Management of nutrition after rotary cultivation of a non-wetting soil in the Geraldton Port Zone - Eneabba

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Key Messages

- Cultivation will often see improved yields in the first two seasons, particularly on lighter soils.
- The 2018 season saw 409 mm of growing season rainfall (GSR) resulting in a significant response to nitrogen (N) and a response to a residual high potassium (K) applied in 2017.
- In soils deficient in K (below 40-50mg/kg) at 0-10 cm, application of higher rates of top dressed K to take advantage of the residual benefits across seasons could be considered.

Aim

To determine the impact of N and K supply on yield and quality, on ameliorated non-wetting soils in the Geraldton Port Zone.
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, and further 3.3 million hectares are high risk, based on the area of coarse sandy topsoils 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 defined by having slow permeability to water, characterised by uneven wetting of soils, water run-off and pooling and/or, flow through the soil via preferential pathways, leaving the surrounding soil dry (Roper et al. 2015).

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 have been successful in mitigating water repellence issues (Davies, Scanlan & Best, 2011; Roper et al. 2015).

These strategic deep 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 the impact of cultivation has to the management of nutrients post amelioration, three sites were selected across the Geraldton Port Zone; Eneabba, Marchagee and Irwin. In 2017, the project team chose to select two nutrients, K and 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. In season rainfall in 2017 was considerably lower than average (265 mm), resulting in no significant differences between treatments. As a result, a second season of research was established to further investigate nutrition management on these ameliorated non-wetting soils. The trial design for the 2018 season was modified to examine the effects of K and N, and the residual value of K, on an ameliorated non-wetting soil.

The Eneabba site was established on white non-wetting sand over gravel, which had been rotary spaded in 2015 to ameliorate the non-wetting soil surface.

Trial Details

Property	Rohan Broun, Eneabba
Plot size & replication	1.54 m x 20 m x 4 replications
Soil type	White sand over gravel
Soil pH ($CaCl_2$)	0-10cm: 6.0 10-20cm: 6.0 20-30cm: 5.8
EC (dS/m)	0-10cm: 0.085
Sowing date	18/04/2018
Seeding rate	1.8 kg/ha (DG 540 RR canola)
Paddock rotation	2015: Wheat 2016: Wheat 2017: Wheat 2018: Canola (RR)
Amelioration	2015: Rotary Spaded
Fertiliser	See Table 1
Herbicides, Fungicides & Insecticides	18/04/2018: Flexi N and compound fertiliser as per treatment schedule, 200 ml/ha Lorsban, 200 ml/ha Dominex Duo. 08/06/2018: 900 g/ha Roundup Ready 3/07/2018: 05/07/2018: 900 g/ha Roundup Ready 2/08/2018: Flexi N top up as per treatment schedule 24/08/2018: 500 kg/ha gypsum 27/09/2018: 750 ml/ha Lorsban, 500 ml/ha Dominex Duo.
Growing season rainfall (GSR)	409 mm

Trial Layout

The initial trial design included a combination of N and K rates ranging from nil to very high. Poor seasonal conditions in 2017 led to harvest results providing no significant difference between treatments. As such, the trial was extended into 2018 with treatment modifications. The final implemented treatments can be found in Table 1 where treatment nine (9) has been modified to reflect grower standard practice of not applying additional top dressed K rather, it utilises the high K rate that had been applied in the previous season (2017). This is now reflected as Residual High K.

Table 1: Implemented nutrient treatments for 2018

	Treatment	Banded (L/ha)	Banded (kg/ha)	Rosette (L/ha)	Budding (L/ha)	N	P	K
1	Std N No K	50 Flexi N	85 Agstar Extra	80 Flexi N		70	12	0
2	Std N Std K	50 Flexi N	100 K-Till Extra	80 Flexi N		70	12	11
3	Liquid K	117 Flexi NK	85 Agstar Extra	80 Flexi N		70	12	11
4	Std N High K	50 Flexi N	100 K-Till Extra/28 MoP	80 Flexi N		70	12	25
5	No N		62 Big Phos/51 MoP			0	12	25
6	Low N	50 Flexi N	100 K-Till Extra/28 MoP			31	12	25
7	High N	50 Flexi N	100 K-Till Extra/28 MoP	80 Flexi N	71 Flexi N	100	12	25
8	High N No K	50 Flexi N	85 Agstar Extra	80 Flexi N	71 Flexi N	100	12	0
9*	Residual High K	50 Flexi N	85 Agstar Extra	80 Flexi N		70	12	0

*200 kg MoP was applied in 2017 with the residual K from this treatment being carried over to 2018.

Results and Discussion

In 2018, the Eneabba site received 409mm of GSR, with consistent falls received between May and October. Early soil tests were taken prior to sowing from treatments 1 and 9. These treatments represent soil with nil K applied compared to residual application of high K rate (Table 2 and 3).

Results have been averaged across all four replicates of the trial site however, Rep 1 did indicate slightly higher N, phosphorous (P) and K levels due to the higher gravel and clay content at that end of the site.

Background soil N status was low and with significant growing season rainfall in 2018, the site showed visual responses to N. Potassium (K) levels under treatment 9 were somewhat higher than in treatment 1 however, soil Colwell K is still below adequate levels and suggests the site would be responsive to K. Water penetration testing was also conducted at the beginning of the project in 2017, to determine the effectiveness of the cultivation treatment removing the non-wetting layer. This has not changed from one season to the next.

Table 2: Soil test results Treatment 1 (Standard N, No K) Eneabba, 26th March 2018

Depth	pH ($CaCl_2$)	OC%	EC	NO_3 N	NH_4 N	Col P	Col K	PBI	MED	WDPT (secs)
0-10 cm	6.2	0.57	0.072	19	1	9.5	20	7.5	0	6.8
10-20 cm	5.9	0.69	0.039	11	1	10	17	8.6		
20-30 cm	5.6	0.42	0.022	6	1	12.5	15	8.6		
30-40 cm	4.9						24			
40-50 cm	5.0						24			

Table 3: Soil test results Treatment 9 (Residual High K) Eneabba, 26th March 2018.

Depth	pH ($CaCl_2$)	OC%	EC	NO_3 N	NH_4 N	Col P	Col K	PBI	MED	WDPT (secs)
0-10 cm	6.2	0.57	0.072	14	1	10	34	7.5	0	6.8
10-20 cm	6.1	0.69	0.039	9	<1	8	30	8.6		
20-30 cm	5.4	0.42	0.022	3	1	12	18	8.6		
30-40 cm	4.9						19			
40-50 cm	5.0						25			

Organic Carbon percent (OC% - determined by Walkley-Black method), Electrical Conductivity ds/m^2 (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)

An analysis of Restricted Maximum Likelihood (REML) was conducted for yield on three of the four replicates in the trial. Replicate four was excluded due to poor establishment and wind damage.

The REML analysis accounts for the yield trend across the site and adjusts the means accordingly resulting in a better ability to distinguish between treatment effects.

Table 4 indicates canola grain yield had a clear response to N, with the high N treatments (100 kg N) achieving significantly higher yields than treatments with lower N rates. Canola grain yield was generally not responsive to K, except for the residual K treatment, which has significantly higher K than the other treatments, at the same standard level (70kg) of N. Despite this the residual K treatment yield was equivalent to the treatments with the highest N levels (treatments 7 and 8), irrespective of K-level applied, further reinforcing the N responsiveness of this site.

Table 4: Impact of fertiliser management strategy on 2018 Canola yield

REML Analysis – 3 reps				
Treatment	**Description**	**Yield**	**N**	**K**
1	Std N No K	1.06 ab	70	0
2	Std N Std K	1.14 bc	70	11
3	Liquid K	1.06 ab	70	11
4	Std N High K	1.11 ab	70	25
5	No N	0.91 a	0	25
6	Low N	0.93 ab	31	25
7	High N	1.32 cd	100	25
8	High N No K	1.32 cd	100	0
9	Residual High K	1.36 cd	70	Residual
l.s.d (p<0.1)		0.21		
P. value		*0.028*		

Means followed by a different letter are significantly different.

An analysis of variance (ANOVA) was conducted to examine the main effect of N only (Table 5). This found that the high N rate was significantly higher yielding than any of the lower N treatments, and the standard N in turn was also significantly higher than no N.

Table 5: Grain yield response to N rate (ANOVA)

Nitrogen rate (kg/ha)	Average yield (t/ha)
0	1.08[a]
31	1.20[ab]
70	1.40[b]
100	1.62[c]

Analysis of oil was conducted using ANOVA, including all four replicates in the trial. High N treatments were significantly higher yielding of oil (Table 6) compared to treatments 5 and 6. While there was no significant difference between those treatments with ‘standard N’ and, treatments 5 and 6.

Table 6: Impact of fertiliser management strategy on 2018 Canola oil % (ranked lowest to highest)

Treatment	Description	Oil %	N	K
1	Standard N, No K	44.7 ab	70	0
2	Std N, Std K	45.4 abc	70	11
3	Liquid K	44.4 a	70	11
4	Std N, High K	45.6 bc	70	25
5	No N	44.6 ab	0	25
6	Low N	44.4 a	31	25
7	High N	46.0 c	100	25
8	High N, No K	45.7 bc	100	0
9	Residual High K	44.9 abc	70	Residual
	l.s.d.	*1.169*		
	P. Value (<0.05)	*0.055*		

Economic analysis

A gross margin analysis has been conducted to investigate the profitability of the nutrition packages applied in this trial. Treatment 2 (standard N, standard K) has been used as the grower standard practice (GSP) cost base for this analysis.

Table 7: Gross margin analysis by treatment

	Treatment	Banded (L/ha)	Banded (kg/ha)	Rosette (L/ha)	Budding (L/ha)	N	P	K	Yield (t/ha)	Oil (%)	Gross Re-turn ($/ha)	Trt. Cost ($/ha)	GM ($/ha)	Diff. cf. Trt. 2 $/t (GSP)
1	Std N No K	50 Flexi N	85 Agstar Extra	80 Flexi N		70	12	0	1.06	44.7	574	158	416	-30
2	Std N Std K	50 Flexi N	100 K-Till Extra	80 Flexi N		70	12	11	1.14	45.4	621	175	447	-
3	Liquid K	117 Flexi NK	85 Agstar Extra	80 Flexi N		70	12	11	1.06	44.4	571	183	388	-59
4	Std N High K	50 Flexi N	100 K-Till Extra/28 MoP	80 Flexi N		70	12	25	1.11	45.6	610	193	417	-30
5	No N		62 Big Phos/51 MoP			0	12	25	0.91	44.6	489	71	418	-29
6	Low N	50 Flexi N	100 K-Till Extra/28 MoP			31	12	25	0.93	44.4	503	136	367	-80
7	High N	50 Flexi N	100 K-Till Extra/28 MoP	80 Flexi N	71 Flexi N	100	12	25	1.32	46	729	243	487	40
8	High N No K	54 Flexi N	85 Agstar Extra	80 Flexi N	71 Flexi N	100	12	0	1.33	45.7	718	211	508	61
9	Residual High K	54 Flexi N	85 Agstar Extra	80 Flexi N		70	12	Res.	1.36	44.9	739	291	448	1

Grain prices use for GM analysis: $520/t GM Canola plus oil bonus $8.64 per tonne clean grain.

Treatments 7 and 8 had strong gross margin returns at $487 and $508/ha (Table 7). When compared to GSP, this was an improvement of $40/t for treatment and $61/t for treatment 8. The additional investment for nitrogen at budding, coupled with adequate growing season rainfall, saw a strong response to N but no additional benefit from K in these two treatments. The additional investment in K from the residual top dressed treatment (treatment 9) only yielded an extra $1/ha above the GSP of treatment 2. This suggests that, while the yield improvements from the residual K treatment were significant, financially the additional investment would be considered uneconomical as the returns from such an application may not be realised every season.

Comments

Eneabba reflects a sand over gravel and clay profile response, where spading has mixed heavier soil (gravel and clay) through the profile and potentially improved root access to this deeper subsoil. Soil testing indicates this clay gravel layer does hold somewhat more potassium than the sandy soil above. This coupled with the reduced crop demand for K from a late emerging crop and dry finish could explain why there was not a strong response to K at this site.

While seasonal rainfall provided adequate conditions to produce an N response at this site, the lack of K response, except where MoP was top dressed in 2017, suggests that current management practices for N and K are sufficient for driving yield and oil. Such responses however, reinforce the continued need for growers to have a greater understanding of their soil profile, to depth, using existing tools such as soil sampling and analysis, to ensure fertiliser decisions meet crop demand as influenced by soil type, nutrient supply and yield potential.

Acknowledgements

Thank you to the Broun family for hosting this site at their Eneabba property. The Liebe Group would also like to acknowledge the project team, including Stephen Davies (DPIRD) and James Easton (CSBP) who helped design this trial and Andrew Van Burgel (DPIRD) for statistical analysis. Thanks are also extended to the field team at Department of Primary Industries and Regional Development (DPIRD) Geraldton, for implementation, management and harvesting of this trial.

This project has been supported by the GRDC investment LIE00010-A Best bet management for ameliorated non-wetting soils of the Geraldton Port Zone.

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Management of nutrition on a mould-boarded non-wetting soil in the Geraldton Port Zone - Marchagee

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Key Messages

- A high application of potassium (K), 25 kg/ha and standard nitrogen (N) rates, 70 kg/ha improved wheat yield and grain quality up to 0.47 t/ha on mould boarded deep sand.
- In the presence of adequate potassium (> 40-50 mg/kg), in favourable seasons, wheat can respond to the application of N) fertiliser, resulting in high yield and protein. Where K is limited, returns from N are likely to be poor.
- The results indicate that a higher rate of K than banding 11 kg/ha K can lead to a significant increase in yield and profitability.

Aim

1. To quantify the impact of nitrogen and potassium fertiliser on wheat yield and quality, after mouldboard ploughing non-wetting soils in the Geraldton Port Zone.
2. 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, with a further 3.3 million hectares at high risk, based on the area of coarse sandy topsoils 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. 2015).

Over the years, farmers have adopted many practices to mitigate soil water repellence, with various levels of success. These include furrow sowing, surfactant application, addition of clay and more recently, deep cultivation through complete or partial inversion of the soil by mouldboard plough, rotary spading or one-way disc plough, which has been successful in mitigating water repellence issues (Davies, Scanlan & Best 2011; Roper et al. 2015).

These strategic deep 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 the impact of cultivation has on the management of nutrients post amelioration, three sites were selected across the Geraldton Port Zone; Eneabba, Marchagee and Irwin. In 2017, the project team chose to select two nutrients, K and 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.

2017 saw a lower than average rainfall for the Marchagee trial site, only receiving 171 mm for the growing season. As a result, there was limited significant difference in yield on all treatments except where liquid K was applied. As such, the project has continued for a second season, investigating the management of N and K in its various forms (liquid, granular, top dressesed or banded). The trial design for the 2018 season focussed on the placement and effects of K on an ameliorated non-wetting soil.

The Marchagee site was established at Clint Hunt's property 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	18/05/2018
Seeding rate	Scepter 70 kg/ha
Paddock rotation	2015: Wheat 2016: Canola 2017: Wheat 2018: Wheat
Amelioration	2014: Mouldboard ploughed
Fertiliser	As per treatment schedule
Herbicides, Fungicides & Insecticides	18/05/2018: 200 ml/ha Lorsban, 200 ml/ha Dominex Duo, 1.5 L/ha Trifluralin, 118 g/ha Sakura
Growing season rainfall (GSR)	218 mm

Trial Layout

The initial trial design included a combination of rates for both N (0, 31, 70, 100 kg N/ha) and K (0, 11, 25, 99 kg K/ha) and application times. Treatment nine has been modified to investigate the residual value of a high rate of muriate of potash (MoP) applied the year before. This is now reflected as residual very high K.

Table 2 Implemented trial design

Treatment		Banded (L/ha)	Banded (kg/ha)	Z23 (L/ha)	Z32 (L/ha)	N	P	K
						(kg/ha)		
1	Std N No K	50 Flexi N	85 Agstar Extra	83 Flexi N		70	12	0
2	Std N Std K	50 Flexi N	100 K-Till Extra	83 Flexi N		70	12	11
3	Liquid K	117 Flexi NK	85 Agstar Extra	83 Flexi N		70	12	11
4	Std N High K	50 Flexi N	100 K-Till Extra/28 MoP	83 Flexi N		70	12	25
5	No N		62 Big Phos/51 MoP			0	12	25
6	Low N	50 Flexi N	100 K-Till Extra/28 MoP			31	12	25
7	High N	50 Flexi N	100 K-Till Extra/28 MoP	83 Flexi N	71 Flexi N	100	12	25
8	High N No K	54 Flexi N	85 Agstar Extra	83 Flexi N	71 Flexi N	100	12	0
9	Residual Very High K	54 Flexi N	85 Agstar Extra	83 Flexi N		70	12	99

Results and Discussion

In 2018, the Marchagee site received 218 mm growing season rainfall (GSR). Early soil tests were taken from treatment 1 (Table 3) and treatment 9 (Table 4) prior to sowing. Being a deep yellow sand, with K levels well below adequate (40-50 mg/kg) it was expected that this site would be responsive to K fertiliser in 2018.

Water droplet penetration testing (WDPT) and molarity of ethanol droplet test (MED) was also conducted at the beginning of the project to determine the effectiveness of the cultivation treatment in removing the non-wetting layer at the surface, to ensure that non-wetting did not impact on the treatments being applied.

Table 3: Soil test results Treatment 1, Marchagee, 19th March 2018

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	0.58	0.047	18	2	21	28	11.5	0	0
10-20 cm	4.9	0.55	0.028	9	< 1	19	22	12.9		
20-30 cm	4.5	0.32	0.017	3	< 1	17	24	10.5		
30-40 cm	4.7					12	27			
40-50 cm	4.7					4	23			

Table 4: Soil test results Treatment 9, Marchagee 19th March 2018

Depth	pH ($CaCl_2$)	OC%	EC	NO_3 N	NH_4 N	Col P	Col K	PBI	MED	WDPT (secs)
0-10 cm	5.2	0.53	0.044	15	1	25	68	9.4	0	0
10-20 cm	5.2	0.55	0.030	11	< 1	17	22	11.9		
20-30 cm	4.6	0.30	0.017	4	< 1	15	18	8.6		
30-40 cm	4.4					12	19			
40-50 cm	4.6					4	18			

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)

Due to the below average GSR that was received in 2017 (117 mm), 2018 soil tests from treatment 9 indicate that there has been little to no movement of the top dressed MoP from the 0-10 cm layer. Presumably much of the K would have been available for the crop in 2018.

Wheat yield and protein were analysed at harvest in Table 5. Treatment 2 has been used at a grower standard practice (GSP) control, to compare the response of other treatments. The site was responsive to the application of K, particularly where K had been banded at seeding. This was observed at all rates of K, where there was a 10% improvement in yield from treatment 1 to treatment 2, 25% yield improvement from treatment 1 to treatment 4 and, a 28% yield improvement under treatment 9. Treatment 3, Liquid K fertiliser, did not provide any benefits to yield, under the management practices being investigated.

Using the modified French and Schultz yield potential calculator, 74mm summer rain (January – March) and the 218mm GSR gave a wheat yield potential of 2.8 t/ha but, this goes down to 1.4 t/ha with the dry finish and low plant densities so, 1.3-1.9 t/ha achieved at this site was reasonable. With a better September, higher yields would have driven greater demand for N and K. There was a limited response to N for yield at this site.

Table 5: Impact of fertiliser management strategy on 2018 wheat protein (lowest to highest)

	Treatment	Yield	Protein %	Hectolitre	Screenings %	Grade	N (kg/ha)	K (kg/ha)
1	Std N, No K	1.34 a	11.9 de	75.0 ab	4.5 bc	H2	70	0
2	Std N, Std K	1.68 de	11.0 cd	76.5 abc	2.6 a	APW1	70	11
3	Liquid K	1.32 a	13.3 fg	75.6 abc	5.4c	AUH2	70	11
4	Std N, High K	1.81 ef	10.9 c	76.8 bc	2.3 a	APW1	70	25
5	No N	1.50 bc	8.1 a	77.5 bc	3.4 ab	ASW1	0	25
6	Low N	1.60 cd	9.5 b	78.1 c	2.7 a	ASW1	31	25
7	High N	1.86 f	12.5 ef	76.4 abc	2.8 a	H2	100	25
8	High N, No K	1.36 ab	13.9 g	73.6 a	5.4 c	AUH2	100	0
9	Residual Very High K	1.72 def	11.0 cd	78.4 c	2.8 a	APW1	70	Residual
	l.s.d	0.159	0.9	3	1.2			
	P value	<0.001	<0.001	<0.06	<0.001			

Means followed by a different letter are significantly different

A significant response to N was observed when analysing grain quality; particularly grain protein. This was noticeable under treatments 4, 5, and 6, with increasing N and constant K rate.

A 0.34 t/ha yield response to K was observed in treatments 1, 2 and 9, where N rate remained constant and K increased from 0 kg/ha K, 11 kg/ha K to the high residual K. While treatment 1 did have a higher protein, resulting in an economic gain, moving from APW1 to H2 grade, as noted in table 5, yield was low. The yield response to treatments with 25 units of K, diluted grain protein.

Grain protein results indicate that treatments with 70 or more units of N, had adequate protein (>10.5%) for APW1, H2 and H1 grades. However, high N without adequate K resulted in high screenings and lower hectolitre weight, sufficient to downgrade grain to AUH2.

There were no differences between treatments in any of the plant tissue testing results, indicating adequate uptake of nutrients in the presence of soil moisture.

Economic analysis

A basic gross margin (GM) analysis was conducted (Table 7) to determine the return from each treatment compared to Treatment, which has been used as the grower standard practice (GSP) cost base for this analysis.

With a significant response to N at this site, the highest yielding treatment, treatment 7 had the highest gross margin return at $486/ha. This was a $40/ha financial improvement from Treatment 2, justifying both the extra investment in N and K.

Where there was a significant response to K in treatments 1, 2 and 9, there was a loss of $103/ha compared to treatment 2 due to the significant capital investment in K applied in the 2017 season.

Table 7: Gross margin analysis by treatment

	Treatment	Banded (L/ha)	Banded (kg/ha)	Z23 (L/ha)	Z32 (L/ha)	N	P	K	Yield (t/ha)	Grade	Gross Return ($/ha)	Trt. Cost ($/ha)	GM ($/ha)	Var. Trt 2 (GSP)
1	Std N No K	54 Flexi N	85 Agstar Extra	83 Flexi N		70	12	0	1.34	H2	522	162	360	-86
2	Std N Std K	50 Flexi N	100 K-Till Extra	83 Flexi N		70	12	11	1.68	APW1	621	175	446	
3	Liquid K	117 Flexi NK	85 Agstar Extra	83 Flexi N		70	12	11	1.32	AUH2	488	183	305	-141
4	Std N High K	50 Flexi N	100 K-Till Extra/28 MoP	83 Flexi N		70	12	25	1.81	APW1	669	193	476	32
5	No N		62 Big Phos/51 MoP			0	12	25	1.50	ASW1	510	71	439	-7
6	Low N	50 Flexi N	100 K-Till Extra/28 MoP			31	12	25	1.60	ASW1	544	136	408	-38
7	High N	50 Flexi N	100 K-Till Extra/28 MoP	83 Flexi N	71 Flexi N	100	12	25	1.86	H2	725	239	486	40
8	High N No K	54 Flexi N	85 Agstar Extra	83 Flexi N	71 Flexi N	100	12	0	1.36	AUH2	503	213	290	-156
9	Residual Very High K	54 Flexi N	85 Agstar Extra	83 Flexi N		70	12	99	1.72	APW1	636	293	343	-103

Grain prices used for GM analysis: APW1 - $370, H2 +20, AUH2 + $0, ASW1 -$30.

Response to potassium, in the economic analysis, indicates the higher rate of K (25kg/ha) was a key factor for profitability in contrast to N. There was little difference between the standard N and high N rates. This suggests that where K is present, in a season where spring rainfall was limited in September, a conservative N strategy was still successful.

Comments

On deep sands adequate K is essential for achieving grain yield however the results also indicate that N levels need to be maintained to ensure adequate grain protein. High N with inadequate K resulted in low yield, high protein and high screenings and poorer gross margin. Higher grain yields as a result of earlier sowing or more September rainfall would have increased crop demand and the importance of N for driving yield. Highest gross margins were achieved in treatments that combined high K (25kg banded at seeding) with some N.

Acknowledgements

Thank you to the Hunt family for hosting this site at their Marchagee property. The Liebe Group would also like to acknowledge the project team, including Stephen Davies (DPIRD) and James Easton (CSBP) who assisted with the development of the trial design and interpretation of results. Thanks are also extended to Andrew Van Burgel (DPIRD for statistical analysis and support and the field team at Department of Primary Industries and Regional Development (DPIRD) Geraldton for implementation, management and harvesting of this trial.

This project has been supported by the GRD investment LIE00010-A Best bet management for ameliorated non-wetting soils of the Geraldton Port Zone.

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