The effect of Brassica species on *Rhizoctonia solani* disease of barley in low-rainfall farming systems on upper Eyre Peninsula.

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Abstract

The soil borne pathogen *Rhizoctonia solani* (AG-8) causes major disease in crops and pastures and is an important constraint in upper Eyre Peninsula farming systems. The upper Eyre Peninsula is a large cereal production zone in southern Australia dominated by light calcareous soils and low, variable rainfall. Paddock scale monitoring on one property from 2001 to 2005 indicated canola in the rotation markedly reduced *Rhizoctonia* inoculum levels. Four years of replicated field trials were subsequently undertaken to research the impact of *Brassica* varieties and management on root disease levels, especially *Rhizoctonia*, in the following cereal crop. These trials showed a canola crop in this environment reduced *Rhizoctonia* levels in soil, root infection in the following wheat crop and increased yield compared to cereal crops and pasture. DNA tests for beneficial microbes [*Pantoea agglomerans, Exiguobacterium acetylicum* and *Microbacteria,* (PEMS)] and *Trichoderma* showed these species did not increase under the *Brassica* treatments. Growing the best adapted canola varieties and controlling weeds is important to maximise reduction in *Rhizoctonia* levels in this environment.

Key Words

Canola, crop rotation, Rhizoctonia

Introduction

Rhizoctonia barepatch caused by the soil-borne fungus *Rhizoctonia solani* is an important soilborne disease in cereal-based farming systems. *R. solani* grows as a saprophyte on soil organic matter and as a pathogen on a wide range of plants (O'Brien and Zamani 2003). *Rhizoctonia* barepatch is often most damaging when farming systems include reduced tillage and crop stubble retention (MacNish and Neate 1996). *Rhizoctonia* barepatch is particularly severe on the upper Eyre Peninsula, which has a Mediterranean environment with 350 mm of average annual rainfall. This disease remains a significant problem despite advances in control and management of other diseases through plant breeding and better understanding of disease cycles.

The DNA-based testing service, PreDicta[?] B (Ophel-Keller et al. 2008) was used to monitor *R. solani* AG8 levels in all cropping paddocks from 2001 to 2005 on a single property at Miltaburra. These results indicated canola crops markedly reduced *R. solani* AG8 levels. Thus a follow up study was conducted using replicated field trials between 2005 and 2008 to test the impact of different *Brassica* crops, varieties and management on root disease levels, especially caused by *Rhizoctonia*, in the following cereal crop.

Method

Thirty-nine paddocks across one farm at Miltaburra were soil sampled annually over a four-year period. Disease inoculum levels were measured using PreDicta[?] B tests. Trends between disease inoculum, previous crop/pasture history and performance of the following crop were investigated.

Replicated field trials were established in 2005, 2006 and 2007 on the same farm at Miltaburra to investigate the impact of *Brassica* variety and management on *Rhizoctonia* inoculum and performance of a following barley crop. Each trial was oversown with barley in the year after the *Brassica* treatments because it is very susceptible to *Rhizoctonia*, and displays *Rhizoctonia* patches readily. Long-term

average rainfall for Miltaburra is 306 mm; annual rainfall and growing season rainfall (mm) for the period of the research is shown in Table 1.

Brassica Variety Trials

A range of *Brassica* lines including high- and low-glucosinolate mustards, three canola varieties (Stubby, Rivette and Eyre) were compared to vetch, wheat and chemical fallow.

Brassica Management Trials

Management options in TT canola (Triazine Resistant (ATR)-Stubby) included early and late removal of grasses, no grass control, Terrachlor, Apron or Maxim XL seed dressings, and granular or fluid fertilisers. Granular fertiliser was applied at 9 units of P and 20 units of N, as 19:13 at 70 kg/ha and urea at 15 kg/ha. Fluid fertiliser was either applied at the same N, P and S rates as granular using ammonium polyphosphate, urea ammonium nitrate and ammonium thiosulphate, or at the same cost as granular using appropriate rates of cheaper phosphorus (phosphoric acid) and nitrogen products (urea). Trace elements were applied at 1 kg Zn/ha, 1.5 kg Mn/ha and 0.5 kg Cu/ha as sulphates added to the fluid fertiliser mixes.

All plots in each trial were oversown in the season after the *Brassica* treatments with Barque barley at 50 kg/ha and 10 units of P and 9 units of N, as 18:20 fertiliser at 50 kg/ha. *R. solani* AG8 inoculum levels were assessed in each plot prior to sowing barley in autumn. *Rhizoctonia* root infection was scored 6-8 weeks after sowing, plant dry matter was assessed at late tillering and grain yield was measured at maturity.

Results

Broadscale farm monitoring

Canola is an unreliable crop at Miltaburra due to low rainfall but it was used on this property to improve productivity of poorly performing paddocks. Monitoring changes in soil-borne pathogen levels using PreDicta$^{?}$ B had indicated *Rhizoctonia* was the most important pathogen.

Rhizoctonia levels following canola (9 separate crops sampled over 4 years) were generally lower than following wheat (15 crops sampled per year for each of the 4 years), barley (5 to 7 crops per year) and pasture paddocks (11–16 per year) (Figure 1). Occasionally triticale and oat crops were grown as part of the rotation but the *Rhizoctonia* inoculum levels following these were similar to wheat, barley and pasture.

Of the nine canola crops grown during this time, six failed to produce viable grain yields. This indicates as few as 2 to 3 canola plants/m^2, even if they are poorly productive, may be all that is required to provide a decline in *Rhizoctonia* inoculum levels (Figure 2).

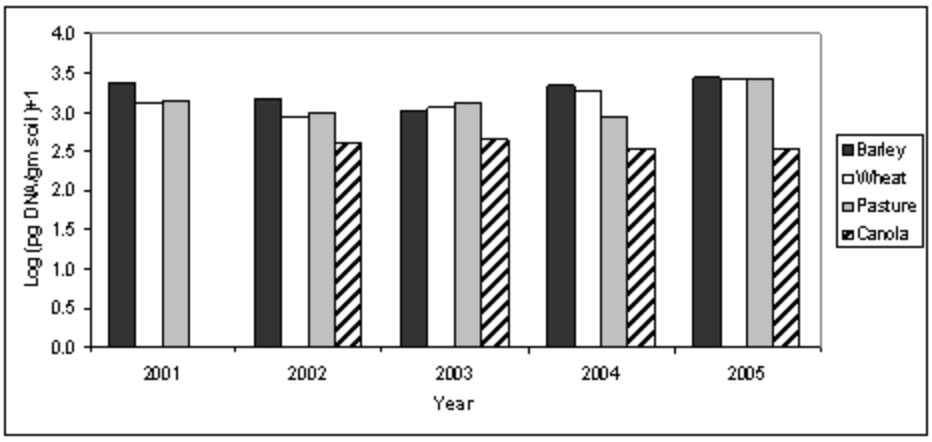

Figure 1. Average *Rhizoctonia* inoculum following barley, wheat, canola or pasture.

There were two extremely poor seasons, 2006 and 2007 and the variety trial was not harvested in 2006 due to little/no grain fill. The DNA results showed *R. solani* AG8 were high after cereal. Despite the low yield of the *Brassicas*, *R. solani* AG8 levels decreased to low or medium; the highest levels occurred following cereal crops in each season. The difference in yield between barley after wheat and barley after canola averaged 0.2 t/ha over three years (Table 2). The impacts of treatments on *Rhizoctonia* were consistent across all seasons over the sampling period.

In 2008 increased residual soil moisture in the profile especially for the fallow and vetch treatments (16 and 13 mm respectively) may explain the higher grain yield. Despite higher levels of soil moisture under the fallow and vetch treatments, the barley crop after canola yielded similar to the fallow (unpublished data).

In 2007, a late germination of broadleaved weeds in the Variety trial resulted in higher *R. solani AG8* compared to the Management trial. The Management trial was sown to ART-Stubby and sprayed with 0.8 L/ha of Simazine post sowing, this gave good control of a range of broadleaved weeds. This resulted in a difference in average yield for barley in 2008 of 1.18 t/ha in the Variety trial compared to 1.51 t/ha for the Management trial.

Table 1. Miltaburra annual and growing season rainfall (mm) and average crop yields.

Year	Annual Rainfall (mm)	Growing Season Rainfall (mm)	Canola Yield (t/ha)	Barley Yield (t/ha)
2005 Brassica trial only	316	270	0.19	-
2006 Brassica trial and barley oversown on 2005 trial	239	118	Not harvested	0.48
2007 Brassica trial and barley oversown on 2006 trial	199	130	0.14	0.24
2008 Barley oversown on	165	146		1.20

2007 trial only

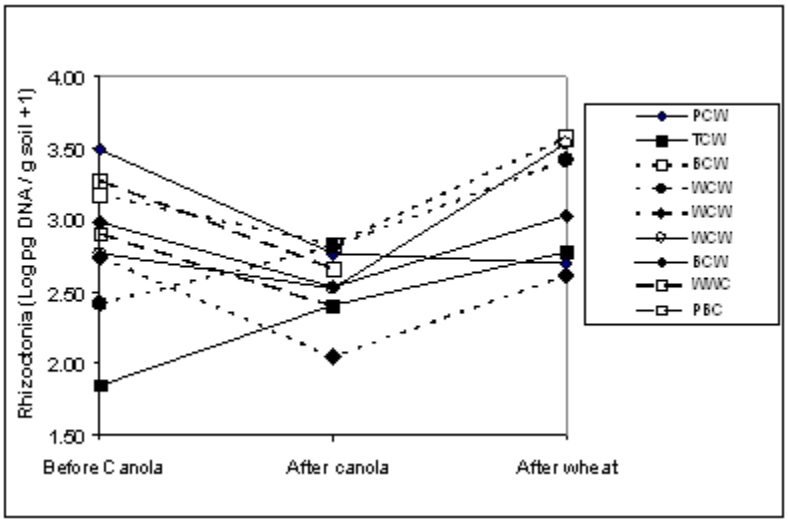

Figure 2. *Rhizoctonia* inoculum levels before and after canola and the following wheat crop. (C = Canola, B = Barley, P = Pasture, W = Wheat, T = Triticale)

Barley seedlings and soil were analysed during the 2006 growing season for presence of beneficial microbes [*Pantoea agglomerans, Exiguobacterium acetylicum,* and *Microbacteria,* (PEM's)] and *Trichoderma* spp., using DNA assays. These microbes have been implicated in playing a role in disease suppression (Barnett 2006). No treatment differences were detected in any of the PEMs or *Trichoderma* spp. in these trials.

Conclusions

Four years of broad-scale farm monitoring and replicated field trials on upper Eyre Peninsula indicate that canola crops can reduce *R. solani* AG8 levels in a low-rainfall environment, resulting in lower root infection and increased yield in following wheat and barley crops. The management options also showed an increase in yield of barley after canola compared to barley on wheat in the rotation. Controlling the grasses and using fungicidal dressings lowered the level of DNA inoculum in autumn but did not provide control of *Rhizoctonia* or increase grain production in this environment.

Despite low *Brassica* yields, *Rhizoctonia* levels were still reduced compared to those after cereal crops in each season tested. In this environment gaining weed control to maximise the benefit of reducing *Rhizoctonia* inoculum levels is essential, and was achieved by growing better adapted canola varieties. DNA results indicated the beneficial microbes (*Pantoea agglomerans, Exiguobacterium acetylicum,* and *Microbacteria,* (PEMS)) and *Trichoderma* spp, did not increase under the *brassica* treatments in the trial sites on upper Eyre Peninsula, indicating a different mechanism or microbial population is reducing the *Rhizoctonia* levels.

This research indicates that canola crops grown on the upper Eyre Peninsula reduced *R. solani* AG8 levels and root damage, and increased yield of the following cereal crop, but the benefit lasted for only one season. Further research is required to understand the mechanism of control.

Table 2. Results for the *Brassica* Variety and Management treatments at Miltaburra, 2005-2008.

Brassica Variety

Rotation Option	Average Yield (t/ha)	PreDicta? B Rhizoctonia level pg DNA/g soil	Rhizoctonia Root Score (0=none, 5=severe)	Barley Dry Matter at 6-8 weeks (g/plant)	Barley Yield following season (t/ha)
Cereal	0.25	234.6	2.40	0.31	0.51
Chemical Fallow		66.3	1.64	0.43	0.67
ATR - Eyre	0.14	52.7	1.78	0.39	0.67
ATR - Stubby	0.14	65.8	1.67	0.40	0.71
Rivette	0.19	39.6	1.81	0.37	0.59
Juncea Canola	0.24	60.9	1.92	0.38	0.62
High glucosinolate - ATR Karoo	0.15	52.3	1.87	0.43	0.69
Biofumigant mustard	0.19	102.6	1.89	0.36	0.51
Low glucosinolate	0.15	65.2	1.75	0.38	0.59
Vetch	0.10	24.1	1.46	0.42	0.81
LSD (P=0.05)	*0.06*	*74.4*	*0.33*	*0.06*	*0.08*
		Brassica Management			
Granular fertiliser (Control Treatment)	0.12	39.2	1.86	0.52	0.81
Chemical fallow		33.4	1.58	0.46	0.83
Cereal	0.28	173.0	2.51	0.42	0.61

Early grass control	0.13	41.8	1.90	0.51	0.80
Late grass control	0.11	43.2	2.36	0.48	0.77
No grass control	0.12	89.0	2.25	0.51	0.79
Maxim XL	0.10	24.7	2.05	0.50	0.78
Terrachlor	0.13	35.4	1.93	0.49	0.81
Apron	0.10	36.0	2.08	0.49	0.77
Fluids same cost gran	0.10	32.3	1.63	0.54	0.82
Fluid same rate gran	0.14	64.7	1.99	0.52	0.78
Fluid same rate gran + TE	0.12	39.0	2.13	0.52	0.83
LSD (P=0.05)	*0.04*	*42.4*	*0.42*	*0.05*	*0.05*

Acknowledgements

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