Section 3

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Disease

Understanding the Impact of Soil Mineral Nitrogen on Disease Suppression

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RESEARCH

Searching for answers

Location: Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 236 mm
2009 Total: 421 mm
2009 GSR: 333 mm
Yield
Potential: 5.2 t/ha (W), 3.6 t/ha (P)
Actual: 4.5 - 5.6 t/ha (86 – 108% of potential yield)
Paddock History
2009: Wheat
2008: Barley
2007: Triticale
Soil
Red sandy loam
Plot size
40 m x 4 reps
Environmental Impacts
Soil Health
Disease levels: See article
Soil Nutrients: High phosphorus, low nitrogen system
Tillage type: Direct drill, stubble retained for 26 years
Economic
Cost of adoption risk: No livestock in system, higher risk cropping

Key messages

- **Vigorous growth in all crops and pasture treatments in 2009 has set up the trial for 2010, when the impact of soil mineral N on disease suppression will be assessed.**
- **At the start of the 2009 season there were already small differences in mineral nitrogen levels in the soil profile, spray topped medic having the highest with 63 kg N/ha and the control wheat the least with 44 kg N/ha.**
- **Since healthy medic will fix around 25 kg N/t DM, the medic spray topped treatment should have fixed around 125 kg N/ha during 2009.**
- **There were slight changes in Rhizoctonia inoculum in some treatments early this season but there were no visual differences in Rhizoctonia patches in the cereal plots in 2009.**

Why do the trial?

This research is the second year of a SAGIT funded project which aims to understand the impact of soil carbon and nitrogen cycling on disease suppression. Disease suppression is a result of increased activity of the soil microbial population reducing the impact of the disease on plant root systems. Rhizoctonia solani (AG-8) is a major disease in our cereal based farming systems. A better understanding of disease suppression offers hope for reducing the impact of this disease in the system.

The development of biological disease suppression in a dry land cereal system was first observed in a rotation trial at Avon, in the lower north of SA. Rhizoctonia caused poor plant growth in 46% of the trial area in 1983, but this declined to negligible levels by 1990. The Avon soil is an alkaline calcareous sandy loam, pH (H_2O) 8.2, organic carbon of 1.6%, total N 0.15%, $CaCO_3$ 8% (Roget, 1995). Mineral nitrogen in the soil is believed to be a 'switch' which turns disease suppressive activity on or off (Roget and Gupta, 2006) with suppressive activity being reduced with increasing mineral N in the surface soil.

Paddock N12 is located on the Minnipa Ag Centre and has been continuously cropped for 26 years and shows a level of disease suppression in both pot bioassays and in the field, although not as great as Avon.

The trial described here is in MAC N12 on the Ag Centre and was designed to see whether typical rotation or nitrogen fertiliser options for upper EP can 'switch' suppression off.

How was it done?

The trial was established in 2008 in MAC N12 to determine the relationships between soil mineral nitrogen, microbial populations and disease suppression. The treatments aimed to increase soil mineral nitrogen and then monitor how this affects disease suppression. The treatments included two nitrogen fertilisers, urea at 60 kg/ha and sulphate of ammonia at 120 kg/ha (split applications; half at seeding and other applied on 27 July), Kaspa peas, medic (with and without grass control or mown to simulate grazing), fallow (no carbon or N input into the system) and wheat, Wyalkatchem @ 60 kg/ha with 50 kg/ha DAP. The trial was sown on 5 May in ideal conditions with 1 L/ha Roundup, 1 L/ha Treflan and 80 ml of Hammer used pre-seeding. The medic plots self generated in early April, and a good stand was established.

Root disease inoculum levels were assessed in March.

What happened?

Initial soil tests were taken to characterise the N12 soil (Table 1). The organic C was low for this soil considering it had not been grazed and all stubbles had been returned to the soil over the last 20 years. Mineral N was relatively low with a total of 61 mg nitrate-N/kg soil in the profile and Colwell P levels were moderate (average 18 mg/kg). The calcium carbonate and boron levels are low until deeper in the profile compared to other local soils which can have higher levels in the top layers of the soil profile.

Rhizoctonia inoculum was below detection for all rotations except the sulphate of ammonia treatment which was low risk. Urea and medic had medium risk. Pratylenchus thornei was present in low levels in all treatments tested. Take all was also detected at low to medium levels in most plots.

Soil moisture at seeding was the same for the control, fallow, peas or medic treatments. Spray topped medic, peas and urea treatments all had higher soil mineral N levels than the control (Table 2).

Table 1 Soil characteristics for MAC N12, February 2008

Soil	Depth (cm)	pH $CaCl_2$	Boron (mg/kg)	Org C (%)	Nitrate N (mg/kg)	Colwell P (mg/kg)	$CaCO_3$ (%)
MAC N12	0 - 10	8.1	1.3	1.1	18	27	0.9
	10 - 20	8.1	1.6	0.8	28	17	1.7
	20 - 40	8.1	2.0	0.6	5	7	9.3
	40 - 60	8.2	2.8	0.4	3	4	14
	60 - 80	8.3	9.0	0.3	3	4	22
	80 - 100	8.3	16.9	0.3	4	4	28

Table 2 Soil profile mineral N (kg N/ha) for selected treatments in MAC N12, February 2009

Treatment	kg N/ha
Wheat - Control	44
Wheat - Sulphate of Ammonia @ 120 kg/ha (split)	51
Wheat - Urea @ 60 kg/ha (split)	59
Fallow	49
Peas	58
Medic spraytopped	83
LSD (P=0.05)	*8*

The trial established and grew well in 2009. There were no visual differences in Rhizoctonia disease between treatments. Harvest dry matter was lower in the control wheat than in wheat after fallow treatment (Table 3). The mown medic treatment, as a simulation of having sheep within the system, produced half the shoot dry matter of the spray topped medic.

The treatments with extra fertiliser nitrogen had better growth, and both yielded higher than the control plots indicating nitrogen was a limiting factor in 2009 (Table 3). Wheat after medic yielded higher than the control but not as good as the wheat after fallow treatment. The added fertiliser nitrogen treatments also had higher grain protein levels than the other plots. All screenings were within the acceptable range.

At head emergence, wheat after medic was more variable in height and vigour than the other treatments. As a consequence, plant roots and soil of wheat after medic, wheat after fallow and wheat after wheat were assessed for presence of root disease inoculum. However, similar levels of pathogen inoculum were found in all sampled treatments. Plant roots had higher levels of Rhizoctonia and Pratylenchus thornei than soil. Wheat after medic showed a high risk of Blackspot of peas due to the fungus Phoma medicaginis being present on the wheat roots. The uneven head emergence in the wheat after medic treatments is possibly due to interactions between microbial population changes and nutritional effects.

What does this mean?

Soil moisture at seeding was similar between the control, fallow, peas or medic plots, possibly due to substantial autumn rainfall. At the start of the 2009 season there were differences in soil mineral nitrogen levels in the selected treatments tested, with the spray topped medic being the greatest with 63 kg N/ha and the wheat control the least with 44 kg N/ha.

Previous research on EP by Damien Adcock showed clay content of the soil was important in mineralisation of N, and he showed that mineralisation was greater in a Minnipa soil with higher clay content than in Rudall or Cungena soils. Work by Damien at Rudall estimated that medic plots fixed 12 kg N/t DM in 1999 and 22 kg N/t DM in 2002; vetch was 13 kg N/t DM and 18 kg N/t DM respectively. Other research indicates medic can fix up to 25 kg N/t DM, therefore in this good season the medic spray topped treatment might have fixed up to 125 kg N/ha.

It is anticipated that large differences in soil mineral nitrogen will influence the soil microbial population and the level of Rhizoctonia next season. This trial will be over-sown with barley next season as barley shows Rhizoctonia patches more obviously than wheat. Next year will involve intensive monitoring of root disease, soil mineral N, nutrition and yield.

Acknowledgements

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Table 3 Dry matter and yields from MAC N12 Increasing N trial, 2009

Treatment	Seeding Rate (kg/ha)	Dry Matter at Harvest (t/ha)	Yield (t/ha)	Protein (%)	Screenings (%)
Wheat - Control	60	10.9	4.5	9.4	4.7
Wheat - Sulphate of Ammonia @ 120 kg/ha (split)	60	12.6	5.4	10.0	3.5
Wheat - Urea @ 60 kg/ha	60	12.2	5.6	10.1	4.6
Wheat after medic	60	11.1	4.8	9.3	4.8
Wheat after fallow	60	13.7	5.2	9.6	4.2
Peas	100	12.0	2.8		
Medic spray topped	10	5.2			
Medic with grass	10	4.9			
Medic mown	10	1.9			
LSD (P=0.05)		*2.5*	*0.5*	*0.6*	*ns*