Best bet management of nutrition on ameliorated Non-wetting soils in the Geraldton Port Zone - Marchagee

Alana Hartley, Research Agronomist and Coordinator, Liebe Group

Key Messages

- Wheat yields were low, around 1 t/ha, as a result of low growing season rainfall in 2017.
- Treatments were adjusted to reflect standard grower practice due to drier than normal conditions at the beginning of winter.
- This site was unresponsive to nutrition treatments in 2017.

Aim

To determine the most effective way to apply nutrients (granular, banded, top dressed or liquid) on non-wetting soils after amelioration, in the Geraldton Port Zone.

Background

Water repellence is a significant constraint to production in Western Australian broadacre farming systems. It is estimated that 6.9 million hectares are considered at moderate risk of water repellence, whilst 3.3 million hectares are considered at high risk, based on the area of coarse sand with low clay content (van Gool 2008). In the Geraldton Port Zone, approximately 52% of the arable soils are at moderate to high risk of water repellence (van Gool 2008).

Water repellent soils are characterised by having slow and uneven water infiltration, water run-off and ponding and 'bypass' flow through the soil via preferential pathways, leaving the surrounding soil dry (Roper et al. 2005).

Over the years, farmers have adopted many practices to mitigate soil water repellence, with various levels of success. These include; furrow sowing, use of surfactants, addition of clay and, more recently, deep cultivation through complete or partial inversion of the soil by mouldboard plough, rotary spader or one-way disc plough, which has been successful in mitigating water repellence issues (Davies, Scanlan & Best 2011).

These tillage practices that mitigate soil water repellence can alter crop nutrition; including nutrient availability and distribution through the soil profile. Physio-chemical aspects of the soil profile are also disturbed and will influence root growth and biological activity (Robson & Taylor, cited in Vu et al. 2009). The implication of the redistribution of the organic matter and nutrient rich topsoil from the use of cultivation equipment varies for each nutrient. Both spading and mouldboard ploughing are likely to increase N mineralisation however, the distribution of other nutrients highlights the need to conduct soil testing post cultivation to understand the new soil profile (Davies, Scanlan & Best 2011).

To investigate what the impact of cultivation has on the management of nutrients post amelioration, three sites were selected across the Geraldton Port Zone at Eneabba, Marchagee and Irwin. As treatments, the project team selected two key nutrients, potassium (K) and nitrogen (N) which were applied in various forms; granular, banded, top-dressed and liquid. It was also agreed that, to avoid the initial flush of nutrients after the first year of cultivation, that selected sites would have been ameliorated a minimum of two years prior to implementing the trial.

The Marchagee site was established at Clint Hunt's property just east of Marchagee, on deep yellow sand, which had been mouldboard ploughed in 2014 to ameliorate the non-wetting soil surface.

Trial Details

Property	Clint Hunt, Hunt Partners, Marchagee
Plot size & replication	1.54 m x 20 m x 4 replications
Soil type	Deep yellow sand
Soil pH ($CaCl_2$)	0-10cm: 5.3 10-20cm: 5.6 20-30cm: 4.6
EC (dS/m)	0-10cm: 0.023
Sowing date	10/05/2017
Seeding rate	Scepter 70 kg/ha
Paddock rotation	2014: Wheat 2015: Wheat 2016: Canola 2017: Wheat
Amelioration	2014: Mouldboard ploughed
Fertiliser	See Table 1 and 2
Herbicides, Fungicides & Insecticides	10/05/2017: 1.5 L/ha Treflan, 118 g/ha Sakura, 13/07/2017: 800 ml/ha Velocity + 1 % Hasten
Growing season rainfall (GSR)	171 mm

Trial Layout

The initial trial design included a combination of N and K rates ranging from nil to very high. Poor seasonal conditions early in the season resulted in the project team altering the original trial design to reflect grower standard practice during a dry season. This meant that the Z23 application of Flexi N was adjusted to 50 L/ha and the Z30 application was not applied. Due to a mistake made during the application of Flexi N at Z23, all treatments received 50 L/ha of Flexi N therefore, there is no nil N treatment at this site. The final implemented treatments can be found in Table 2.

Table 2 Implemented trial design

Treatment	Planned Description	Applied Description	IBS (Kg/ha)	Banded (L/ha)	Banded (kg/ha)	Z23	N	P	K
1	Std N No K	Std N No K		54 Flexi N	85 Agstar Extra	50 Flexi N	56	12	0
2	Std N Std K	Std N Std K		50 Flexi N	100 K-Till Extra	50 Flexi N	56	12	11
3	Liquid K	Liquid K		117 Flexi NK	85 Agstar Extra	50 Flexi N	56	12	11
4	Std N High K	Std N High K		50 Flexi N	100 K-Till Extra/28 MoP	50 Flexi N	56	12	25
5	No N	Low N High K			62 Big Phos/51 MoP	50 Flexi N	21	12	25
6	Low N	Std N High K		50 Flexi N	100 K-Till Extra/28 MoP	50 Flexi N	56	12	25
7	High N	Std N High K		50 Flexi N	100 K-Till Extra/28 MoP	50 Flexi N	56	12	25
8	High N No K	Std N No K		54 Flexi N	85 Agstar Extra	50 Flexi N	56	12	0
9	High K	Std N Very High K	200 MoP	54 Flexi N	85 Agstar Extra	50 Flexi N	56	12	99

Results and Discussion

In 2017, the Marchagee site received 171 mm of GSR. The majority of the rainfall received (approximately 120 mm) did not fall until late in the season, in August and September.

Early soil tests taken prior to sowing (Table 3), indicated that there was little requirement for N at this site as good summer rainfall received in January and February of 2017 provided additional mineralised N prior to the implementation of the trial. While low, results indicate higher organic carbon and associated N supply at 10-20 cm associated with burial of the organic horizon during mouldboard ploughing remains a feature of the site. Potassium at this site indicated the possibility of the site being K responsive. Water penetration testing was also conducted to determine the effectiveness of the cultivation treatment removing the non-wetting layer, so ensure that non-wetting did not impact on the treatments being applied.

Table 3: Soil test results, Marchagee, 4th April 2017

Depth	pH ($CaCl_2$)	OC%	EC	NO_3 N	NH_4 N	Col P	Col K	PBI	MED	WDPT (secs)
0-10 cm	5.3	0.32	0.023	5	2	16	30	12	0	0
10-20 cm	5.6	0.56	0.031	10	1	19	37	11.6		
20-30 cm	4.6	0.22	0.015	3	1	16	24	10		
30-40 cm	4.5		0.011	2	0	13	23			
40-50 cm	4.6		0.010	2	0	4	27			

Organic Carbon percent (OC% - determined by Walkley-Black method), Electrical Conductivity ds/m (EC), Nitrate nitrogen (NO_3 N), Ammonium nitrogen (NH_4 N), Colwell Phosphorus (Col P), Colwell potassium (Col K), Phosphorus Buffering Index (PBI), molarity of ethanol droplet test (MED), water droplet penetration time (WDPT)

Table 4: Impact of fertiliser management strategy on 2017 wheat yield and quality

Treatment	2017 Wheat Yield	Protein (%)	Hectolitre (g/hL)	Screenings (%)	Grade
Std N No K	1.00[a]	13.3[a]	80.9[bc]	4.5[ab]	H1
Std N Std K	0.98[a]	13.3[a]	81.8[a]	3.6[c]	H1
Liquid K	0.84[b]	13.0[ab]	80.6[c]	5.3[a]	AUH1
Std N High K	0.95[a]	13.1[ab]	81.9[a]	4.3[bc]	H1
Low N High K	0.99[a]	12.6[c]	82.2[a]	4.2[bc]	H2
Std N High K	0.99[a]	12.8[bc]	81.7[ab]	4.4[abc]	H2
Std N High K	1.05[a]	12.6[c]	81.8[a]	4.9[ab]	H2
Std N No K	0.98[a]	13.3[a]	80.8[c]	4.2[bc]	H1
Std N Very High K	0.97[a]	13.0[ab]	82.4[a]	4.2[bc]	H1
LSD (P=0.05)	*0.11*	*0.33*	*0.74*	*0.93*	
CV (%)	*7.4*	*1.74*	*0.62*	*14.23*	
P value	*0.043*	*<0.001*	*<0.001*	*0.053*	

Means followed by a different letter are significantly different.

There was no significant impact of the applied treatments on grain yield at the Marchagee site (Table 4), with the exception of Liquid K (treatment 3). This treatment was significantly lower yielding than all other treatments at only 0.84 t/ha. Irrespective of the slight differences in grain protein at this site most treatments reached H1 or H2 milling grade, with the exception of the Liquid K treatment which was downgraded to AUH1 grade due to screenings above the 5% receival standard. All samples met the CBH receival standards of minimum 74 g/hl for hectolitre weight.

Plant counts were conducted at early emergence (3-5 leaf); however there was no significant treatment difference with plant numbers ranging from 28-38 plants/m^2 (average 32 plants/m^2) across the whole site. While there was a large range between head density counts, 86-102 heads/m^2 (average 92 heads/m^2), and the variability in these numbers across each treatment meant that there was no significant treatment effect in 2017.

A post emergent foliar nitrogen application was conducted on the 13th of July, where treatment 5 (nil N) received 50 L/ha of nitrogen, resulting in no nil treatment to compare other treatments against. Plant sampling was conducted four weeks post nitrogen application, plant samples were taken to assess the difference in nutrient uptake across the various treatments (Table 5)

Table 5: Plant sample analysis from plants sampled 11th August 2017, at Z28 (mid-late tillering)

Treatment	Tot N	NO_3N	P	K	Cu	Zn	Mn
1	5.32	762.5	0.71	3.20	11.37	45.7	131.3
2	5.36	835.2	0.71	3.29	11.79	50.3	129.4
3	5.53	805.5	0.71	3.50	12.14	47.6	114.1
4	5.28	754.5	0.73	3.27	12.27	48.7	124.4
5	5.19	808.5	0.68	3.61	11.24	49.1	116.8
6	5.18	710.8	0.67	3.71	11.35	48.6	130.7
7	5.18	672.0	0.70	3.02	11.67	45.1	139.9
8	5.04	597.3	0.64	3.48	10.70	44.7	148.0
9	5.08	714.7	0.68	3.79	10.91	45.9	120.8

There were no differences between treatments in any of the plant sample results. What was evident was all treatments had low nitrate levels, indicating that there was no translocation of N through the plant at the time of sampling. This aligned with a period of no rainfall post nitrogen application. All other nutrients analysed at the time of plant sampling, were considered to be adequate for optimal plant growth. Plant sampling was only conducted once in 2017 due to poor seasonal conditions at early emergence, resulting in inadequate plant numbers and maturity for sampling. Warm weather and late spring rains (late August) resulted in the crop maturing very quickly, hence no second plant test was able to be conducted to capture changes in plant nutrient requirements.

Comments

The unresponsive nature of the results in 2017 was reflective of the poor early season rains, poor crop growth and subsequent lack of nutrient demand. Good spring rains received in September allowed some crop recovery however, grain yield and nutrient requirements remained low. All of the applied treatments provided adequate nutrition, apart from Liquid K which performed significantly worse.

Should the trial be continued, in subsequent seasons the additional top up N treatments will be included providing an opportunity to better understand N responses and interaction of N with K nutrition on ameliorated soils.

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Contact

Alana Hartley
Research Agronomist and Coordinator
Liebe Group
research@liebegroup.org.au
(08) 9661 0570

Stephen Davies
Soil Scientist and Project Manager
Department of Primary Industries and Regional Development
Stephen.davies@dpird.wa.gov.au
(08) 9956 8515

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