Investigating the Impact of Carbon Inputs on Disease Suppression

RESEARCH

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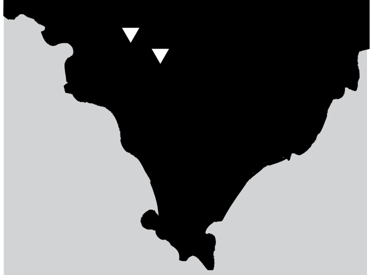
Searching for answers



Location: Poochera
I & J Gosling

Rainfall
Av. Annual: 324 mm
Av. GSR: 245 mm
2010 Total: 326 mm
2010 GSR: 279 mm

Yield
Potential: 3.7 t/ha (W)
Actual: 3.1 t/ha

Paddock History
2010: Wheat
2009: Pasture/trial treatments
2008: Wheat/trial treatments
2007: Oats

Soil
Grey calcareous loam

Plot size
40 m x 4 reps

Yield Limiting Factors
Late seeding due to initial trial having mice damage

Location: Minnipa
B and K Heddle

Rainfall
Av. Annual: 325 mm
Av. GSR: 236 mm
2010 Total: 411 mm
2010 GSR: 346 mm

Yield
Potential: 5.1 t/ha (B)
Actual: 2.5 t/ha

Paddock History
2010: Medic Canola Hay
2009: Wheat
2008: Wheat
2007: Medic

Soil
Brown calcareous sandy loam

Plot size
40 m x 4 reps

Yield Limiting Factors
Late seeding due to initial trial having mice damage

Key messages

- **Canola in rotation reduced Rhizoctonia inoculum levels and increased following cereal yields.**
- **Fluid fertiliser increased plant dry matter and yield on highly calcareous grey soils.**
- **A barley/vetch brown manure increased soil mineral nitrogen and this appears to have exacerbated Rhizoctonia disease symptoms on a following barley crop.**
- **Added carbon (10 t/ha/yr) has increased microbial respiration and microbial nitrogen.**

Why do the trial?

This research aims to understand the impact of soil carbon and nitrogen cycling on disease suppression. If we understand suppression more thoroughly, then we will be in a stronger position to manipulate it for improved control of rhizoctonia in cereal crops. This article reports on activities in the final year of a SAGIT funded project.

Trials were established on two highly calcareous soils to see if disease suppression can be stimulated by increasing carbon inputs into farming systems under local conditions. The dynamics of disease suppression to Rhizoctonia are not fully understood but increased microbial activity, especially of certain specific microbes that compete with Rhizoctonia is an important factor. Vibrant microbial populations need rich supplies of carbon (as a food source) for normal functions and for growth in the soil.

How was it done?

Identical trials were established on a grey calcareous soil at Poochera and a red calcareous soil at Minnipa, to vary carbon input into soil with different crops and management practices. Treatments in 2008 and 2009 were:

- extra cereal stubble added as chaff (5 or 10 t/ha).
- wheat, barley or canola at high seeding rates with fluid fertiliser (to encourage high dry matter production).
- wheat (Wyalkatchem @ 60 kg/ha with DAP @ 60 kg/ha) as a control.

Fluid fertiliser was APP and UAN at the same nutrient rate as granular (12 kg P/ha and 10 kg N/ha). A barley/vetch mixture was included as a brown manure treatment sprayed out at late tillering. Zinc was drilled below the seed on all treatments as a fluid at 1 kg Zn/ha.

Chopped oaten chaff was added to the soil surface a month before seeding for appropriate treatments. Both trials were sown with Hindmarsh barley @ 60 kg/ha with DAP @ 60 kg/ha in 2010; on 4 June under ideal conditions at Minnipa and on 7 June at Poochera into reasonable moisture. Both trials had 1 L/ha Roundup®, 1 L/ha Treflan® and 80 mL/ha of Hammer® pre sowing. Severe mice damage occurred to both trials so they were both resown on 28 June; the Minnipa trial was also harrowed post seeding to further reduce mice damage.

What happened?

The trial sites were chosen for severe Rhizoctonia and low productivity in cereal crops to try to improve production levels. Soil pH down the profile is similar for both soils but the Minnipa site has higher boron at a depth of 20-40 cm compared to Poochera.

Organic carbon levels at the sites are typical for the upper EP; being relatively low in the surface profile and decreasing with depth. In 2008 the Poochera site had a much higher level of nitrate-N throughout the profile (total of nearly 400 kg N/ha compared to Minnipa at 180 kg N/ha). Soil Colwell P levels were only moderate for the highly calcareous soils at Minnipa and Poochera (47 P and 50 P (mg/kg) respectively). These sites have high calcium carbonate (free lime) throughout the profile (see EPFS Summary 2008, p126).

At both sites PredictaB® (RDTS) results at the beginning of 2010 showed high inoculum and high risk of Rhizoctonia in all treatments except where canola had been grown in the previous season (Table 1 & 2). At the Minnipa site the barley/vetch brown manure treatment (sprayed out at booting in 2009) had greater Rhizoctonia root damage and more patches (Table 2). There were some patches in the same treatment at Poochera but not as strongly developed, which is reflected in the lower Rhizoctonia root score (Table 1). The mineral N level in the 0-10 cm zone in the barley/vetch treatment was highest.

***Table 1** PredictaB® levels, Rhizoctonia disease scoring, and soil data for Poochera, 2010*

Treatment	R Solani AG8 (pgDNA/g soil)	Average Seminal Root Rhizoctonia Score (0-5)	Colwell Phosphorus (mg/kg)		Microbial Biomass N (mg/kg)	Mineral N (kg/ha)		Total Mineral N (kg/ha)
	0-10 cm	0-10 cm	0-10 cm	10-60 cm	0-10 cm	0-10 cm	10-60 cm	0-60 cm
Barley DM*	345	0.8	22	5	3.4	25	72	97
Barley & Vetch	173	1.3	20	6	3.0	46	89	134
Control Wheat	236	1.1	22	6	2.3	24	134	157
Canola*	11	0.3	34	6	3.5	27	86	114
Wheat DM*	210	1.2	27	6	3.2	28	158	186
Stubble 5 t	213	1.1	27	6	5.4	41	61	102
Stubble 10 t	236	1.2	31	8	6.7	35	63	97
LSD (P=0.05)	*119*	*0.3*	*8*	*NS*	*NS*	*13*	*NS*	*NS*

**Fluid fertiliser system*

***Table 2** PredictaB® levels, Rhizoctonia disease scoring, and soil data for Minnipa, 2010*

Treatment	R Solani AG8 (pgDNA/g soil)	Average Seminal Root Rhizoctonia Score (0-5)	Colwell Phosphorus (mg/kg)		Microbial Biomass N (mg/kg)	Mineral N (kg/ha)		Total Mineral N (kg/ha)
	0-10 cm	0-10 cm	0-10 cm	10-60 cm	0-10 cm	0-10 cm	10-60 cm	0-60 cm
Barley DM*	270	1.2	43	5	7.0	15	74	89
Barley & Vetch	431	2.3	38	8	7.0	62	83	145
Control Wheat	189	1.4	34	5	7.2	18	59	77
Canola*	6	0.3	30	7	5.4	35	58	93
Wheat DM*	327	1.4	35	5	7.1	21	63	84
Stubble 5 t	217	1.4	35	7	7.3	24	43	67
Stubble 10 t	232	1.2	38	7	10.0	20	46	66
LSD (P=0.05)	*133*	*0.3*	*NS*	*2*	*2.5*	*9*	*13*	*16*

**Fluid fertiliser system*

The Colwell phosphorus levels are considered adequate for Poochera and Minnipa, with 18 mg/kg being in the adequate zone for mallee soils. Both trials are showing an increase in microbial nitrogen with the 10 t/ha/yr of added stubble treatment (Tables 1 & 2).

Fluid fertiliser increased early and late plant dry matter at both sites, with barley on canola having the greatest dry matter and grain yield. There was greater production potential at Poochera (Table 3) which resulted in higher screenings compared to the Minnipa site (Table 4).

The greatest amount of added carbon to the system has been through the added 10 t/ha treatments with an accumulated total of 47 t/ha at Poochera and 45 t/ha at Minnipa. The barley fluid fertiliser system has produced the greatest amount of dry matter, in two exceptional seasons.

Table 3 Dry matter and yield results of Hindmarsh barley at Poochera, 2010

Treatment 2008/2009	Early Dry Matter (g/plant)	Dry Matter at pre-harvest 2010 (t/ha)	Total Dry Matter accumulated 2008,09,10 (t/ha)	Yield (t/ha)	Protein (%)	Screenings (%)
Barley DM*	0.10	5.7	13.1	2.9	9.8	51
Barley & Vetch	0.07	5.2	7.8	2.5	10.0	29
Control Wheat	0.07	4.9	10.5	2.3	9.6	37
Canola*	0.13	6.6	13.9	3.1	9.8	79
Wheat DM*	0.09	5.4	11.7	2.9	9.7	43
Stubble 5 t	0.06	5.4 (+5)	26.5	2.1	9.6	34
Stubble 10 t	0.07	5.7 (+10)	47.7	2.7	9.7	29
LSD (P=0.05)	*0.02*	*0.5*	*2.3*	*0.2*	*0.2*	*16*

**Fluid fertiliser treatments and these treatments accidentally received double fertiliser rates in 2008*

Table 4 Dry matter and yield results from Hindmarsh barley at Minnipa, 2010

Treatment 2008/2009	Early Dry Matter (g/plant)	Dry Matter at harvest 2010 (t/ha)	Total Dry Matter accumulated 2008, 09, 10 (t/ha)	Yield (t/ha)	Protein (%)	Screenings (%)
Barley DM*	0.09	5.6	12.2	1.7	9.9	13.7
Barley & Vetch	0.06	5.0	7.9	1.5	10.1	8.0
Control wheat	0.06	4.9	10.5	1.5	10.2	4.4
Canola*	0.11	6.2	11.6	2.5	9.8	12.0
Wheat DM*	0.09	5.3	11.5	1.8	10.0	8.1
Stubble 5 t	0.07	4.8 (+5)	25.3	1.7	10.0	5.0
Stubble 10 t	0.07	4.8 (+10)	45.5	1.7	10.1	5.7
LSD (P=0.05)	*0.03*	*0.7*	*2.1*	*0.1*	*NS*	*NS*

**Fluid fertiliser treatments*

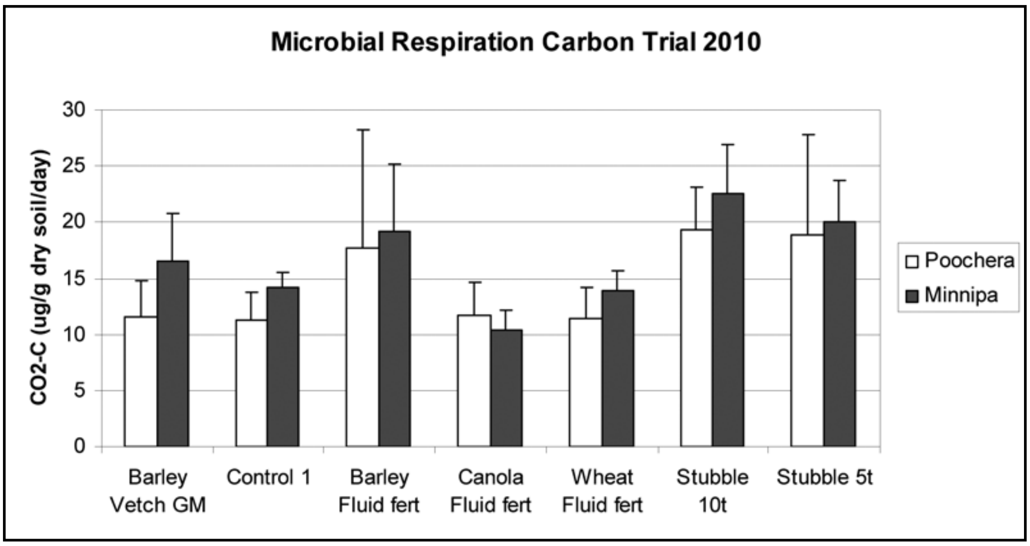


Figure 1 Microbial Respiration (CO_2-C (ug/g dry soil/day) at Poochera and Minnipa sites, 2010

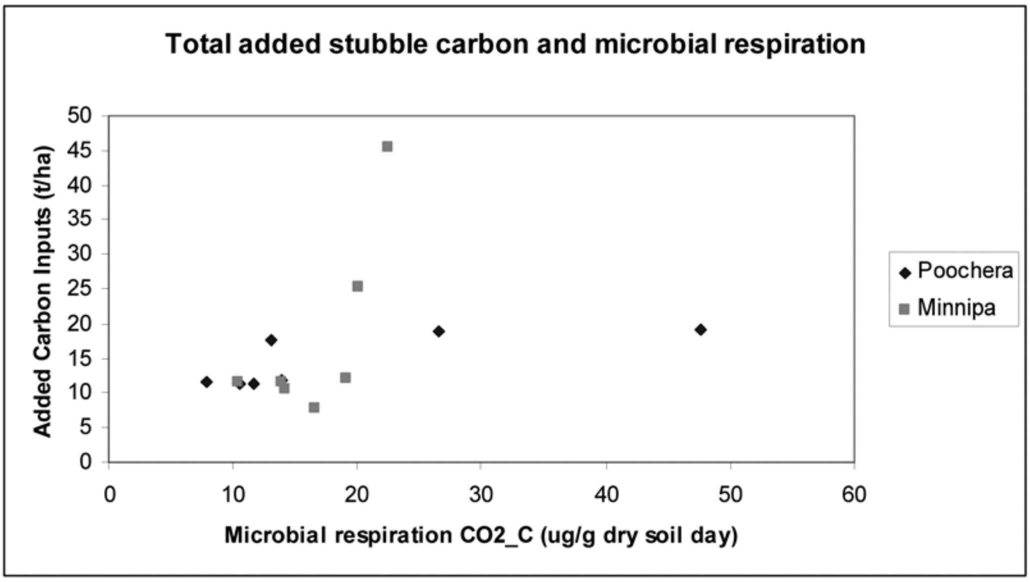


Figure 2 Added carbon inputs (t/ha) and Microbial Respiration (CO_2-C (ug/g dry soil/day) at Poochera and Minnipa sites, 2010

Microbial respiration is a measure of the potential activity of the microbial population, estimated under controlled conditions in the lab (Figure 1). Both sites show similar trends with the added carbon treatments having the highest microbial activity.

Figure 2 shows the total amount of added carbon against microbial activity, the Minnipa site shows a greater response of the microbial population to the added carbon than the Poochera site. The lower response at Poochera may indicate some other factor is limiting the population and its ability to utilise the carbon resource available.

What does this mean?

Canola has again shown the ability to reduce Rhizoctonia disease inoculum, which has resulted in an increase in yield in following barley crops at both sites this season. The fluid fertiliser system also continues to increase yield and dry matter production at both these sites.

The brown manure barley vetch treatment showed an increase in soil mineral nitrogen and increased Rhizoctonia disease incidence especially at the Minnipa site. This interaction requires further research to see if nitrogen will exacerbate Rhizoctonia disease symptoms in suppressive paddocks with high inoculum levels.

This season has shown a response by the microbial population to the added carbon with an increase in microbial respiration and microbial nitrogen but at this stage the treatments show no development of disease suppression or decreased Rhizoctonia disease patches. However it is hoped these trials will continue to be monitored so that any future developments will be detected.

Acknowledgements

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