Preston Phosphorus Rate Response trial

Hosts: Preston Family

Dan Fay, Project Officer, SCF

Trial Aim and Background

Phosphorus (P) is an essential nutrient for plant development in all broadacre crops. It is a constituent of plant cells and is essential for cell division and plant growth. Phosphorus is vital for early plant growth, so P enriched starter fertilisers are needed to meet this demand. The weathered soils of WA are among the most P depleted in the world. When combined with the low P use efficiency of fertilisers (5-30% is plant available), P deficiency can be a significant yield constraint for growers in the Albany Port Zone. However, phosphorus can remain soluble within the soil over seasons, and as a result, P can be banked in the soil and accessed by the plant over the following years. This trial is a longitudinal study conducted by the Preston family and Stirlings to Coast Farmers to determine how long it takes to deplete the pooled P supplies and what rate of P fertilisers are needed to meet these P demands.

Treatments

The trial was designed to use varying rates (Table 1) of starter fertiliser (82:18 MAPSZC: MOP) applied across farm-scale plots, with the rest of the paddock receiving a control rate of 100kg/ha. Flinders barley was sown in 2021 at 100kg/ha.

The starter fertiliser was applied on the 11th of May when the paddock was sown. The trial plots were then subject to the farmer's "normal" agronomic package, and no further in-season P was used.

Table 1: Starter fertiliser rates applied in the Preston phosphorus trial in 2021 and their input breakdown (kg provided/hectare).

		N	P	S	Cu	K
MAPSZC®/MOP 82:18	*40kg/ha*	*3.8*	*6.6*	*1.9*	*0.098*	*3.6*
MAPSZC®/MOP 82:18	*60kg/ha*	*5.7*	*9.8*	*2.8*	*0.148*	*5.4*
MAPSZC®/MOP 82:18	*80 kg/ha*	*7.6*	*13.1*	*3.7*	*0.197*	*7.2*
MAPSZC®/MOP 82:18	*100 kg/ha*	*9.5*	*16.4*	*4.6*	*0.250*	*9.0*
MAPSZC®/MOP 82:18	*120 kg/ha*	*11.4*	*19.7*	*5.6*	*0.300*	*10.8*
MAPSZC®/MOP 82:18	*140 kg/ha*	*13.3*	*23.0*	*6.5*	*0.340*	*12.6*

Results and Discussion

The harvest yields were collected directly from the harvester using a calibrated yield monitor data. These were then spatially analysed to form an accurate set of data. The paddock was subject to prolonged periods of waterlogging, which likely influenced the P accumulation. Waterlogging does not influence P sorption (Phillips, 2008). Still, the reduced root mass resulting from prolonged periods of waterlogging would reduce the plants' ability to accumulate P. For this study, we have assumed that the plant phosphorus removal for the barley was at the standard rate of 2.7kg/t/ha.

The relatively high barley yields across all plots resulted in a P deficit in 2021 for the 80kg, 60kg, and 40kg/ha plots, whilst the plots with a fertiliser rate of 100kg/ha or higher resulted in a P credit.

In 2021 there was a statistically significant relationship between fertiliser rate and harvest yields. There was also a strong trend to suggest that the P rate directly influenced yields, with yields going up in response to the P rate, except for the 140kg/ha plots. The result for the 140kg/ha treatment was influenced by a replicate that suffered from significant waterlogging stress and yielded much lower than the other three replications. With the outlier removed, the 140kg/ha treatment averaged 5.66t/ha compared to the 4.87t/ha with the waterlogged replicate included. The adjusted 140kg/ha result indicates that P responses follow a non-linear pattern with a flattened response curve at 100k/ha of applied fertiliser.

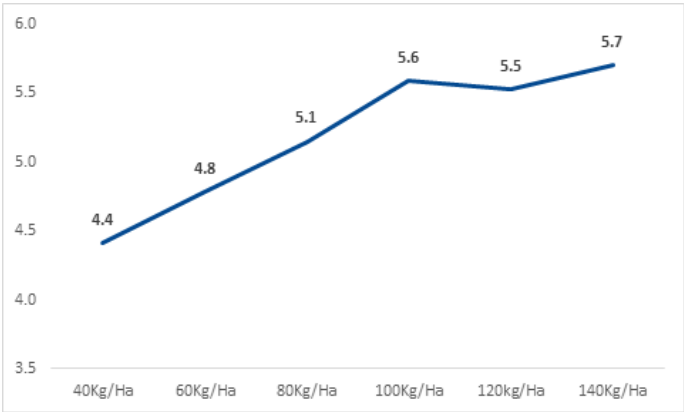

*Figure 1: Preston Phosphorus (P) rate response trial results in 2021. The crop sown was Flinders barley and the X-axis depicts the fertiliser rate (MAPSZC®/MOP 82:18) applied in kg/ha. The Y-axis displays the adjusted barley yields in t/ha. *Adjusted because a waterlogged replicate was removed from the 140kg/ha treatment.*

Table 2: Summary of the fertiliser applied on the Preston Phosphorus (P) rate trial in 2021. The paddock was sown to Flinders barley in 2021. The fertiliser was a blend of MAPSZC®/MOP 82:18.

Fertiliser Rate	P units in Fert	Yield (t/ha)	P removal	P Balance
40Kg/Ha	*6.6*	*4.4*	*11.9*	*-5.3*
60Kg/Ha	*9.8*	*4.8*	*12.9*	*-3.1*
80Kg/Ha	*13.1*	*5.1*	*13.9*	*-0.8*
100Kg/Ha	*16.4*	*5.6*	*15.1*	*1.3*
120kg/Ha	*19.7*	*5.5*	*14.9*	*4.8*
140Kg/Ha	*23.0*	*5.7*	*13.2*	*9.8*

Table 3: The cumulative Phosphorus (P) applied from fertiliser and the P removed in grain over the last five seasons in the Preston Phosphorus rate trial in West Cranbrook WA. The yield in (t/ha) displays the combined yields from the same period.

Fertiliser Rate	P units in Fertiliser	Yield (t/ha)	P removal	P Balance
40Kg/Ha	*31*	*18.7*	*63.6*	*-34.7*
60Kg/Ha	*46*	*19.0*	*63.8*	*-18.6*
80Kg/Ha	*61*	*20.1*	*69.4*	*-11.6*
100Kg/Ha	*76*	*20.9*	*72.1*	*0.6*
120kg/Ha	*92*	*21.0*	*73.0*	*13.9*
140Kg/Ha	*107*	*20.6*	*72.1*	*30.7*

The cumulative P from the five years of the project shows a surplus for the three heavier fertiliser rates and the 100kg/ha rate, netting a small credit but essentially breaking even. The lower rates continue to enter a P deficit.

The 2021 yields would suggest the P deficit in the 40, 60, & 80kg/ha applications are influencing grain yields, with the 40kg/ha and the 60kg/ha plots yielding significantly less than the 120 and 100kg/ha treatments.

Given there is a positive P balance resulting from the three heavier rates 100, 120, 140kg/ha in the 2021 season, the slight differences observed in the yields of these plots is unlikely to be a result of P availability. For example, there would have been enough available P in the 120kg/ha plot for it to yield the same as the 140kg/ha plot, however this did not occur, hence there is something other than P availability limiting yield in the plots with a positive P balance.

Conclusions

The results of the 2021 Preston P trial showed a continuation of the trend observed in prior seasons. We are now observing yields being limited by the absence of P on the lower treatment rates applied over the last five seasons. The P yield limitations are expected to escalate over time as the P balance moves into a further deficit. Whist the positive P balance won't increase yields, it will result in ample P being available to support higher-yielding crops. P availability will always be an issue in the typically acidic soils of Southwest WA, it's availability in the soil solution is reduced in acid soils, and the need for P based fertilisers is critical. While P does not easily leach, it's often bound in organic forms and is not readily available for plant uptake. Plants also compete with microflora for the available P, further reducing fertiliser efficiency.

This trial highlights the effect seasonal yield variability has on P requirements and the need for adequate fertiliser input or a bank of P within soils to support crop growth and increase yield potential. When coming from a low base, the P input must meet the yield demand and be adjusted with the paddock's cumulative yield demand in mind.

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