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Section 3

Disease

The Impact of Soil Mineral Nitrogen on Disease Suppression

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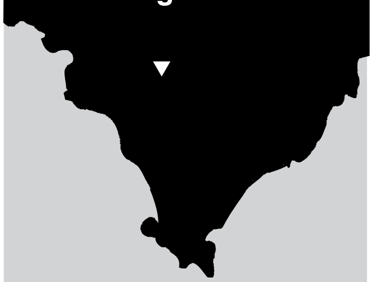
RESEARCH

Searching for answers



Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 236 mm
2010 Total: 410 mm
2010 GSR: 346 mm
Yield
Potential: 5.1 t/ha (B)
Actual: 4.3 - 6.0 t/ha
Paddock History
2010: Wheat
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 27 years
Economic
Cost of adoption risk: No livestock in system, higher risk cropping

Key messages

- **It appears that once disease suppression is achieved in low rainfall farming systems of upper EP and inoculum levels are low, it is quite robust and will be maintained despite systems with substantially different amounts of mineral N.**
- **Fallow, Medic/Fallow and Peas all lowered rhizoctonia inoculum levels in 2010, and Fallow and Peas lowered levels in 2009.**
- **Continuous cereals produced the highest inoculum levels but all levels were low at this site.**
- **Even high mineral N (118 kg N/ha) in the top 60 cm (measured in April after spraytopped medic) did not increase Rhizoctonia patches in 2010.**
- **Trichoderma fungus and the beneficial PEM microbes are present in the MAC N12 system.**

Why do the trial?

Rhizoctonia solani (AG-8) is a major disease in our cereal based farming systems. This research is the final 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 activity of some particular soil microbial populations reducing the impact of the disease on plant root systems. A better understanding of disease suppression offers hope for reducing the impact of this disease.

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 over summer 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 Minnipa Agricultural Centre (MAC) and has been continuously cropped for 27 years and shows a level of disease suppression in both pot bioassays and in the field, although not as great as Avon. This trial in MAC N12 was designed to test 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 these were then monitored for disease suppression. The treatments in 2008 and 2009 included two nitrogen fertilisers (urea at 60 kg/ha and sulphate of ammonia at 120 kg/ha [split applications]), peas, medic (with and without grass control or mown to simulate grazing), fallow (no carbon or N input into the system) and wheat. In 2009 two ammonium sulphate plots were accidently spraytopped at booting, giving an extra treatment.

In the 2010, all treatments were sown with Hindmarsh barley @ 60 kg/ha on 31 May. A pre-seeding application of 1 L/ha Roundup®, 1 L/ha Treflan® and 80 mL/ha of Hammer® was followed mid season by 400 g/ha Achieve® and 300 mL/ha of Lontrel®.

Soils were collected in March to measure soil mineral nitrogen and root disease inoculum levels (measured by the PredictaB® root disease testing service). Plant roots were scored for Rhizoctonia disease and number of crown roots on 21 July at 7 weeks post seeding. Early dry matter, grain yield, quality and biomass at maturity was measured.

What happened?

Rhizoctonia inoculum levels in March were low, but still sufficient to cause disease symptoms in a barley crop in a non-suppressive paddock. The lowest levels of Rhizoctonia inoculum were following Fallow, Medic/Fallow (medic in 2008 followed by fallow in 2009) and Peas (Table 1). In 2009, Fallow and Pea treatments also lowered Rhizoctonia inoculum levels. It appears that grass free medic options had lower Rhizoctonia inoculum than cereals. There was very little grass in the Medic grass treatments in this paddock. These results indicate rotation may affect Rhizoctonia inoculum more than previously thought.

Barley did not develop typical bare patches in 2010 and relatively low levels of disease scores on the seminal roots are consistent with this low level of disease severity. A root disease score of 2.5 is normally required for patches to develop within a crop.

By seven weeks after seeding an average of 3.5 crown roots had developed, but this was also dependent on soil mineral nitrogen as the higher nitrogen systems were more advanced both in root growth and early dry matter. The PredictaB® test is also able to measure beneficial microbes. These microbes were first isolated from the Avon soil, and have been shown to be linked to disease suppression. The PredictaB® results showed the Trichoderma fungus (which attacks Rhizoctonia) and PEM microbes are present in the MAC N12 system, data not shown.

Table 1 PredictaB® levels in March and Rhizoctonia disease scoring on barley at tillering for MAC N12, 2010

Treatment (2008/2009)	R solani AG8 (pgDNA/g soil) (level in 2009)	Early Dry Matter (g/plant)	Average Rhizoctonia Score on Seminal Roots (0-5)	Infected Crown Roots	Number Crown Roots	Infection Crown Roots (%)
Amm Sulphate	107 (34)	0.23	0.9	0.9	3.4	25
Amm Sulphate + spraytop booting	173	0.34	0.5	0.9	3.9	24
Wheat Control 1	80 (0)	0.25	0.9	0.7	3.1	23
Wheat Control 2	107	0.26	0.9	0.3	2.7	14
Fallow	0 (2)	0.40	0.3	0.2	3.9	4
Fallow/Wheat	40	0.22	0.8	0.4	2.6	14
Medic/Fallow	2	0.37	0.4	0.2	4.0	5
Medic Grass	13	0.35	0.6	0.5	3.7	13
Medic Mow	63	0.39	0.8	1.0	4.2	23
Medic Spraytop	24 (23)	0.36	0.7	0.4	3.8	10
Medic/Wheat	54	0.23	0.6	0.5	2.9	17
Peas	8 (4)	0.46	0.5	0.3	3.8	8
Urea	99 (31)	0.27	1.2	0.7	3.2	20
Wheat spraytop booting	73	0.34	1.3	1.2	3.7	31
LSD (P=0.05)	*48*	*0.08*	*0.3*	*0.6*	*0.7*	*33*

Table 2 Soil phosphorus and nitrogen, MAC N12 2010

Treatment	Colwell Phosphorus (mg/kg)	Mineral N (kg/ha)		Total Mineral N (kg/ha)
	0-10 cm	0-10 cm	10-60 cm	0-60 cm
2008 (initial)	*63*	*23*	*234*	*257*
Amm Sulphate	44	19	46	64
Amm Sulphate + spraytop booting	52	56	37	93
Wheat Control 1	41	23	43	66
Wheat Control 2	*	19	35	53
Fallow	47	29	45	74
Fallow/Wheat	44	17	39	56
Medic fallow	48	28	55	83
Medic Grass	40	45	69	115
Medic Mow	43	45	53	98
Medic Spraytop	40	50	68	118
Medic/Wheat	54	20	34	54
Peas	47	26	63	89
Urea	46	19	34	52
Wheat spraytop booting	57	40	56	96
LSD (P=0.05)	*44*	*15*	*16*	*31*

Crop growth in MAC N12 is not limited by phosphorus as Colwell P levels are considered greater than adequate for mallee soils. However, despite high mineral N reserves at the start of the trial (Table 2) barley growth and quality in 2010 were limited by N (Table 3). Medic, peas and added N fertiliser treatments had higher yields and protein but also higher screenings than the cereals without extra N. Mineral N reserves which would normally be considered sufficient for typical upper EP crops were inadequate for the very high yields achieved in 2010, following the good season of 2009.

Table 3 Dry matter, yields and grain quality from MAC N12 Increasing N Trial, 2010

Treatment oversown with Hindmarsh barley @ 60 kg/ha	Dry Matter at Harvest (t/ha)	Yield (t/ha)	Protein (%)	Screenings (%)
Amm Sulphate	11.5	5.1	7.6	8.8
Amm Sulphate spraytop booting	13.7	5.9	8.1	11.3
Wheat Control 1	8.6	4.3	7.2	5.5
Wheat Control 2	*	4.4	7.7	6.5
Fallow	11.4	5.6	9.3	21.0
Fallow/Wheat	8.0	4.5	7.5	6.7
Medic Fallow	15.4	5.9	9.1	19.7
Medic Grass	14.9	5.9	9.1	19.7
Medic Mow	14.4	5.8	9.0	16.8
Medic spraytop	15.4	5.8	9.7	23.3
Medic/Wheat	9.6	4.6	7.3	7.9
Peas	15.2	6.0	8.8	18.1
Urea	11.2	5.4	8.0	14.1
Wheat spraytop booting	11.5	6.0	7.7	6.0
LSD (P=0.05)	*3.3*	*0.4*	*0.5*	*7.5*

What does this mean?

Previous Rhizoctonia research has indicated there was very little rotational control of Rhizoctonia disease, but the use of Predicta B® (RDTS) to measure DNA inoculum levels in recent research, has shown canola has the ability to lower Rhizoctonia inoculum levels. The results from this trial indicate rotation may be linked to Rhizoctonia inoculum levels more than previously thought, as the Fallow, Medic/Fallow and Peas all lowered Rhizoctonia inoculum levels in 2010, and Fallow and Peas lowered levels in 2009. It appears the grass free medic systems have Rhizoctonia inoculum levels higher than fallow and break crops, but lower than the cereal systems. This rotational effect on inoculum level will need further research and clarification through the new crop sequencing project.

MAC N12 is a low nitrogen system with grain yields and quality influenced by nitrogen levels in 2009 and 2010, and the medic and added nitrogen systems yielding highest. The highest nitrogen levels achieved by spraytopped medic did not increase Rhizoctonia patches in barley in this system. The soil tests show N12 is unlikely to be limited by phosphorus with the soil having low calcium carbonate and hence a lower phosphorus buffering index. Soil characteristics like high calcium carbonate and high phosphorus fixation may limit the ability of both the plant to cope with Rhizoctonia disease infection and the development of suppression within the microbial population.

MAC N12 has been shown in bioassays to have a level of suppression which is almost as high as that achieved in the Avon soil. The beneficial microbes which are linked to disease suppression in the Avon soil, Trichoderma fungus and PEM microbes are present in the MAC N12 system. In N12 the low Rhizoctonia inoculum levels and lack of disease symptoms are due to the disease suppressive abilities of the microbial populations present in this paddock. The disease suppressive ability of MAC N12 appears non-responsive to increased mineral N in soil, and it is a relatively low N system, so once suppression is achieved in low rainfall farming systems it should be robust.

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