Effect of Intensive no-till cropping systems on Rhizoctonia disease incidence at the Waikerie Core site

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Waikerie MSF Core Trial Site, SA

Key messages:

- *Rhizoctonia solani* AG8 inoculum in soil prior to sowing in 2009 was generally higher than previously observed due to a run of dry seasons in recent years.
- Soil inoculum levels were generally higher under intensive cereal cropping treatments and lower immediately after canola.
- Eight years of intensive no-till cropping resulted in improvements in disease suppression potential compared to traditional pasture-cropping systems.
- The role of microbial activity in disease development suggests that *Rhizoctonia* inoculum level may not alone indicate the likely level of disease in the following crop.
- Increased C inputs and turnover over a number of years appear to increase natural biological disease suppression and reduce the impact of Rhizoctonia disease in cereals.

Aim:

- To determine the long-term effect of crop management practices on Rhizoctonia bare patch disease in the MSF core site at Waikerie.

Background:

Management practices in rainfed agricultural systems can be modified to promote the benefits from soil biological activities without compromising productivity and soil health (Gupta et al. 2010). Reduced tillage, crop residue retention and intensive cropping are key components of new farming systems in the Mallee. In most southern Australian agricultural soils, carbon availability dictates the level of microbial populations and associated biological processes. Results from the Mallee Sustainable Farming Project demonstrated that improved microbial functions due to increased C inputs have resulted in improvements in nutrient efficiency, disease suppression and

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stability of soil aggregates. At the Waikerie core site, it was demonstrated that intensive cropping with adequate nutrition and no-till practices resulted in increased total plant production and C inputs into soil which (i) promoted nutrient supply capacity, (ii) reduced losses of N from leaching, (iii) helped maintain a store of N for favourable seasons and (iv) increased potential for N fixation by free-living N fixing bacteria.

Disease suppressiveness of soil is the ability of a soil to reduce disease severity even in the presence of a pathogen, its host plant and favourable climatic conditions. Based on observations from a long-term farming system trial at Avon, it was suggested that increased C inputs over a number of years would cause a change in the composition of the microbial community resulting in increased suppression of soilborne diseases such as Rhizoctonia bare patch (Roget 1995). Rhizoctonia bare patch is a disease of seedlings caused by *Rhizoctonia solani* Kühn AG-8 which decreases root length resulting in reduced plant growth and yield losses. Recent estimates indicate that it causes significant losses in wheat, $59 million pa across southern Australia (Murray and Brennan, 2009).

In this article we discuss the influence of various management treatments on *Rhizoctonia solani* inoculum and disease suppression potential and links with disease incidence in the wheat crop during 2009 crop season.

About the trial:

The Waikerie Core Site Farming Systems Trial was established in 1998 and has continued with generally the same farming systems treatments on the same plots for 11 years. Treatments ranged from district practice crop/pasture systems to intensive cereals as well as variations with pulses and canola. Some plots were cultivated and sown conventionally while others were direct drilled, with some systems using higher inputs. The experimental plots are 60 m long and 1.6 m wide, with 4 replications. For this work we only monitored the first three replications.

In 2009 the site was sown on 22 May, four weeks after the season break. There had been no volunteer grass control (mainly barley grass, brome grass and cereals) to this stage which would have allowed the buildup of Rhizoctonia inoculum.

All plots were sown to Mace wheat at a low fertiliser rate of 30 kg/ha DAP to assess the impact of previous systems on fertility and disease control. Wheat seedlings emerged as soil temperatures through June began to decrease which would have favoured Rhizoctonia disease incidence.

While knockdown weed control was used prior to seeding, subsequent later germination of brome grass led to generally poor grass control.

Assessments:
The collection of data at the trial site included:

- *Rhizoctonia solani* AG8 DNA levels – surface soils collected prior to sowing and pathogen inoculum measured through SARDI Root Disease Testing Service.
- Disease incidence was measured by counting the number of rows with symptoms of Rhizoctonia damage at 20 places in each plot.
- Grain yield.
- In 2007, disease suppression potential (DSP) against Rhizoctonia disease in wheat was estimated using a growth chamber based incubation assay (Gupta et al. 2009) with surface soils from field plots.

Results:
Grain yields were highest in the intensive cropping no-till treatments (e.g. Opportunity crop, canola-wheat and legume-wheat) and lower in the traditional pasture-wheat system (e.g. Treatment 1) (see table 1). Grain yield was also lower in the intensive cropping treatment with cultivation (Treatment 6) compared to Treatments 9 & 11. The differences between other combinations of treatments were not significant. Low yields across the site were generally attributed to extreme moisture stress through winter and competition with late germinating brome grass.

Table 1. Biological measurements for surface soils and grain yield of wheat in 2009.

Treatment number	**Details**	**2008 crop**	**Disease suppression potential#** (2007)	**Rhizoctonia DNA** (prior to 2009 crop)	**Grain yield**
				log(pg DNA)	kg/ha
1	W/Past-CC DP	Wheat	0.69a	2.3 - 2.4	232 c
2	Past/W-CC DP	Pasture			273 abc
3	W/Past-CC Hi	Wheat	0.65a	1.8 - 2.6	323 abc
4	Past/W-DD DP	Pasture			318 abc
5	W/Pulse-CCDD Hi	Wheat			301 abc
6	Intensive-CC Hi	Barley	0.68a	3.1 - 2.8	237 c
7	Intensive-DD Hi	Barley			261 bc
8	W/Pulse- DD Hi	Wheat			345 abc
9	W/Canola-DD Hi	Wheat	0.85b	1.4 - 2.5	400 a
11	Opportunity-DD Hi	Barley	0.94b	3.0 - 2.3	387 ab

Values range between 0 to 1, representing 'low' to 'high' DSP.
Numbers followed by different letters within a column are significantly different from each other.

Results from the 2007 analysis indicated that DSP against rhizoctonia was higher in soils under intensive cropping no-till treatments (e.g.

opportunity cropping and wheat-canola) compared to the traditional pasture-crop rotations (e.g. lower inputs or cultivated systems). DSP was lower in the intensive cropping treatment with cultivation (Treatment 6). Observations during the 7 years after treatment implementation indicated generally higher levels of microbial activity in soils under intensive high-input no-till cropping treatments compared to traditional pasture-wheat rotation (Roget and Gupta 2004; Gupta et al. 2009). In addition, cultivation of intensive high-input treatments after 4 years of no-till caused a significant decline in soil organic carbon and microbial activity.

In general, the amounts of *Rhizoctonia solani* inoculum were higher in 2009 samples than in the previous years measurements (>100 pg DNA/g soil in 2009 compared to < 60 pg DNA/g soil previously). Similar observations of higher amounts of *Rhizoctonia* inoculum were also reported across southern Australia (McKay). In recent years, there has been a higher frequency of below average rainfall years, in particular below average rainfall in spring and summer. *Rhizoctonia solani* fungus grows on soil organic matter and produces hyphal networks in the surface soil. The overall lower levels of microbial activity for longer periods during and following the droughts favour the growth of this fungus and thus higher than usual amounts of Rhizoctonia inoculum prior to sowing in 2009. In addition, poor weed control during the autumn would also have contributed to the build up of Rhizoctonia inoculum.

The amount of Rhizoctonia inoculum was highest in soils under intensive cropping treatments (Treatments 11 and 6) whereas inoculum levels were generally lower in the soils under canola-wheat treatment. Cultivation showed limited effect on the amount of pathogen DNA in the soil. Results from an extensive survey conducted in another GRDC project also showed that the levels of Rhizoctonia DNA were lower immediately after canola compared to that after wheat.

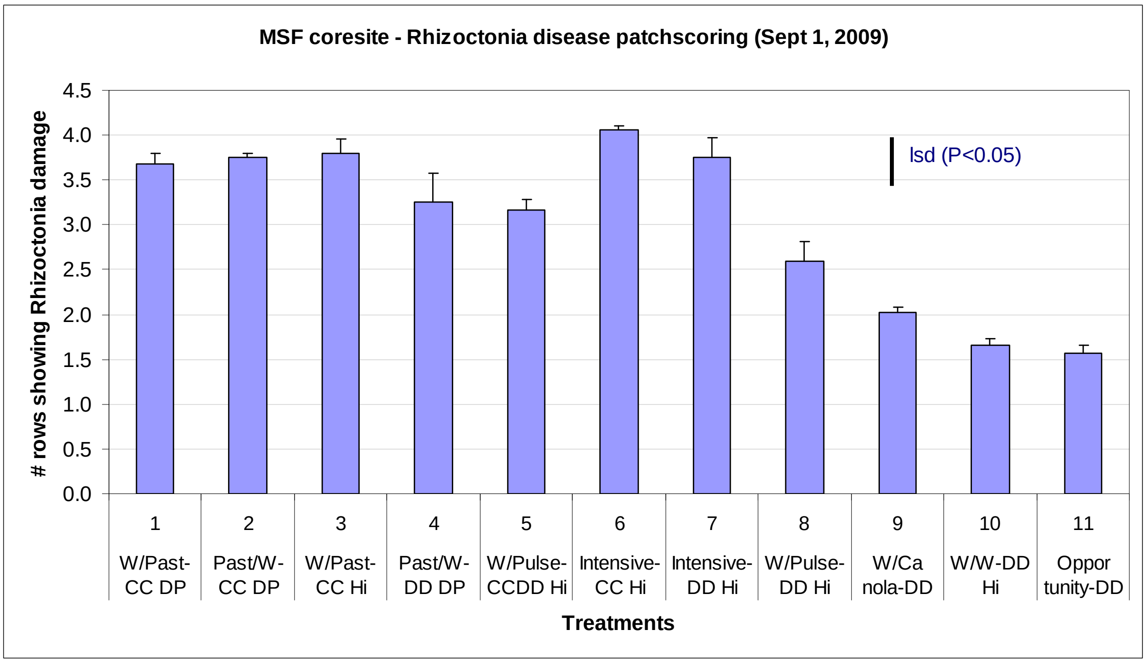

Figure 1. Rhizoctonia bare patch disease incidence in the 2009 wheat crop at the MSF core site, Waikerie, SA.

Data in Figure 1 shows the incidence of Rhizoctonia disease in the 2009 wheat crop. In general the level of Rhizoctonia disease incidence in 2009 was higher than that observed during the previous 10 years. The different factors that contributed to this high Rhizoctonia incidence can be attributed to (i) higher levels of pathogen inoculum (ii) no control of green bridge prior to sowing, (iii) late sowing which resulted in seedling emergence when soil temperatures were cooling down and (iv) inadequate nutrition due to reduced fertiliser inputs. The incidence of rhizoctonia disease was lower in the intensive cropping no-till systems compared to that in the traditional pasture-crop systems. Although cultivation had no effect on the amount of Rhizoctonia DNA in soil (e.g. comparison between Treatments 6 and 11), there was more disease affecting the crop in the cultivated treatment. This difference is probably due to the higher DSP in the no-till treatment. In the traditional pasture-crop rotations, lower DSP and higher amount of Rhizoctonia DNA have resulted in higher levels of disease incidence.

The differences in Rhizoctonia disease incidence between treatments were reflected in grain yield (Figure 2), an indication of the impact of rhizoctonia disease in Mallee soils. Treatment effects on available nutrients (e.g. N and P) may also have contributed to the differences in yield. Farmers with intensive systems often rely on cultivation for rhizoctonia control, and while this may provide a quick fix in managing the disease, it may delay longer term disease suppression. Overall, Rhizoctonia disease incidence in 2009 was the product of inoculum level and disease suppression potential built up during the previous 10 years of crop management practices.

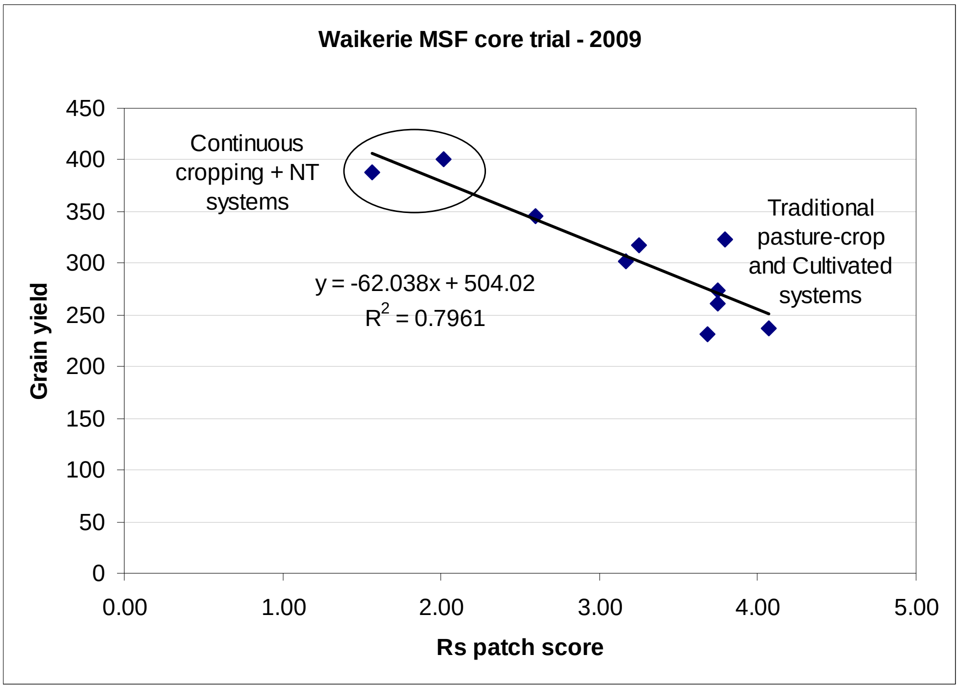

Figure 2. Relationship between Rhizoctonia patches and grain yield of Mace wheat in 2009.

Who's Involved:

The trial is supported by:

- Alan Buckley (farmer), Chris McDonough and Richard Saunders (Rural Solutions SA).
- GRDC project (CSE 00048) – Better prediction and management of Rhizoctonia risk in cereals

Activities, Events and Industry Participation:

Waikerie field day on September 1, 2009.

Future Directions:

No further research is planned at the MSF core site at Waikerie.
Future research on the Rhizoctonia management will be conducted in field experiments located on Glen Schmidt's farm near Waikerie and Streaky Bay in Eyre Peninsula.

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