below 2°C). Disease pressure was highest at Muresk and Wittenoom Hills across all fungicide treatments and the untreated control, and was significantly higher in TOS1. Disease management was more successful in TOS2 at all sites, including in the untreated control, and in TOS2 differences between fungicide treatments are apparent (Figure 1). Following analysis of variance (ANOVA) percentage disease infection in the lower canopy at Wittenoom Hills showed a significant difference between TOS ($F=1127.08$, $P<0.05$), and between fungicide treatment ($F=3.74$, $P<0.05$), with no significant interaction. Following Tukey's *post hoc* test, plants in Treatment 2 had greater infection than those in Treatments 1, 4, 6 and 10. Infection in the untreated control was not significantly different than any of the fungicide treatments. Results for Wittenoom Hills only are shown in Figure 1.

The final yields recorded at the three sites in relation to time of sowing (TOS) is shown in Figure 2, where it can be seen following analysis of variance (ANOVA) that there is a significant interaction between trial site and TOS ($F=71$, $P<0.05$), and a significant difference between trial sites ($F=214.85$, $P<0.05$), mostly likely as a result of waterlogging and frost impacts at Muresk and Nyabing, and TOS ($F=161.84$, $P<0.05$). There was no significant difference between fungicide treatments in final field pea yield.



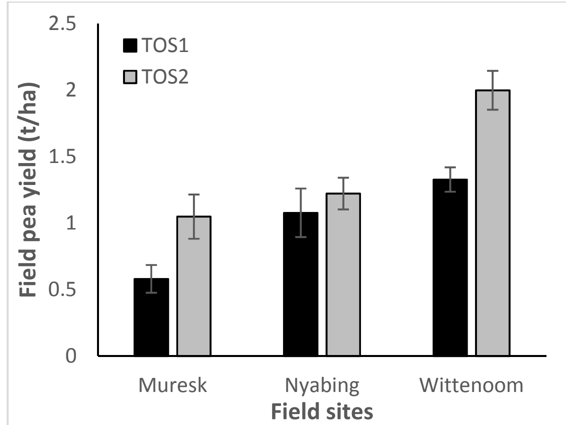


Figure 1. Percentage Ascochyta blight infection in the lower canopy on 2 Sep 2016 in field peas cv. Kaspa at Wittenoom Hills at two times of sowing; TOS1 – 1 May, TOS2 – 1 June by fungicide treatment.

Figure 2. Field pea yield in 2016 at three field sites at two times of sowing (TOS); TOS1 – 1 May, TOS2 – 1 June, averaged across all fungicide treatments.

Stubble management by time of sowing trial

Canopy height did not meet the assumptions of normality and was transformed using a log10 transformation. Repeated measures analysis of variance on the transformed data showed that there was a significant interaction between TOS and +/- stubble (F=7.22, P<0.05), and a significant difference between early and late sowing (F=886.10, P<0.05) and between +/- stubble (F=241.62, P<0.05), as well as a significant increase in plant height over time (F=399.37, P<0.05). In Figure 3A the difference between the taller early sown canopy, and shorter later TOS is clearly apparent, and also the taller canopy when grown between retained stubble, compared to no retained stubble, particularly at TOS1.

The percentage of infected plants was recorded along each third of the plant on the same dates as plant height. The bottom third was most affected by Ascochyta blight throughout the season, with up to 54% of the bottom third infected by 13 Sep on plants in TOS1 with no retained stubble. This compares to only 10% in TOS2 with retained stubble (Figure 3B). A repeated measures ANOVA showed that there was a significant difference between dates (F=29.23, P<0.05) with infection increasing through the season, and there was a significant interaction between TOS and +/- stubble treatment (F=38.12, P<0.05). Throughout the season infection was significantly higher in TOS1, compared to TOS2 and where stubble was not retained, but when stubble was retained infection rates in TOS2 were the same as TOS1 by 13 September, and in both cases were significantly lower than when the stubble was not retained (F=173.80, P<0.05) (Figure 3B). Final yield reflected Ascochyta blight infection with the highest yield recorded in TOS1 with retained stubble (2.3 t/ha), with all other treatments recording a yield between 1.0 and 1.4 t/ha.

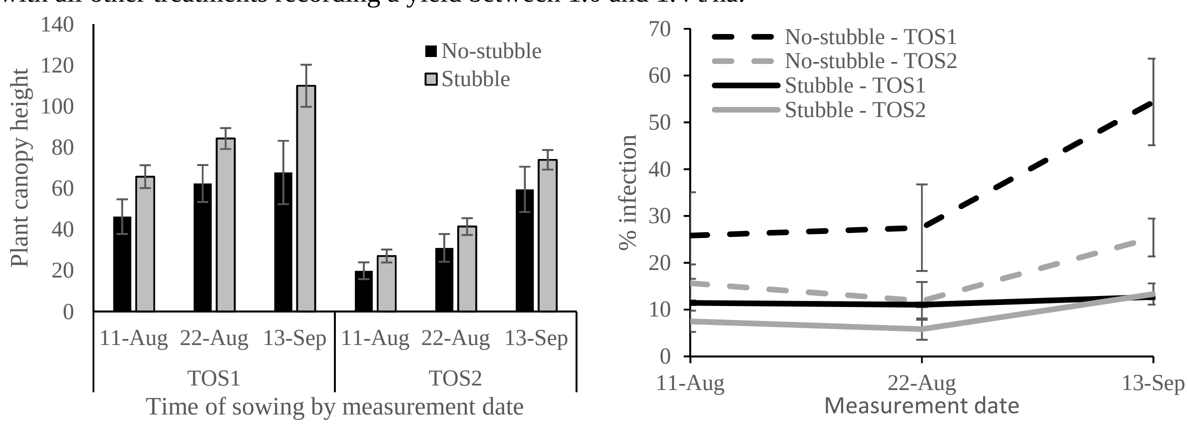


Figure 3. A: Plant canopy height and B: Ascochyta blight infection in the lower third of the plant in field peas over the growing season sown at two times of sowing (TOS) and with stubble left as a trellis, or not retained.

Discussion

Despite the impact of frost and waterlogging in 2016, the field trial results suggest that time of sowing has a much greater impact on reducing infection than the type and timing of fungicide, with the second time of sowing in early June leading to increased field pea yields at both Muresk and Wittenoom. As a seed dressing was used in all treatments, the impact of this on managing Ascochyta blight cannot be determined. In contrast to this, the use of stubble-trellising led to a more elevated canopy, reduced lodging through the main infection period, and reduced the spread of Ascochyta infection through the crop. Thus the highest yield was recorded in TOS1 with stubble-trellising.

The main release for Ascochyta spores and subsequent aerial inoculum source is typically within the first two weeks of rain after the break of season. Current recommendations in Western Australia are therefore to delay sowing of field peas until after the initial autumn spore release (GRDC 2017). The results from the first trial showed that this is still the primary form of management that should be used to reduce the impact of Ascochyta blight, with the different fungicide treatments or timing of applications having little impact on controlling Ascochyta infection, particularly at TOS1 (1 May). However, the risk is always that if there is little to no disease in a season, that the yield loss from delaying sowing is greater than the potential disease loss. MacDonald & Peck (2009) showed following six years of field trials that Ascochyta infection was halved and yield increased by 6% by delaying sowing until after the initial spore release, but that in years when infection levels were low, delaying sowing resulted in a 20% reduction in yield.

One of reasons for the increased disease infection in plants sown earlier is that there is a much greater amount of vegetative material in these crops, compared to crops sown later, and that this enables the humidity within the crop to be maintained. Therefore stubble-trellising using stubble from the previous crop is a potential method of raising the canopy off the ground allowing greater air flow below the crop, and reducing humidity. Wang, Gossen et al. (2006) investigated the impact of lodging on disease severity, along with a fungicide treatment. Their results support those found in this study where both reduced lodging and a fungicide treatment reduce disease incidence, but that the greatest impact on reducing disease is from reduced lodging in the crop rather than the fungicide treatment. The use of stubble-trellising was listed as a potential method of reducing disease in lentil (Hawthorne, Materne et al. 2012), but has not been followed up since or expanded to other pulse crops where disease management is an issue. Field peas have a greater vegetative biomass than lentils, and, due to their weak stems and tendrils form a closed canopy that is close to the ground. Stubble trellising in field peas therefore has the potential to raise the crop from the ground, reducing the susceptibility of the lower leaves to Ascochyta infection.

Conclusion

Initial field trials in 2016 at Muresk, Nyabing and Wittenoom Hills found that time of sowing had a greater impact on final disease infection and crop yield than fungicide treatment when disease levels were high. This is likely to be due to increased vegetative production in the crop at TOS1, as well as seedling emergence occurring during maximum spore release. Stubble trellising has the potential to reduce disease by raising the field pea canopy off the ground. This could improve the prospect for early sowing and increased yields that result from the extended growing season.

Acknowledgements

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References

ABARES (2018). Australian Crop Report. No. 188. Canberra, ABARES. **No. 188**.

Davidson, J. A., D. Hartley, M. Priest, M. Herdina, A. McKay and E. S. Scott (2009). "A new species of Phoma causes ascochyta blight symptoms on field peas (Pisum sativum) in South Australia." Mycologia **101**: 120-128.

GRDC (2017). Field pea. GRDC Grownotes™. Southern Region. Canberra, GRDC.

Hawthorne, W., M. Materne, J. Davidson, K. Lindbeck, L. McMurray and J. Brand (2012). Lentil disease management strategy. Southern Pulse Bulletin, No. 5, Pulse Australia.

McDonald, G. K. and D. Peck (2009). "Effects of crop rotation, residue retention and sowing time on the incidence and survival of ascochyta blight and its effect on grain yield of field peas (*Pisum sativum* L.)." Field Crops Research **111**: 11-21.

Wang, T. F., B. D. Gossen and A. E. Slinkard (2006). "Lodging increases severity and impact of mycosphaerella blight on field pea." Canadian Journal of Plant Science **86**(3): 855-863.