Lower severity of ascochyta blight and higher grain yields from chickpeas sown into standing cereal stubble compared to slashed stubble.

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Abstract

Chickpea ascochyta blight caused by *Didymella rabiei* result in significant grain yield losses, especially in susceptible varieties. Current management is to sow varieties with partial resistance and apply numerous fungicides to prevent crop losses. Previous observations indicated that the spread of infection was slower when chickpeas were sown in a no-till farming system with standing stubble, compared to stubble being slashed or burnt. This experiment investigated the impact of inter-row sowing on the severity of ascochyta blight and grain yields of moderately susceptible Genesis 090 (currently one of the least susceptible varieties) and susceptible PBA Striker when sown into standing stubble versus slashed cereal stubble with or without fungicides. In the absence of fungicides, Genesis 090 yielded 24% (339 kg/ha) higher and PBA Striker 132% (701 kg/ha) higher in standing stubble and had reduced ascochyta blight severity compared to slashed stubble. Results demonstrate the benefits of standing stubble in a no-till farming system on disease management in pulses.

Keywords

Didymella rabiei, PBA Striker, Genesis 090, disease management

Introduction

Chickpea is the most widely grown winter grain legume in Australia and accounted for 46% (1,069,000 ha) of the total land area under winter pulses in 2018 (ABARES 2018). Australia produced 2004 kt of chickpeas, which accounted for 43% of total grain legume production in 2018 – 2019 growing season (ABARES 2018). However, 16% of the crop is lost due to diseases amounting to about $24 million each year, which is the highest loss among pulses (Murray and Brennan 2012).

Ascochyta blight is one of the major diseases of chickpea in Australia causing about $4.8 million in losses annually (Murray and Brennan 2012). Ascochyta blight caused by *Didymella rabiei* (syn. *Ascochyta rabiei*), is a fungal disease that became an epidemic in 1998 and is becoming increasingly pathogenic and infectious (Galloway and MacLeod 2003; Bar et al. 2020). Ascochyta blight has a rapid rate of infection and once established it is very hard to control and thus, can cause up to 70% crop losses in Australia (Murray and Brennan 2012).

In Australia, ascochyta blight management includes adopting a combination of breeding, agronomic and fungicide strategies, which costs around $34.9 million annually (Murray and Brennan 2012). Currently, the best approach is to apply prophylactic foliar fungicides (costing $49 – 118/ha) to prevent infections and avoiding susceptible varieties (Murray and Brennan 2012; Fanning et al. 2020). However, there is an increasing threat of *D. rabiei* developing fungicide resistance (Lopez-Ruiz et al. 2018). Thus, there is an emerging need to identify successful and economical agronomic strategies to manage ascochyta blight in chickpeas that do not heavily rely on fungicides. Previous field observations in chickpeas sown into standing cereal stubble in a no-till farming systems indicated that the fungal infection frequently occurred along the chickpea rows and that the infection rarely crossed over standing cereal stubble on to adjoining chickpea rows (Jason Brand 2020, Personal Communication). Therefore, the current experiment investigated the effect of sowing Genesis 090 (moderately susceptible) and PBA Striker (susceptible) varieties into standing versus slashed cereal stubble, managed with or without fungicides on the severity of ascochyta blight and grain yields.

Methods

Experimental site and Design

A field experiment was conducted in a commercial paddock in Horsham (36°36'25.3"S 142°15'18.5"E), Victoria. The rainfall during the growing season (April to October) was 301 mm and the soil was characterised as black cracking clay.

The experiment was laid out in split plot design with three replications. The main plot factor was two wheat stubble heights (slashed and standing). Split plot treatments included factorial combinations of two varieties (Genesis 090 and PBA Striker) and two levels of disease-fungicide strategies (disease inoculated-nil fungicides and disease not introduced-complete disease control with fungicides), which were randomised into split plots.

Experimental Procedure

The crop was sown on May 26 to 8 m x 1.44 m experimental plots at 37.50 cm inter row space in between the previous year`s wheat stubble rows at 35 plants/m^2. At sowing, all experimental plots were fertilized with a monoammonium phosphate (N-9.2, P-20.2, K-0, S-2.7 %) and zinc (2.5 %) blend at a rate of 100 kg/ha.

Seven weeks after sowing (on July 16) six ascochyta blight infected stubble pieces (from the previous season) 10 cm in length were pegged at the geometric centre of each plot to initiate primary infections in the disease inoculated-nil fungicide plots. Plots which were not inoculated received eight, fortnightly chlorothalonil sprays (1.5 kg/ha) to achieve full disease control.

Data collection and analysis

Disease severity was visually rated from 0 – 100% stem breakages per plot where 0 is the complete absence of symptoms and 100 is complete plant death at 45, 58, 70, 90, 111 and 123 days after inoculation (in nil fungicide plots) or first fungicide sprays (in non-inoculated plots). At maturity, plots were harvested with a small plot harvester and grain yields recorded. All data were analysed using ANOVA with Bonferroni post hoc tests ($P<0.05$) using GenStat 18.0 (VSN International, Hemel Hempstead, UK).

Results

Severity of ascochyta blight symptoms

The crop did not demonstrate any ascochyta blight symptoms during the first two months after sowing (June and July) prior to inoculation, which maybe a result of below average rainfall received during this time. The first symptoms were visible 45 days after the inoculation event in both varieties and stubble heights that did not receive the fungicide (Table 1). In inoculated plots, without fungicides, the disease symptoms progressed rapidly from the point of inoculation during August to October, with above average temperature and rainfall recorded during these months. However, plots, which received the fungicide remained disease free throughout the season irrespective of the variety and stubble height (Table 1).

PBA Striker without the fungicide applications had significantly greater disease severity in the slashed stubble as compared to standing stubble, especially towards the end of the season when the disease was progressing rapidly (Table 1). In the more resistant Genesis090, disease severity was significantly lower than PBA Striker towards the end of the growing season, where the crop recovered by producing disease free new growth. Disease severity in Genesis 090 was far less in the standing stubble compared to the slashed stubble, particularly early in the season when disease symptoms were first detected (Table 1).

Grain yield

Highest grain yields (2.05 ± 0.07 t/ha) were produced in plots that were not inoculated but received fungicides when averaged across varieties and stubble treatment (Figure 1). The stubble height did not have a significant effect on grain yields when fungicides were applied. The grain yields of inoculated plots that were not sprayed with fungicides decreased by 41% on average compared to those that received the fungicide across both varieties and stubble heights (Figure 1). In inoculated plots without any fungicides, Genesis 090 produced 24% (339 kg/ha) more and PBA Striker 132% (701 kg/ha) greater grain yields when sown in standing stubble compared to slashed stubble (Figure 1).

Table 1 Severity of ascochyta blight symptoms in two different chickpea varieties (Genesis 090 and PBA Striker) inter-row sown into standing versus slashed cereal stubble, managed with or without fungicides at Horsham, Victoria in 2020.

Disease-fungicide strategies	Variety	Stubble	Severity of ascochyta blight symptoms (% stem breakages per plot)[1]					
			28 Aug	11 Sep	23 Sep	13 Oct	04 Nov	16 Nov
Fungicide applied (not inoculated)	Genesis090	Standing	0d	0c	0b	0d	0c	0c
		Slashed	0d	0c	0b	0d	0c	0c
	PBA Striker	Standing	0d	0c	0b	0d	0c	0c
		Slashed	0d	0c	0b	0d	0c	0c
Fungicide not applied (inoculated)	Genesis090	Standing	7cd	8bc	7b	5cd	0c	0c
		Slashed	17ab	12ab	18ab	17bc	05c	02c
	PBA Striker	Standing	12bc	12ab	12ab	22b	22b	25b
		Slashed	23a	18a	32a	53a	60a	65a

[1]Different letters in the same column indicate statistically significant differences for disease severity for each day ($P < 0.05$).

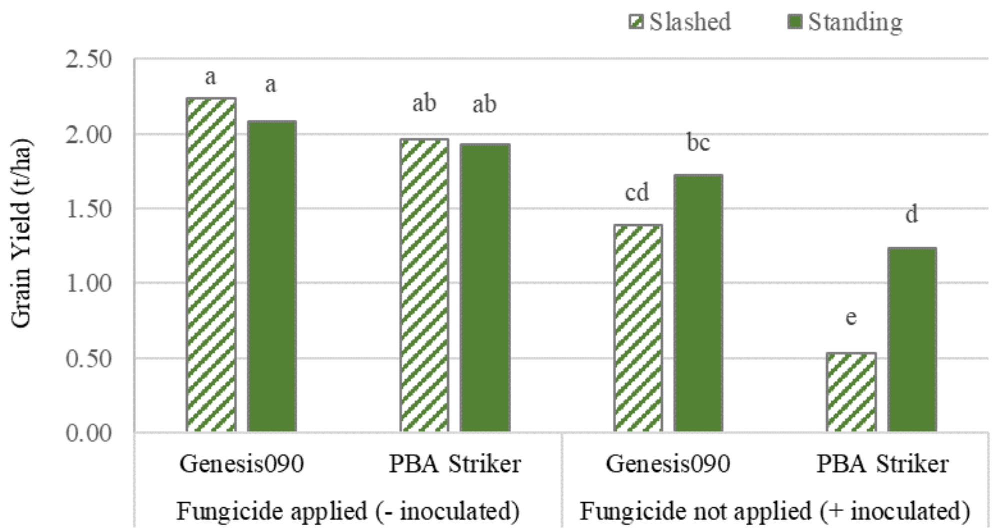

Figure 1. Grain yields (t/ha) of Genesis090 and PBA Striker inter-row sown into standing versus slashed cereal stubble, managed with (not disease inoculated) or without fungicides (disease inoculated) at Horsham, 2020. Different letters indicate significant differences (P<0.05).

Conclusions

Sowing chickpea into standing cereal stubble as compared to a slashed stubble resulted in a 24% and 132% grain yield increase for Genesis 090 and PBA Striker, respectively. This yield increase was associated with lower severity of ascochyta blight symptoms in chickpeas sown onto standing stubble compared to slashed stubble in both varieties. These results demonstrate the benefits of a standing stubble in a no-till farming system on disease management in chickpeas. Further research is necessary to understand the effects of stubble management strategies on ascochyta blight disease dynamics in currently used fungicide regimes practiced on a paddock scale.

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