SA Drought Hub Technical Report

Optimising nutrient input into low nutrient availability calcareous sands of southern YP

PROJECT LEAD: Northern Sustainable Soils

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Contents

SA Drought Hub Technical Report	**1**
PROJECT SUMMARY	3
EXECUTIVE SUMMARY	4
PROJECT BACKGROUND AND OBJECTIVES	4
METHODOLOGY	6
LOCATION	7
RESULTS	8
CONCLUSION	8
REFERENCES	30
APPENDIX 1: MEL SUMMARY DATA	31

PROJECT SUMMARY

This project was established to improve crop production on highly calcareous sandy soils on the Southern Yorke Peninsula. These soils types generally have high pH (strongly alkaline), high levels of free lime and as a result poor nutrient availability or nutrient toxicity and low soil biological activity. Four barley nutrition trials were successfully established and monitored at Marion Bay in 2024. The nutrients investigated focused on manganese, potassium and phosphorus management strategies. There were a range of outcomes from the trials which can inform future grower and advisor fertiliser and organic amendment inputs.

EXECUTIVE SUMMARY

This project was established to determine best practice nutrient management on highly calcareous sandy soils on the Southern Yorke Peninsula. This region is a unique environment (soil, rainfall and temperature) compared to other parts of the Yorke Peninsula. These highly calcareous soils generally have high pH (strongly alkaline), high levels of free lime ($CaCO_3$) and as a result poor nutrient availability or nutrient toxicity and low soil biological activity.

Four barley nutrition trials were successfully established at Marion Bay on the Southern Yorke Peninsula in 2024. The nutrients and management strategies investigated included:

- The effect of manganese fertiliser application timing, rate and product (soil applied vs foliar)
- Application rate and placement position of potassium fertilisers
- Evaluation of liquid and granular P fertilisers
- Assessment of alternative nutrient products such as chicken litter and biosolids

Within each trial a range of crop assessments were completed to determine differences in nutrient uptake, grain yield and grain quality. Where applicable economic analysis has also been included to assist growers to optimise financial returns. This is particularly important as the inherently low nutrient status of these soils can require high fertiliser inputs and therefore high input costs.

The results from these trials are of most benefit to growers and advisors. While this is the first season of investigation, there are a range of outcomes and practices that can be adopted now. Many of these outcomes have been shared through grower and advisor networks. One of the main extension activities completed during the reporting period was a local crop walk at the Marion Bay trial site focused on “improving crop production on highly calcareous sands”. In addition, the trials were visited by the Independent Ag Consultants of SA, a group consisting of 17 leading advisors and trial findings were included in a presentation to a GRDC NGN meeting held at Warooka. Findings from this research were also shared by Trengove Consulting at a sticky beak crop walk on the far west coast (Coorabie) of the Eyre Peninsula. The calcareous soil type at Marion Bay has a number of similar properties compared with trials hosted at Coorabie. It was another opportunity to share key learnings from this project. The main outcomes from all trials have been summarised into a report and will be shared on GRDCs Online Farm Trials and published in the 2025 NSS Trial Booklet.

Some of the outcomes and practices from these trials will require further investigation before growers and advisors are able/willing to adopt. For example, the lack of response to manganese on this soil type was surprising. Industry will need to see the results replicated over more sites and seasons before they are willing to reduce manganese inputs.

For more information to support adoption:

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PROJECT BACKGROUND AND OBJECTIVES

Background

Calcareous soils are strongly alkaline, contain free lime (calcium carbonate) and are particularly common in subsoils on SA's lower Yorke Peninsula, upper Eyre Peninsula, Mid North and the Mallee. Calcareous soils exist in other parts of Australia, but mainly in the subsoil, which restricts root growth after crop establishment and tillering.

Very highly calcareous soils on the Eyre and Yorke Peninsulas and in the South-East of SA contain large amounts (>40%) of calcium carbonate in the topsoil and this often increases with depth. Crops often struggle before they can get established and this if further exacerbated if the topsoil is sandy and dries out quickly.

Some of the major constraints to crop production on highly calcareous soils are poor uptake of nutrients, sodicity, nutrient toxicity, poor water holding capacity, persistence of residual herbicides, low soil biological activity, root diseases, weeds and snails. These factors combined with dry conditions often result in poor crop establishment, vigour, and grain yield. The water-limited yield gaps on these soils are often more than 50%.

Aims

The aim of this research was to determine best practice nutrient management strategies on highly calcareous soils of the southern Yorke Peninsula. Field trials were established in barley and the main nutrients under evaluation were phosphorus (P), manganese (Mn), potassium (K), but the full nutrient package also considered inputs of nitrogen (N), sulphur (S), zinc (Zn) and copper (Cu). Organic amendments and carbon coated minerals which have shown promise on similar soils elsewhere were also assessed.

The following report summarises the results from four field trials located on a very highly calcareous sand at Marion Bay, SA.

1. The effect of manganese application timing, rate and product on barley growth and yield
2. Application rate and placement position of potassium fertilisers
3. Improving crop phosphorus uptake: evaluation of liquid and granular fertilisers and rates
4. Evaluation of alternative nutrient products

METHODOLOGY

Methods

Site selection and soil properties

Five cereal nutrition trials were established adjacent to one another in a paddock at Marion Bay, SA (-35.14097, 136.97456). The soil test results suggest the site had very high soil available nitrogen pre-seeding and high organic carbon at 1.9% (Table 1). The site was very highly calcareous with 92% free lime ($CaCO_3$) in the top 0-10 cm. The soil pH was moderately to strongly alkaline. The site had a high phosphorus buffering index (PBI) of 223 indicating a strong potential for "tie up" and a significant proportion of P fertiliser applied will be unavailable to plants. This contributed to the very low DGT-P level of 15 µg/L.

Soil tests for micronutrients generally have a lower reliability than soil tests for macronutrients. Within the current information available, Mn levels at Marion Bay would be categorised as deficient. Critical soil test Mn is <5-10 mg/kg (Brennan et al 2013; Norton 2014). Both Cu and Zn soil levels would be considered adequate at this site.

Table 1. Soil properties for all cereal nutrition trials at Marion Bay sampled pre-seeding, 2024.

Soil properties	Units	0-10 cm	10-40 cm	40-100 cm
pH 1:5 water		8.0		
pH $CaCl_2$		7.6		
Organic carbon	%	1.92		
Soil available N	kg/ha	89	53	39
$CaCO_3$	%	92		
Colwell P	mg/kg	92		
PBI + Col P		223		
DGT-P	µg/L	15		
Colwell K	mg/kg	120	62	<25
Total sulphur	kg/ha	22	66	94
Zinc	mg/kg	6		
Manganese	mg/kg	3.5		
Copper	mg/kg	0.56		
ECEC	cmol/kg	25		
EC 1:5	dS/m	0.36		

For specific crop assessments in each trial please refer to the methods section in each trial report below.

LOCATION

Where demonstration sites, field trials, events or other activities have been conducted, provide the following location details in the table below: latitude and longitude for field trials, or LGA for events and other activities. (Add additional rows as required.)

Site # and name	Latitude (decimal degrees)	Longitude (decimal degrees)	LGA
Trial Site #1 The effect of manganese application timing, rate and product on barley growth and yield	-35.14097	136.97456	Yorke Peninsula
Trial Site #2 Application rate and placement position of potassium fertilisers	-35.14097	136.97456	Yorke Peninsula
Trial site #3 Improving crop phosphorus uptake: evaluation of liquid and granular fertilisers and rates	-35.14097	136.97456	Yorke Peninsula
Trial site #4 Evaluation of alternative nutrient products	-35.14097	136.97456	Yorke Peninsula

RESULTS

Trial 1. The effect of manganese application timing, rate and product on barley growth and yield

Key messages

- Pre-seeding soil testing showed the site had marginal Mn levels (<5 mg/kg).
- Manganese fertiliser applications (timing, rate and product) however, did not improve crop growth or grain yield this season.
- Tissue testing (GS31) showed Mn concentrations ranged from 14.0 – 16.7 mg/kg indicating the crop had deficient to marginal levels of Mn. Mn concentration increased with increasing rate of foliar Mn applied, but these treatments also reduced P concentration.

Why do the trial?

The availability of Mn in soil is strongly related to soil pH. Soils with higher pH have lower Mn availability than soils with lower pH. Manganese deficiency is therefore more likely to be a problem on alkaline soils. The availability of Mn is also strongly affected by seasonal conditions and the soil availability is lowest during a dry spring.

Foliar Mn can be more efficient than soil applied Mn, as the latter can result in iron or phosphate precipitates. Chelated formulations are also available. Generally, rates are around 1-5 kg Mn/ha in relatively high-water volumes although a "little (<1 kg/ha) and often" approach may be more effective (Norton 2014). The appropriate timing will depend on the degree of stress, and crops often show good recovery if Mn is applied when symptoms appear and when there is good crop cover.

This trial aimed to evaluate a range of Mn fertiliser strategies including banded and foliar application timings and rates to improve uptake and grain yield.

How was it done?

Stenhouse Bay rainfall 2024 (long-term):	Annual 328 mm (449 mm) Growing season 254 mm (358 mm)	**Variety:**	Maximus CL barley @ 80 kg/ha
Sowing date:	3rd June 2024	**Foliar spray application dates:**	GS14 - 31st July GS31 - 22nd August GS39 - 10th September

The trial was a randomised complete block design, consisting of 10 treatments with 3 replicates. Plots were 10 m long with 25 cm row spacing. Plots were sown using knife points and press wheels. All plots received starting fertiliser of MAP Zn at 120 kg/ha and urea at 100 kg/ha incorporated by sowing.

A range of Mn fertiliser strategies were trialled including application timing, rate and product (Table 1). Manganese sulphate ($MnSO_4$) was the main fertiliser source utilised in the trial, excluding

treatment 10 which assessed the effectiveness of a 100% EDTA Manganese Chelate. Foliar treatments of $MnSO_4$ were applied at 100 L/ha with a medium droplet size.

Measurements throughout the season included GreenSeeker NDVI (31st July, 22nd August, 10th September and 27th September) and tissue tests at Zadok's Growth stage 31. The trial was harvested for grain yield on the 20th of November. All plots were assessed for grain quality.

Table 1. Manganese fertiliser application timing, rate and products evaluated in the Mn strategy trial at Marion Bay, SA 2024.

Treatment	Product	IBS kg or L/ha	GS14 kg/ha	GS31 kg/ha	GS39 kg/ha	Total applied kg Mn/ha
1	Nil	-	-	-	-	
2	$MnSO_4$	10	-	-	-	3.1
3	$MnSO_4$	10	3	3	3	5.9
4	$MnSO_4$	-	1	1	1	0.9
5	$MnSO_4$	-	2	2	2	1.9
6	$MnSO_4$	-	3	3	3	2.8
7	$MnSO_4$	-	2	2	-	1.2
8	$MnSO_4$	-	2	-	2	1.2
9	$MnSO_4$	-	-	2	2	1.2
10	Mn Chelate	2	-	-	-	0.1

$MnSO_4$ = 31% Mn and Mn Chelate = 6% Mn

Results and discussion

GreenSeeker NDVI and tissue testing

Multiple NDVI assessments prior to and including the 10th of September showed there was no response to Mn fertiliser (product or rate). In late September, the results continued to show no Mn treatment increased NDVI compared to the control (Table 2). However, in some cases there was a negative NDVI response to increasing Mn fertiliser rate (Figure 1).

Tissue testing was completed on select treatments at GS31 (August 22). There was no difference in Mn tissue concentration, with all samples ranging from 14.0 – 16.7 mg/kg (Table 2). Interestingly, all values indicated the barley crop was deficient (<15.0 mg/kg) to marginal (15-20 mg/ka) in Mn, despite fertiliser application. These results suggest low crop uptake of the applied Mn, possibly caused by the dry seasonal conditions (low soil availability for granular products and reduced foliar uptake from a stressed crop). A broader look at the tissue tests also suggests there is relationship between plant Mn and P uptake (Figure 2). The results show there was a reduction in plant P concentration with increasing Mn concentration.

Later in the season there were some visual differences in the canopy colour among the barley plots (Table 3). Visually treatments which included in-season foliar Mn applications had better plant colour compared to the nil and granular applied Mn at seeding. These plots also appeared to be greener and have slightly delayed maturity compared to the nil (Figure 1). However, the crop never fully presented 'classic' Mn deficiency symptoms and the crop visually appeared to be relatively healthy.

Table 2. Summary of GreenSeeker NDVI and shoot Mn (mg/kg) sampled at GS31 in the Mn strategy trial at Marion Bay, SA 2024.

Fertiliser treatment	Total applied kg Mn/ha	NDVI 10th Sep	NDVI 27th Sep	Shoot Mn* mg/kg	Shoot P %
Nil	-	0.641	0.646 a	14.0	0.27 a
10 kg/ha $MnSO_4$ IBS	3.1	0.592	0.574 abc	14.3	0.26 ab
10 kg/ha $MnSO_4$ IBS fb 3 kg/ha @ GS14, GS31, GS39	5.9	0.553	0.514 c	16.0	0.24 b
1 kg/ha @ GS14, GS31, GS39	0.9	0.586	0.568 abc	14.7	0.24 b
2 kg/ha @ GS14, GS31, GS39	1.9	0.583	0.525 c	16.0	0.24 b
3 kg/ha @ GS14, GS31, GS39	2.8	0.549	0.505 c	16.7	0.24 b
2 kg/ha @ GS14, GS31	1.2	0.564	0.542 bc	-	-
2 kg/ha @ GS14, GS39	1.2	0.587	0.555 bc	-	-
2 kg/ha @ GS31, GS39	1.2	0.612	0.547 bc	-	-
Mn Chelate 2 L/ha IBS	0.1	0.612	0.625 ab	14.7	0.27 a
	Pr(>F)	0.416	0.041	0.32	0.038
	LSD	ns	0.084	ns	0.03

* note, only seeding and GS14 applications applied at the time of tissue sampling at GS31.

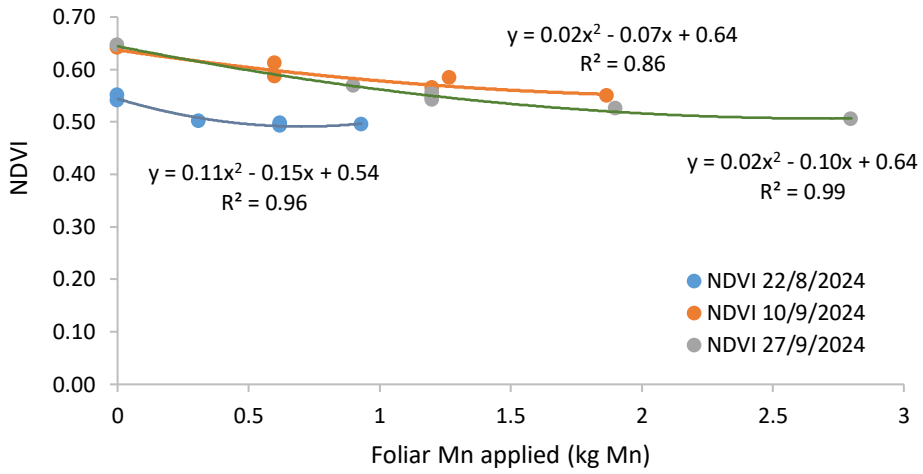

Figure 1. Relationship between GreenSeeker NDVI and foliar applied Mn (mg/kg) at various dates in the Mn strategy trial at Marion Bay, SA 2024.

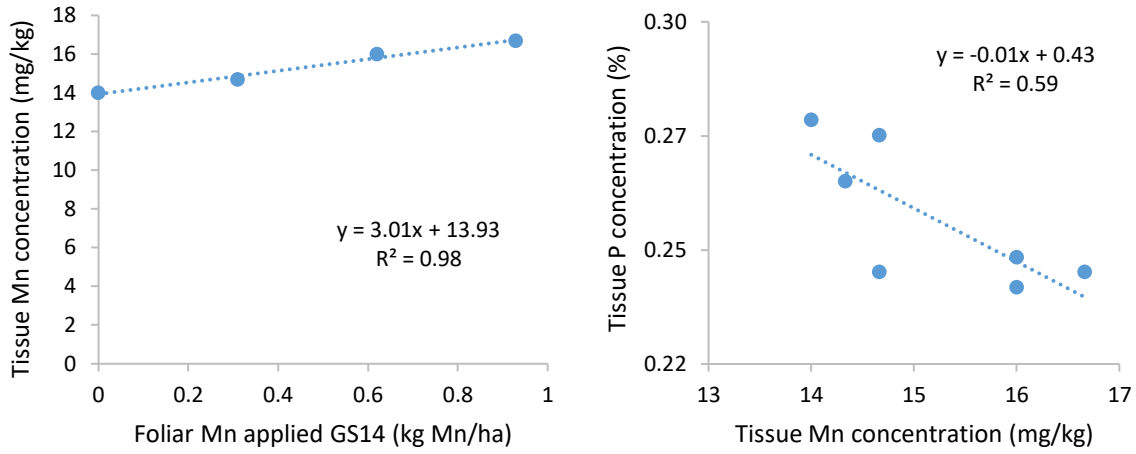

Figure 2. (left) Plant tissue Mn concentration in response to foliar Mn application rate and (right) relationship between plant tissue Mn and P concentrations at GS31 in the Mn strategy trial at Marion Bay, SA 2024.

Grain yield and quality

Manganese fertiliser strategy had no impact on grain yield or grain quality. Barley grain yields averaged 3.91 t/ha across the trial. Grain protein, test weight and retention averaged 12.1%, 70 kg/hL and 95%, respectively (Table 3). All treatments had screening levels <5% (data not shown). The receival standard for all treatments was either MALT 1 or BAR1 depending on grain protein (12.0% maximum level for malt 1).

Table 3. Summary of barley grain yield and grain quality for the Mn strategy trial at Marion Bay, SA 2024.

Fertiliser treatment	Canopy colour score (1-10)*	Yield (t/ha)	Protein %	Test weight (kg/hL)	Retention %
Nil	6.3 b	3.85	12.4	70.2	93.1
10 kg/ha $MnSO_4$ IBS	6.7 b	3.85	12.3	70.4	95.6
10 kg/ha $MnSO_4$ IBS fb 3 kg/ha @ GS14, GS31, GS39	8.7 a	3.96	12.2	69.1	95.6
1 kg/ha @ GS14, GS31, GS39	8.3 a	3.94	12.2	69.3	95.0
2 kg/ha @ GS14, GS31, GS39	8.7 a	3.85	12.1	69.2	94.8
3 kg/ha @ GS14, GS31, GS39	8.7 a	3.86	12.0	69.1	94.6
2 kg/ha @ GS14, GS31	8.3 a	3.92	12.0	69.4	95.7
2 kg/ha @ GS14, GS39	8.3 a	3.81	12.0	69.7	95.4
2 kg/ha @ GS31, GS39	8.3 a	4.05	11.9	69.6	96.7
Mn Chelate 2 L/ha IBS	6.3 b	4.01	11.7	70.8	94.8
Pr(>F)	0.003	0.802	0.208	0.279	0.153
LSD	1.4	ns	ns	ns	ns

*1 = light pale straw and beard, green in plot through to 10 = brown/purple straw and beard.



Figure 3. The nil (left plot) versus Mn treated (right) which display a different canopy colour (brown/purple straw and beard) and later maturing. Photo: Sam Trengove.

Trial 2. Application rate and placement position of potassium fertilisers

Key messages

- Barley was not responsive to any K fertiliser application rates (0 up to 120 kg K/ha).
- Fertiliser placement (deep banded, with seed or surface applied) had no impact on crop establishment, growth or grain yield this season.
- These results suggest the Colwell K soil test critical limit for barley is lower than 120 mg/kg for the soils at Marion Bay.

Why do the trial?

Most soils in the Southern region contain sufficient potassium (K) levels for crop production however, deficiencies (suspected or confirmed) are increasingly being reported. Deficiency may first appear as poor crop growth between windrows or header tracks from the previous year. Locally recent work by Trengove et al. (2024) has revealed the initial Colwell K for responsive sites were well above the current critical soil value of 45 mg K/kg in the top 0-10 cm. The authors showed for soil types on the Yorke Peninsula, Colwell K values between 98 – 175 mg K/kg were responsive to K fertiliser applications.

This trial aimed to help growers on the southern YP diagnose if K deficiency was limiting their productivity and profitability. It also aimed to identify the most cost-effective applications of K fertiliser, where they are needed the most, and to avoid wasteful applications where K deficiency is unlikely.

How was it done?

Stenhouse Bay rainfall:	Annual 328 mm Growing season 254 mm	**Variety:**	Maximus CL barley 80 kg/ha
Sowing date:	3rd June 2024	**Fertiliser placements:**	1. Deep banded 2. With seed 3. Surface applied IBS + PSPE

The trial was a randomised complete block design, consisting of 7 treatments with 3 replicates (Table 1). Plots were 10 m long with 25 cm row spacing. Plots were sown using knife points and press wheels. All plots received starting fertiliser of MAP Zn at 120 kg/ha and urea at 100 kg/ha incorporated by sowing. Muriate of potash (MoP) was used as the source of potassium (Table 1).

Measurements throughout the season included GreenSeeker NDVI (31st July, 22nd August, 10th September and 27th September) and tissue tests at Zadok's Growth stage 31. The trial was harvested on the 20th of November with grain quality traits measured.

Table 1. Treatments evaluated in the potassium strategy trial at Marion Bay, SA 2024.

Treatment	Timing	Potassium rate (kg K/ha)	Fertiliser position
1	Seeding	0	Deep Banded
2		15	
3		30	
4		60	
5		120	
6		60	With Seed
7	Spread IBS and PSPE	60 IBS + 60 PSPE	Surface

Results and discussion

GreenSeeker NDVI and tissue testing

Rate and placement of potassium fertiliser had had no effect on any NDVI assessment this season (data not shown).

Tissue testing at GS31 (first node) showed there was no increased in K levels for rates up to 120 kg K/ha compared to the nil (Table 2). All tissues tests averaged 5.0% K (Table 2). While not well-defined, adequate K levels in whole shoot samples at early growth stages (e.g. tillering up until GS31) are generally around 2 – 2.5% (Brennan 2017; Reuter and Robinson, 2008). These levels show the barley crop was not limited by K and had adequate soil reserves.

G*ain yield and quality*

Potassium strategy had no impact on grain yield or grain quality. Grain yields averaged 3.62 t/ha, with protein, test weight, retention and screenings averaging 12%, 70 kg/hL, 94% and 1.8% respectively (Table 3). The receival standard for majority of treatments was MALT 1 or BAR1 depending if grain protein was >12.0%.

Table 2. Summary of youngest emerged blade (YEB) K, grain yield and grain quality for the K response trial at Marion Bay, SA 2024.

Fertiliser strategy	YEB K %	Yield (t/ha)	Protein %	Test weight (kg/hL)	Retention %	Screenings %
0 kg K/ha	4.9	3.78	11.7	70.2	94.5	1.7
15 kg K/ha deep banded		3.76	11.8	68.8	94.3	1.9
30 kg K/ha deep banded	5.1	3.51	12.3	70.4	94.3	1.7
60 kg K/ha deep banded		3.58	11.7	69.8	94.1	1.7
120 kg K/ha deep banded	5.1	3.65	11.9	69.4	94.2	1.7
60 kg K/ha with seed		3.56	12.4	69.4	93.5	1.8
60 kg K/ha IBS + 60 kg K/ha PSPE		3.48	12.0	69.1	93.2	1.9
Pr(>F) LSD	ns	ns	ns	ns	ns	ns

Trial 3. Improving crop phosphorus uptake: evaluation of liquid and granular fertilisers and rates

Key messages

- Large yield increases were observed in response to P fertiliser, with barley grain yields across the trial increasing from 2.98 to 4.45 t/ha.
- The performance of liquid P alone shows there was a greater increase in grain yield than for comparable granular rates up to 7.5 kg P/ha (Figure 2).
- The P fertiliser recovery across the P rates and forms trialled ranged from 5 – 44%. The highest P recovery resulted from liquid P alone followed by liquid + granular P and granular alone.

Why do the trial?

Previous research in South Australia has demonstrated more efficient uptake of P and improved yields of wheat when fluid P fertiliser is used on calcareous soils. It appears that, on these highly calcareous soils, P added as granular fertiliser is rapidly precipitated as insoluble calcium phosphates, which are not available to plants (McLaughlin et al. 2008). The fluid P fertiliser is better distributed and may remain in solution longer, with less fixation of insoluble forms of P. In some experiments, there is evidence that fluid fertilisers have actually released some of the insoluble P from the soil, rather than contributed to the immobile pool.

This trial aimed to assess optimum granular and/or liquid P fertiliser rates on a highly calcareous sand on the southern Yorke Peninsula.

How was it done?

Stenhouse Bay rainfall:	Annual 328 mm Growing season 254 mm	**Fertiliser:**	Refer to treatment list.
Sowing date:	3rd June 2024	**Variety:**	Maximus CL barley 80 kg/ha

The trial was a randomised complete block design, consisting of 18 treatments with 3 replicates. Plots were 10 m long with 25 cm row spacing. Plots were sown using knife points and press wheels.

Phosphorus fertiliser treatments consisted of granular, liquid or a combination of both application methods (Table 1). All granular treatments were applied as MAP. The liquid treatments were made up of a blend of phosphoric acid, nitrogen fertiliser and proprietary additives resulting in a N:P:K:S ratio of 8:16:0:1. Nitrogen was matched in all plots at seeding (as urea) to the treatment with the highest N rate (Treatment 18 = 44 kg N/ha).

Measurements throughout the season included GreenSeeker NDVI (31st July, 22nd August, 10th September and 27th September) and tissue tests at Zadok's Growth stage 31. The trial was harvested on the 20th of November for grain yield. All plots were assessed for grain quality.

Table 1. Summary of the phosphorus fertiliser treatments used in the P fertiliser form and rate trial at Marion Bay, 2024.

Treatment	Granular P (kg P/ha)	Liquid P (kg P/ha)	Total P (kg P/ha)
1	0	0	0
2	7.5	0	7.5
3	15	0	15
4	22.5	0	22.5
5	30	0	30
6	50	0	50
7	90	0	90
8	0	3.75	3.75
9	7.5	3.75	11.25
10	15	3.75	18.75
11	0	7.5	7.5
12	7.5	7.5	15
13	15	7.5	22.5
14	22.5	7.5	30
15	0	15	15
16	7.5	15	22.5
17	15	15	30
18	75	15	90

Results and discussion

Greenseeker NDVI

The site was highly P responsive, with growth responses measured up to 90 kg P/ha applied (Figure 1). Barley NDVI for the various P treatments followed a similar trend throughout the season. In general, the liquid P treatments showed a greater growth response per kg P applied compared to the granular treatments (Figure 1), with the steepest response curve. This was also observed in the combined granular plus liquid treatments, where the response curve sits between the liquid only and granular only curves.

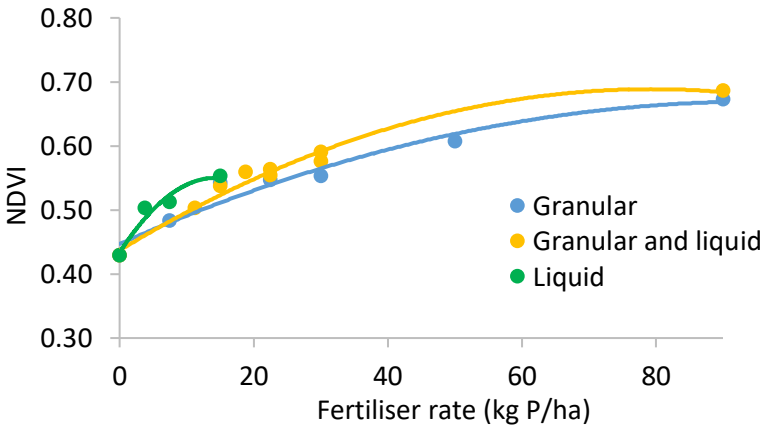

Figure 1. Greenseeker NDVI at GS31 (22 August) in response to P fertiliser rate and form at Marion Bay, 2024.

Tissue testing

Tissue testing at GS31 (youngest emerged blade) showed no increase in P concentration in response to P fertiliser rate or product (Table 2), despite large growth responses observed at the same time (Figure 1). The P concentration averaged 0.26% across all treatments, which is considered marginal-deficient. It indicates that increased P uptake has been diluted through higher dry matter production, resulting in the same P concentration across treatments.

Many other nutrients show a decline in concentration with increasing P rates and increased growth (Table 2). This is due to these nutrients being diluted through greater dry matter, and the crop not being able to increase nutrient uptake to compensate. Nutrients that declined with increasing P rate and crop growth included sulphur, manganese, copper, zinc, molybdenum and potassium. However, all nutrients were in adequate concentration according to industry benchmarks despite these declines, except for manganese. Manganese declined from 15.7 mg/kg in the untreated to 13.7 mg/kg in the 90 kg P/ha treatment (Table 2). Manganese is considered deficient when the concentration is less than 15 mg/kg and marginal when the concentration is 15-20 mg/kg.

Table 2. Summary of youngest emerged blade (YEB) GS31 tissue test results for phosphorus and manganese at Marion Bay, SA 2024.

Treatment	Granular P (kg P/ha)	Liquid P (kg P/ha)	Total P (kg P/ha)	Phosphorus (%)	Zinc (mg/kg)	Manganese (mg/kg)
1	0	0	0	0.27	74.7 a	15.7 a
2	7.5	0	7.5	0.26	65.0 ab	16.0 a
3	15	0	15	0.28	64.7 ab	14.7 abc
5	30	0	30	0.25	56.3 bcd	14.7 abc
7	90	0	90	0.28	49.7 cd	13.7 c
11	0	7.5	7.5	0.26	65.0 ab	15.3 ab
12	7.5	7.5	15	0.25	58.0 bcd	13.7 c
14	22.5	7.5	30	0.25	61.3 bc	14.7 abc
15	0	15	15	0.27	56.7 bcd	16.0 a
17	15	15	30	0.27	52.0 bcd	14.0 bc
18	75	15	90	0.27	47.3 d	14.0 bc
			Pr(>F)	ns	0.012	0.021
			LSD		13.1	1.53

Grain yield and quality

Large yield increases were observed in response to P fertiliser, with barley grain yields across the trial increasing from 2.98 to 4.45 t/ha (Table 3). The performance of liquid P alone shows there was a greater increase in grain yield than for comparable granular rates up to 7.5 kg P/ha (Figure 2). For example, for a total P application rate of 7.5 kg P/ha grain yield was lower for granular P at 3.30 t/ha compared to 3.72 t/ha for liquid P alone (Table 3). However, at the 15 kg P/ha rate the grain yields were similar for both liquid and granular P. While earlier in the season there was still an increase in biomass at this P rate, it did not translate to grain yield.

For the granular P treatments, grain yields increased up to rates of 50 kg P/ha. At this point no further grain yield increase was observed with higher P rates. Across all granular + liquid combinations there is a trend for slightly higher yield than straight granular treatments (Figure 2). This ranges from 1.4-2.1% higher yield for P rates of 5-30 kg P/ha, but the yield increase is smaller than the NDVI response observed earlier in the season (Figure 1). According to the trend lines (Figure 2), 20 kg P/ha applied as granular MAP fertiliser would have produced 3.70 t/ha, whereas the same rate applied as a combination of granule and liquid would have produced 3.77 t/ha. To achieve the same yield using only granular P would have required 23 kg P/ha to be applied.

Another way to evaluate fertiliser performance is to look at the phosphorus use efficiency (PUE). The most common way of calculating the recovery by crops of fertiliser P applied is using the difference method (P removal fertilised – P removal nil / P rate). The P fertiliser recovery across the P rates and methods trialled ranged from 5 – 44%. The highest P recovery resulted from liquid P rates 3.75 kg P/ha and 7.5 kg P/ha at 44% and 30%, respectively. In comparison all granular P treatments had PUE ranging from 5-14%. In general, the granular + liquid P recovery rates were similar to the granular alone, ranging from 5 – 18%. This is consistent with the outcomes from the grain yield results.

Grain quality across the site was high (data not shown) with the majority of samples meeting MALT 1 classification (depending on protein). Grain protein ranged from 10.7 – 12.9%. Test weight and retention average 69.6 kg/hL and 94.5%, respectively. Screening levels were <5% for all samples.

Table 3. Grain yield, P fertiliser recovery and partial gross margin (PGM) for the P form and application rate trial at Marion Bay, 2024. Assumptions, barley = $300/t, granular P = $4.2/kg P, liquid P = $7.2/kg P, no application costs considered.

Treatment	Granular P (kg P/ha)	Liquid P (kg P/ha)	Total P (kg P/ha)	Yield t/ha		P fertiliser recovery	PGM ($/ha)
1	0	0	0.0	2.98	g		894
2	7.5	0	7.5	3.30	fg	13	959
3	15	0	15	3.70	def	14	1046
4	22.5	0	22.5	3.73	cdef	10	1025
5	30	0	30	3.96	bcde	10	1062
6	50	0	50	4.25	abc	8	1064
7	90	0	90	4.44	ab	5	955
8	0	3.75	3.8	3.53	def	44	1033
9	7.5	3.75	11.3	3.65	def	18	1037
10	15	3.75	18.8	3.94	cde	15	1093
11	0	7.5	7.5	3.72	cdef	30	1062
12	7.5	7.5	15	3.48	efg	10	957
13	15	7.5	22.5	3.89	cde	12	1049
14	22.5	7.5	30	4.02	abcd	10	1058
15	0	15	15	3.67	def	14	994
16	7.5	15	22.5	3.83	cde	11	1009
17	15	15	30	3.88	cde	9	993
18	75	15	90	4.45	a	5	913
			Pr(>F)	<0.001			
			LSD	0.399			

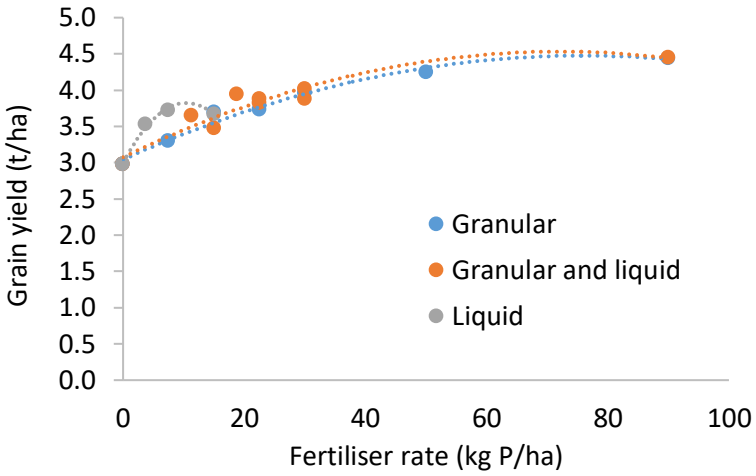

Figure 2. Grain yield response to P fertiliser rate and form at Marion Bay, 2024.

Partial gross margin

Across all P fertiliser treatments, the lowest and highest partial gross margin differed by $164/ha (Table 3). The highest PGM at the site was achieved by applying 15 kg P/ha as granular with 3.75 kg P/ha as liquid (treatment 10, Table 2). The addition of liquid in this treatment increased PGM by $47 compared to 15 kg P/ha as granular (treatment 3). Other high performing treatments were those including liquid P at 7.5 kg P/ha, or high rates of granular P at 30-50 kg P/ha. Based on the predicted PGM, the granular P rate that optimises PGM is 34 kg P/ha (155kg MAP/ha) (Figure 3).

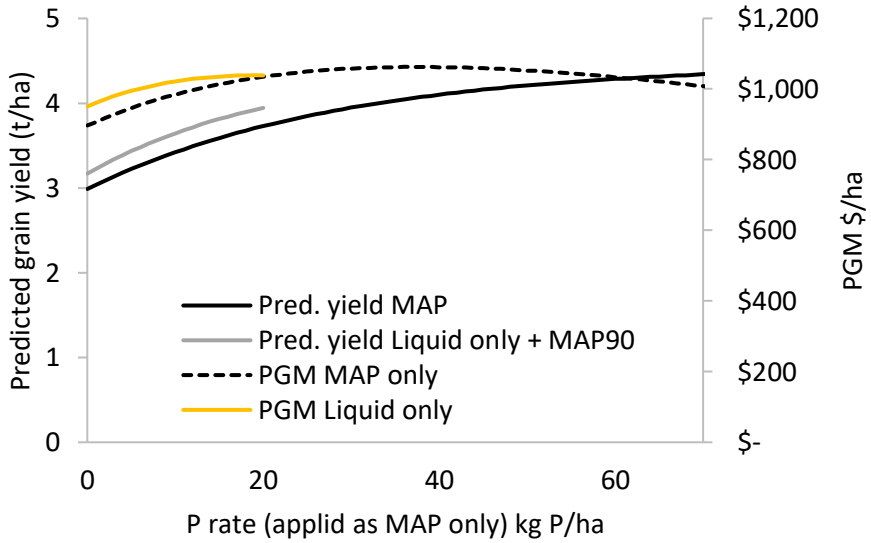

Figure 3. Predicted grain yield response and partial gross margin for P fertiliser rates and form at Marion Bay, 2024.

Trial 4. Evaluation of alternative nutrient products

Key messages

- Chicken litter was the only alternative nutrient source to outperform synthetic fertilisers yielding 4.69 t/ha. This was an increase of 0.61 t/ha (15%) when compared to the matched MAP treatments.
- The application of biochar and biosolids had lower grain yields compared to the matched MAP treatments. While these alternative products contain comparative levels of nutrients, the results suggest they may be less available, or their release may be slower and over a longer timeframe.

Why do the trial?

Organic amendments such as manures and biosolids are used in farming systems as alternatives to inorganic fertiliser to supply nutrients, to improve poor performing soils and to ameliorate subsoil constraints. Fertiliser inputs are the single largest variable cost for grain growers and the use of / interest in alternative nutrient sources is increasing. In the Mid-North and Yorke Peninsula biosolids and chicken litter (CL) are commonly applied to paddocks because of the proximity to Bolivar Sewage Treatment Works and a network of local chicken farms. There are also more products coming onto the market for example, biochar and nano technologies.

Crop yield and quality improvements from the application of organic amendments can be due to a range of factors such as amelioration of soil constraints and/or plant nutrient input. Where positive crop responses to organic amendments have been reported, they are often attributed to the presence of nutrients in more bioavailable forms, nutrient release patterns better matched to seasonal conditions, increase in organic matter and microbial activity, or providing nutrients not supplied by the current fertilizer strategy. However, the exact mechanisms behind the yield improvement from organic amendment applications are still unclear.

This trial aims to compare crop performance from different nutrient sources (e.g. synthetic fertilisers versus alternative products).

How was it done?

Stenhouse Bay rainfall:	Annual 328 mm Growing season 254 mm	**Variety:**	Maximus CL 80 kg/ha barley
Sowing date:	3rd June 2024		

The trial was a randomised complete block design, consisting of 9 treatments with 3 replicates. Plots were 10 m long with 25 cm row spacing. Plots were sown using knife points and press wheels. All granular fertiliser was deep banded below the seed.

The nutrient content of the chicken litter and biosolids used within these trials are summarised in Table 1. The biosolids, CL, biochar at 350 kg/ha and the gypsum dispersion product were spread prior to seeding. Biochar at 500 kg/ha was deep banded prior to seeding. Foliar trace elements were applied to treatment 3 on 22nd August containing 2 kg/ha $MnSO_4$, 300 g/ha $CuSO_4$, 2 kg/ha $ZnSO_4$, 100g/ha Boron, 8.4 kg/ha Iron EDDHA and 100g/ha sodium molybdate. The gypsum dispersion with Aqua-Sil was applied by hand at 2 t/ha with approximately 5% phosphoric acid. Excluding the chicken litter treatment (148 kg N/ha), nitrogen was matched across all treatments at 69 kg N/ha.

Table 1. Nutrient concentration of the chicken litter and biosolids and the total nutrient applied with each product at 4.12 t/ha chicken litter and 3.47 t/ha biosolids.

Product		**Nitrogen**	**Phosphorus**	**Potassium**	**Sulphur**	**Calcium**	**Magnesium**	**Iron**
Chicken Litter	**%**	3.43	0.85	2.79	0.59	1.29	0.69	0.20
	kg/ha	141.2	34.9	114.9	24.1	53.0	28.3	8.4
Biosolids	**%**	0.89	1.01	0.84	0.41	3.35	0.97	1.97
	kg/ha	30.9	34.9	29.0	14.3	116.2	33.7	68.3
Product		**Aluminium**	**Boron**	**Copper**	**Manganese**	**Molybdenum**	**Zinc**	
Chicken Litter	**%**	0.31	0.007	0.04	0.05	0.0008	0.03	
	kg/ha	12.6	0.3	1.5	1.9	0.032	1.2	
Biosolids	**%**	3.58	0.005	0.02	0.02	0.0005	0.02	
	kg/ha	124.0	0.2	0.6	0.7	0.017	0.8	

Measurements throughout the season included GreenSeeker NDVI (31st July, 22nd August, 10th September and 27th September) and tissue tests (youngest fully emerged leaf) at Zadok's GS31 (first node). Biomass cuts were completed at anthesis on 27th of September and tissue tests were also taken from these samples (whole tops). The trial was harvested for grain yield on the 20th of November. All plots were assessed for grain yield and quality.

Table 2. Summary of treatments implemented in the alternative products trial at Marion Bay, SA 2024.

Trt	MAP (kg/ha)	MoP (kg/ha)	$MnSO_4$ (kg/ha)	Urea (kg/ha)	Treatment description	Total P kg P/ha	Total N kg N/ha
1	-	-	-	150	Synthetic fertiliser – N only	0	69
2	227	50	11.6	100	Synthetic fertiliser – N, P, K, Mn	50	69
3	227	50	11.6	100	Synthetic fertiliser (N, P, K, Mn) + foliar trace (Cu, Zn, B, Fe, Mo)	50	69
4	-	-	-	150	Biochar + phos acid 10% @ 500 kg/ha deep banded + N	50	69
5	-	50	11.6	150	Biochar + phos acid 10% @ 500 kg/ha deep banded + N + Mn + K	50	69
6	-	50	11.6	150	Gypsum dispersion with Aqua-Sil @ 2 t/ha + phos acid 5%	100	69
7	68	50	11.6	135	Biochar + phos acid 10% @ 350 kg/ha pre-spread + N + starter P, K, Mn	50	69
8	68	-	-	0	Chicken Litter @ 4118 kg/ha pre-spread + starter P	50	148
9	68	-	-	68	Biosolids @ 3465 kg/ha pre-spread + starter P	50	69

Results and discussion

Crop vigour and GreenSeeker NDVI

Early crop vigour was improved by the application of CL, which was slightly better compared to biosolids (Table 3). There was minor difference in crop vigour among the remaining treatments.

Across all NDVI assessments, CL also returned the highest values and this could visually be seen (green, larger biomass) within the trial during the growing season (Table 3). Treatments 2 and 3 which included 227 kg/ha of MAP also had consistently high NDVI values compared to the nil (urea only) from late July to late September. The gypsum dispersion product also had similarly high NDVI by the end of September. Early in the season NDVI for the biochar and biosolid treatments was higher. However, these differences were no longer observed later in the season (equal to the nil).

Table 3. Crop vigour and NDVI assessments for the alternative nutrient source trial at Marion Bay, SA 2024.

Trt #	Description	Vigour 27 June	NDVI 31 July	NDVI 22 Aug	NDVI 10 Sept	NDVI 27 Sept
1	N Fert only (Nil)	2.7 d	0.194 d	0.363 d	0.557 c	0.613 bc
2	N + P + K + Mn Fert	3.0 cd	0.258 b	0.593 b	0.681 b	0.677 ab
3	N + P + K + Mn Fert + Foliar trace	3.0 cd	0.261 b	0.584 b	0.681 b	0.679 ab
4	N Fert + Biochar P	3.0 cd	0.225 c	0.477 c	0.603 c	0.610 bc
5	N Fert + Biochar P + K + Mn	3.3 c	0.224 c	0.505 c	0.620 bc	0.610 bc
6	N Fert + Gypsum disp + P	2.7 d	0.191 d	0.479 c	0.684 b	0.714 a
7	N Fert + Biochar P + Starter P	3.0 cd	0.225 c	0.479 c	0.628 bc	0.655 abc
8	Chicken litter (N+P) + Starter P	8.0 a	0.357 a	0.752 a	0.768 a	0.710 a
9	N Fert + Biosolid P + Starter P	5.0 b	0.236 bc	0.512 c	0.597 c	0.575 c
	Pr(>F)	<0.001	<0.001		<0.001	0.036
	LSD	0.527	0.026		0.074	0.088

Crop biomass and tissue testing

Tissue test results at GS31 show a large increase in P concentration for the CL treatment at 0.38%, compared to all other treatments averaging 0.27% (Table 4). This is despite a large increase in biomass, as indicated in the NDVI measurement on 22 August (Table 3). In comparison the P concentration did not change at GS31 in response to 50 kg P/ha applied as MAP, though it did increase NDVI. This result is consistent with the outcomes from the P rate and form trial discussed previously. The CL treatment, supplying the same rate of P, increased both tissue P concentration and NDVI.

There were also differences in other nutrient concentrations at the GS31 sampling time. For example, the molybdenum concentration increased in response to both CL and biosolids (Table 4). Several nutrients, including calcium, sodium and zinc, showed declines in concentration from the application of CL at this growth stage (Table 4). This is most likely a result of nutrient dilution due to increased crop growth. None of these nutrient concentrations are considered deficient.

Table 4. Nutrient concentration for youngest fully emerged leaf sampled at GS31 (22 August) for selected treatments.

Trt	Description	K %	P %	Na %	Zn mg/kg	Mo mg/kg	Mn mg/kg	Fe mg/kg
1	N Fert only (Nil)	4.9	0.27 b	0.21 a	77.3 a	0.33 c	17.3	75
2	N + P + K + Mn Fert	5.1	0.27 b	0.18 a	55.3 bc	0.48 c	15.3	74
5	N Fert + Biochar P + K + Mn	4.7	0.25 b	0.18 a	61.7 b	0.28 c	14.3	66
8	Chicken litter (N+P) + Starter P	5.0	0.38 a	0.09 b	47.0 c	1.93 a	14.3	70
9	N Fert + Biosolid P + Starter P	5.0	0.28 b	0.20 a	65.0 b	1.27 b	15.6	72
	Pr(>F)	ns	0.003	0.019	0.001	<0.001	ns	ns
	LSD		0.05	0.07	10.1	0.26		

Chicken litter resulted in the highest crop biomass at anthesis (Table 6). The CL treatment had an 80% increase when compared to the nil and 37% higher than the synthetic fertiliser treatment. The remaining two treatments tissue tested (N + P + K + Mn and biosolids) also increased crop biomass by 31 and 17%, respectively. These results are consistent with NDVI measurements (Table 3). No difference in P concentration was measured at anthesis for the CL treatment, which is not consistent with the increase measured at GS31. However, given the biomass increase, the total P uptake was increased to 11.9 kg/ha from CL and to 8.8 kg/ha for the N + P + K + Mn treatment compared to 6.9 kg/ha for untreated (Table 6). This increase in P uptake equates to 10% and 4% of the 50 kg P/ha applied in these treatments. Greater P uptake from the CL maybe be due to better timing of P availability from the CL with crop demand. There are a range of P forms within CL and many require soil microbes to convert them into plant available forms. Therefore, CL may not have high soil P availability upfront but, smaller and slower amounts may be released over the growing season. Biosolids did not increase P uptake at all. The P in biosolids is largely in unavailable forms and is not a good P fertiliser source, at least in the short term.

It was hypothesised that the large growth increases observed in the CL treatments may be due to more N applied (148 kg N/ha) in this treatment, where all other treatments were balanced to 69 kg N/ha (Table 2). However, N uptake at anthesis was the same for both the N + P + K + Mn treatment and the CL (Table 6), indicating they had similar N availability. Similarly, at harvest these treatments were removing similar quantities of N in the grain as protein (Table 7).

At anthesis, similar to the GS31 sampling time, several nutrients showed concentration declines in better performing treatments. This included nitrogen, calcium, sulphur and zinc (Table 5), but total nutrient uptake for these still increased, relative to the untreated control (Table 6). Molybdenum concentration and uptake was increased in response to CL and biosolids, in line with the molybdenum contained within these products (Table 1).

Aluminium and iron (Fe) concentration increased in response to CL at anthesis (this was not observed at GS31). A nearby trial in lentil showed a 30% yield increase in response to an application of EDDHA Fe, therefore increasing Fe availability in the CL treatment may also be important in the

barley response. However, treatment 3 included an application of EDDHA Fe and no improvement in NDVI or grain yield was observed following application. Interestingly, biosolids apply much greater quantities of Al and Fe (Table 1) compared to CL however, it does not appear to be taken up by the plant. Sewage waste streams typically contain ions of Fe^{++} and Al^{+++}. Treatment to remove these ions from the liquid stream into the solids can include the addition of ferric chloride and aluminium sulphate to the sludge, causing the metals to flocculate and settle out. This likely explains their high concentration in the resulting product but, also lower plant availability. Reactions between P and Fe and Al may produce insoluble precipitates and explain why the P in biosolids also has low availability.

Table 5. Nutrient concentration of whole barley tops for selected treatments at anthesis 27 September, 2024.

Trt	Description	N %	P %	K %	S %	Cu mg/kg	Zn mg/kg	Al mg/kg	Fe mg/kg	Mo mg/kg	Mg %	Mn mg/kg	Ca %
1	N Fert only (Nil)	2.1 a	0.20	2.7	0.18 a	4.6 a	30.7 a	20.0 b	45.0	0.17 c	0.14	7.5	0.46 a
2	N + P + K + Mn Fert	1.9 a	0.18	2.5	0.14 b	3.8 b	23.7 b	17.3 b	40.0	0.22 c	0.14	7.2	0.44 ab
8	Chicken litter (N+P) + Starter P	1.6 b	0.19	2.7	0.14 b	4.0 ab	25.3 b	36.7 a	52.0	0.60 a	0.14	8.0	0.38 b
9	N Fert + Biosolid P + Starter P	1.7 b	0.17	2.3	0.14 b	3.8 b	24.7 b	19.7 b	40.0	0.43 b	0.13	6.8	0.39 b
Pr(>F)		0.01	ns	ns	0.04	0.05	0.04	0.00	ns	0.00	ns	ns	0.046
LSD		0.25			0.03	0.61	4.76	8.15		0.15			0.06

Table 6. Dry matter production at anthesis and nutrient uptake (dry matter x nutrient concentration) for selected treatments sampled 27 September, 2024.

Trt	Description	Dry matter t/ha	N uptake kg/ha	P uptake kg/ha	K uptake kg/ha	S uptake kg/ha	Cu uptake g/ha	Zn uptake g/ha	Al uptake g/ha	Fe uptake g/ha	Mo uptake g/ha	Mg uptake kg/ha	Mn uptake g/ha	Ca uptake kg/ha
1	N Fert only (Nil)	3.5 b	74 b	6.9 b	92 c	6.1	15.9 b	106 b	69 b	156 b	0.6 c	5.0 c	26.0 b	15.9 b
2	N + P + K + Mn Fert	4.6 b	96 a	8.8 b	126 b	7.2	18.7 b	118 b	86 b	200 b	1.1 bc	6.8 b	36.3 b	21.7 a
8	Chicken litter (N+P) + Starter P	6.3 a	101 a	11.9 a	166 a	8.8	25.2 a	159 a	232 a	327 a	3.8 a	8.6 a	50.3 a	24.1 a
9	N Fert + Biosolid P + Starter P	4.1 b	67 b	6.9 b	91 c	5.7	15.3 b	100 b	81 b	162 b	1.7 b	5.2 c	27.6 b	15.9 b
Pr(>F)		0.009	0.008	0.004	0.004	ns	0.011	0.018	0.003	0.003	<0.001	0.002	0.005	0.003
LSD		1.32	17.5	2.2	32.2		5.1	32.9	67.3	71.0	1.0	1.4	10.7	3.6

Grain yield and quality

The application of CL was the highest yielding treatment at 4.7 t/ha (Table 7). The next best yielding treatments were those with synthetic fertilisers (treatments 2 and 3). All remaining alternative nutrient products (3.46 t/ha average) evaluated were lower yielding compared to the district practice (treatment 2).

The lowest grain protein was in the CL treatment (Table 7). This reduction in protein is a yield dilution effect (higher yield = lower protein) for the CL, despite higher total N application. Given higher N application but similar N removal to other high yielding treatments it indicates lower recovery or nitrogen use efficiency of the N in CL. The biosolid treatment also had lower protein but lower grain yield, producing low N removal. Biosolids supplied 31 kg N/ha, with the remaining 38 kg/ha supplied from urea and MAP, the same as treatments 1-7. Similar to CL, it appears the N supply from biosolids is less available and less efficient, at least in the short term.

Test weight, retention, and screenings average 69 kg/hL, 94% and 2%, respectively. For these quality parameters all samples met MALT 1 classification.

Table 7. Grain yield and quality for the alternative products trial at Marion Bay, SA 2024.

Trt	Description	Grain yield t/ha	Protein %	Test weight kg/hL	N removal kg/ha
1	N Fert only (Nil)	2.73 d	12.6 ab	66.9 c	55 c
2	N + P + K + Mn Fert (District Prac)	4.08 b	12.0 c	69.7 ab	79 a
3	N + P + K + Mn Fert + Foliar trace	4.11 b	12.4 abc	69.8 ab	82 a
4	N Fert + Biochar P	3.45 c	12.1 bc	69.9 ab	68 b
5	N Fert + Biochar P + K + Mn	3.46 c	11.8 c	68.7 abc	66 b
6	N Fert + Gypsum disp + P	3.31 c	13.0 a	68.7 abc	69 b
7	N Fert + Biochar P + Starter P	3.59 c	12.0 bc	68.6 bc	70 b
8	Chicken litter (N+P) + Starter P	4.69 a	10.7 d	70.7 a	81 a
9	N Fert + Biosolid P + Starter P	3.50 c	11.1 d	69.6 ab	62 bc
	Pr(>F)	<0.001	<0.001	0.045	<0.001
	LSD	0.38	0.60	2.00	8.8

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CONCLUSION

Key findings

The trials at Marion Bay have a range of nutrient management outcomes for highly calcareous sandy soils. For example, in the Mn trial we expected to see a greater response to Mn fertiliser applications. The pre-seeding soil testing showed the site had marginal Mn levels (<5 mg/kg) however, Mn fertiliser applications did not improve crop growth, Mn uptake or grain yield this season. Interestingly, the tissue testing uncovered a relationship between plant Mn and P uptake which requires further investigation. The key finding from this trial was the potential for growers to reduce Mn fertiliser inputs.

The potassium trial showed barley was not responsive to any K fertiliser application rates (0 up to 120 kg K/ha). Fertiliser placement (deep banded, with seed or surface applied) also had no impact on crop establishment, growth or grain yield this season. Overall, the results suggest the Colwell K soil test critical limit for barley is lower than 120 mg/kg for the soils at Marion Bay.

For the granular and liquid P evaluation trials there were large yield increases observed in response to P fertiliser. Grain yields across the trial increased from 2.98 to 4.45 t/ha. The performance of liquid P alone shows there was a greater increase in grain yield than for comparable granular rates up to 7.5 kg P/ha. The P fertiliser recovery across the P rates and forms trialled ranged from 5 – 44%. The highest P recovery resulted from liquid P alone followed by liquid + granular P and granular alone. The main outcome from this trial was the potential for growers to adopt liquid P applications for improved crop production, or to consider higher P rates using traditional granular P products. The P rate to optimise partial gross margin using granular MAP was approximately 50% higher than rates commonly used.

In the alternative nutrient products trial, the chicken litter outperformed synthetic fertilisers yielding 4.69 t/ha. This was an increase of 0.61 t/ha (15%) when compared to the matched MAP treatments. The application of biochar and biosolids had lower grain yields compared to the matched MAP treatments. While these alternative products contain comparative levels of nutrients, the results suggest they may be less available, or their release may be slower and over a longer timeframe.

Benefits to industry

This is the first season of investigation and more sites and seasons will be required to confirm the nutrient responses observed in 2024. Overall, the trials have demonstrated three key nutrient management outcomes:

1) Potential to reduce nutrient inputs where we have not observed responses to fertiliser applications
2) Potential to increase nutrient inputs where a yield response and economic benefit has been determined
3) Potential for industry to adopt other fertiliser forms (e.g. liquid P) or alternative products (e.g. chicken litter)

Future adoption opportunities

Northern Sustainable Soils and Trengove Consulting will continue to extend previous and future research outcomes with a range of grower, consultant and industry networks across the Southern Yorke Peninsula region. They will also continue to link with other growers in areas of SA who manage highly calcareous sands (e.g. Eyre Peninsula and Upper South East). Specifically, this will include; sharing written trial reports, presenting key results at crop walk and other relevant industry events.

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