A closer look at a potassium response

CSBP trial, Strawberry, 2017 - 2020

August 2021

Background

In 2017, CSBP started a potassium (K) trial at Strawberry, near Mingenew, Western Australia. The trial is investigating different K strategies in a wheat/lupin rotation. Table 1 below outlines annual K rates for the trial's ten treatments.

Table 1. Annual K rates.

Treatment	kg K/ha/year				kg K/ha
	2017 (wheat)	2018 (lupins)	2019 (wheat)	2020 (lupins)	TOTAL
1	0	0	0	0	0
2	13	13	13	13	52
3	26	26	26	26	104
4	38	38	38	38	152
5	13	63	13	63	152
6	63	13	63	13	152
7	63	13	63	63	202
8	105	13	13	13	144
9	150	0	0	0	150
10	105 (incl. Mg)	13	13	13	144

Using Laconik's industry best practice processes for statistical and economic analyses this article examines the K responses of the reported results, annually and cumulatively. We have assumed sound scientific processes were used for the trial design and its implementation.

Yield responses

The yearly yield responses to K (Figures 1 – 4) suggest the rate of K applied up to and including each year (cumulative K amount) has a bigger impact on yield response than the K "freshly" applied each year. The obvious exception is **2017**, the first year of the trial, when the well-defined response in wheat could only be attributed to that years' applied K (Figure 1). The optimum K rate in 2017 was close to 40 kg K/ha.

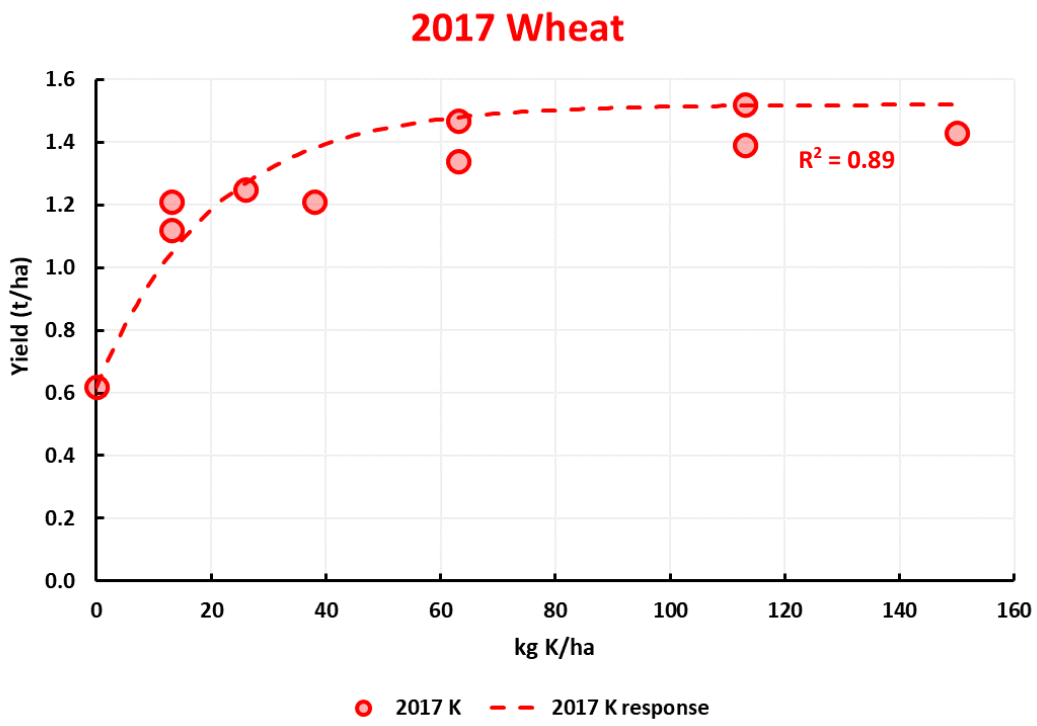

Figure 1. 2017 K response in wheat.

In **2018**, lupins did not respond to rate of freshly applied K (R^2 = 0.18) (Figure 2) because the 2018 K rate treatments were complicated by the different rates of K they received in 2017 (shown in Table 1). There was, however, a large and very clear (R^2 = 0.96) response to the combination of residual K applied to the treatments in 2017 and 2018's fresh K (i.e. the cumulative amount of K applied up to and including 2018).

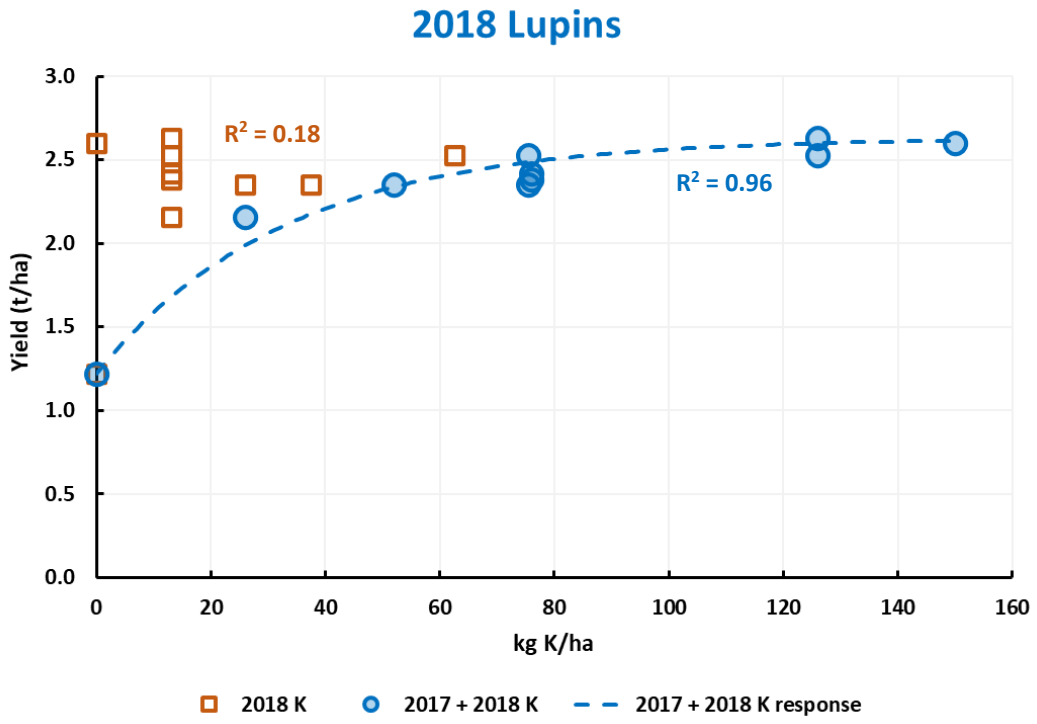

Figure 2. 2018 vs 2017 + 2018 K response in lupins.

Again, in the tough **2019** season there was a clear though small and fiscally dubious response in wheat to the cumulative amount of K applied in 2017, 2018 and 2019 (Figure 3). As in 2018, there was no response to the freshly applied K.

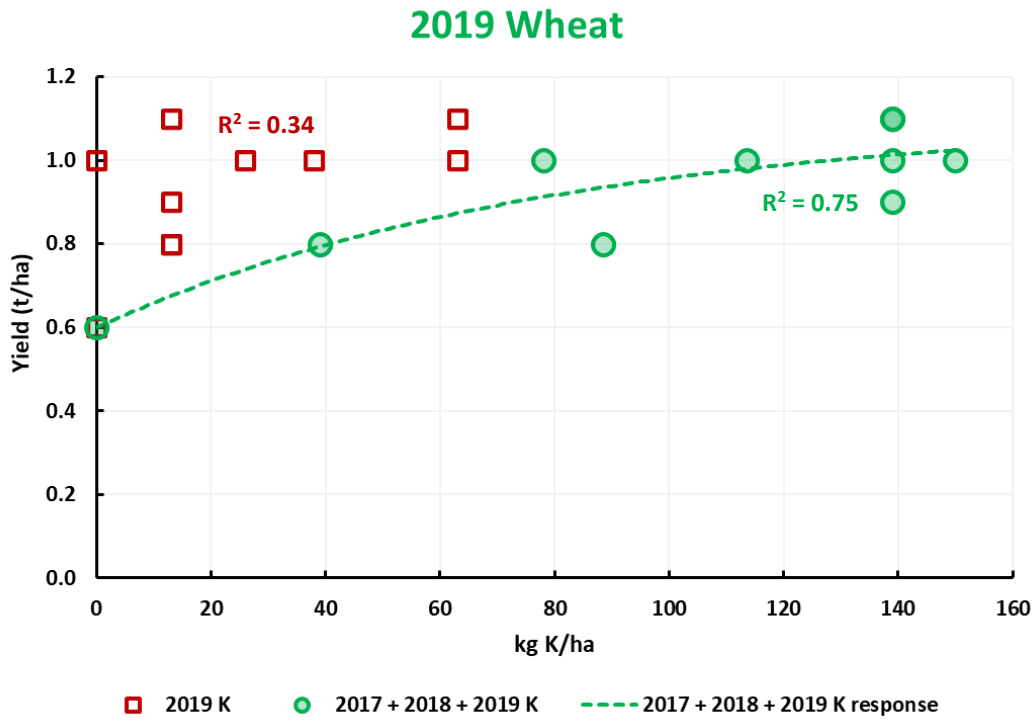

Figure 3. 2019 vs 2017 + 2018 + 2019 K response in wheat.

In **2020**, there was again no response to fresh K in lupins but a large and well-defined response to the 2017 – 2020 cumulative rate of K (Figure 4).

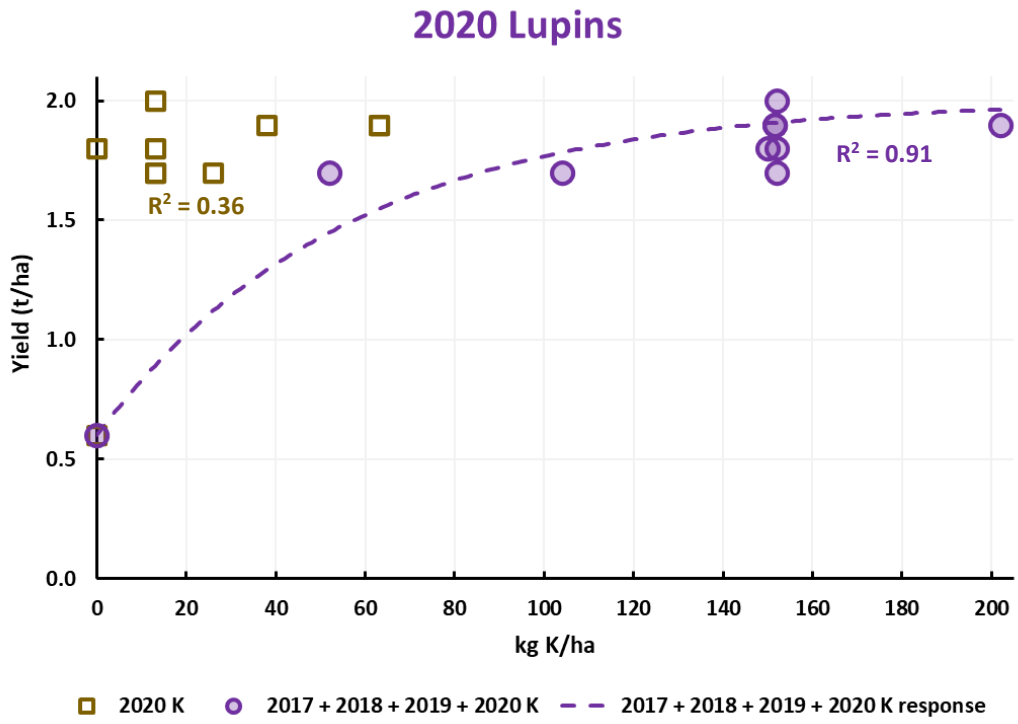

Figure 4. 2020 vs 2017-2020 K response in lupins.

Changes to marginal returns

Using the responses to the cumulative amount of K applied in Figures 1 – 4 we calculated the changes in margin in net present value (NPV) terms. These are shown for each year in Figure 5 assuming a K cost of $1.75/kg (equivalent to $860/t muriate of potash), prices of $300/t and $330/t for wheat and lupins respectively, and an inflation rate of 3%. The large yield responses to high rates of cumulative K in lupins in 2018 and 2020 were major drivers of returns.

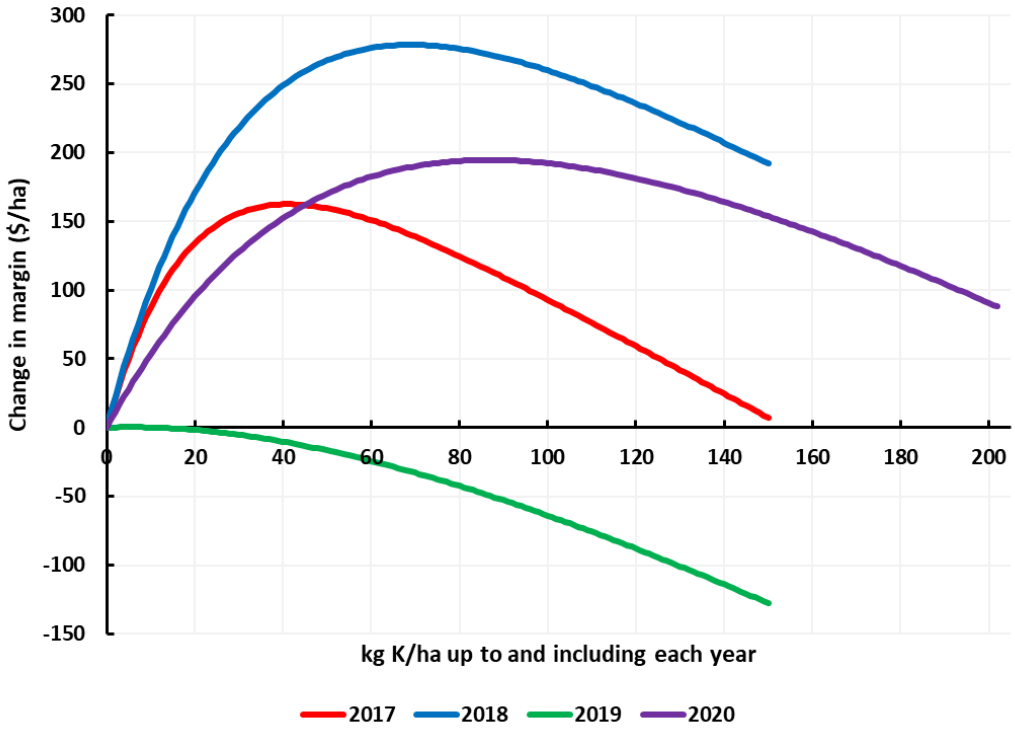

Figure 5. Changes in margin ($/ha) for the cumulative K rates up to and including each year.

Using the curves in Figure 5 we calculated the summed NPV margin for the total amount of K applied over four years for each treatment. These are shown in Figure 6 and clearly demonstrate that margin was related to K rate and plateaued at about 150 kg/ha of total K, equivalent to about 38 kg K/ha/year.

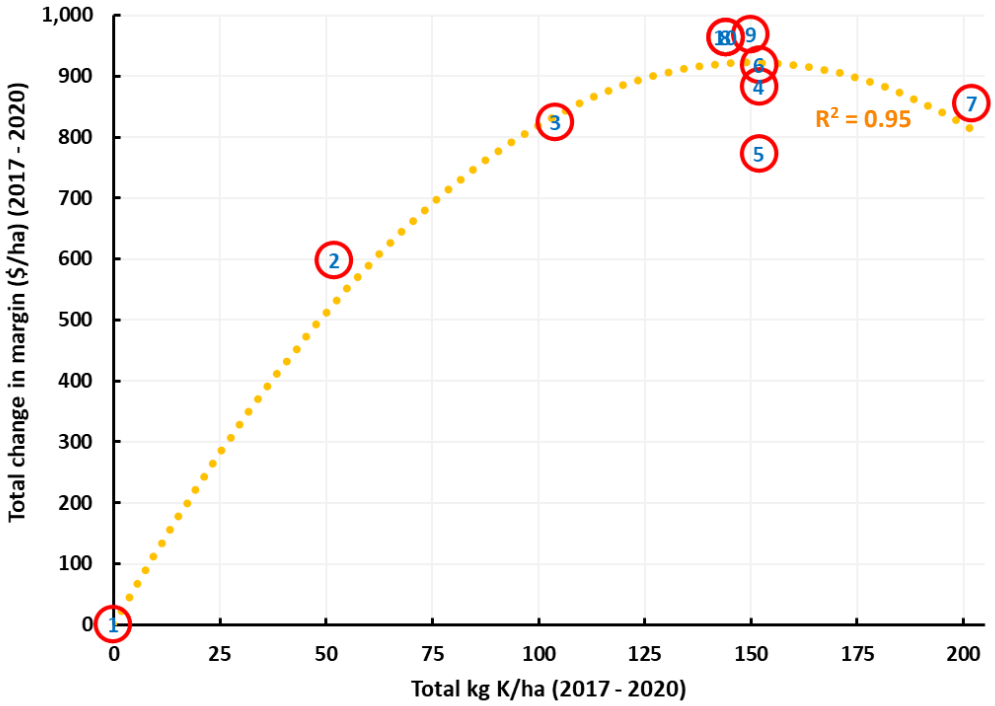

Figure 6. Total change in margin ($/ha) over four years for each treatment. The treatment numbers displayed in each data point correspond to those in Table 1.

Return on investment

Return on the K invested (ROI) in each treatment was calculated and related to the total amount of K applied (Figure 7) where 0% is money back, 100% is $2 back for $1 invested and 800% is $9 back for $1 invested. Like all ROI in fertiliser rates, there were clear diminishing marginal returns, with ROI falling about 3% per kg/ha of total K applied.

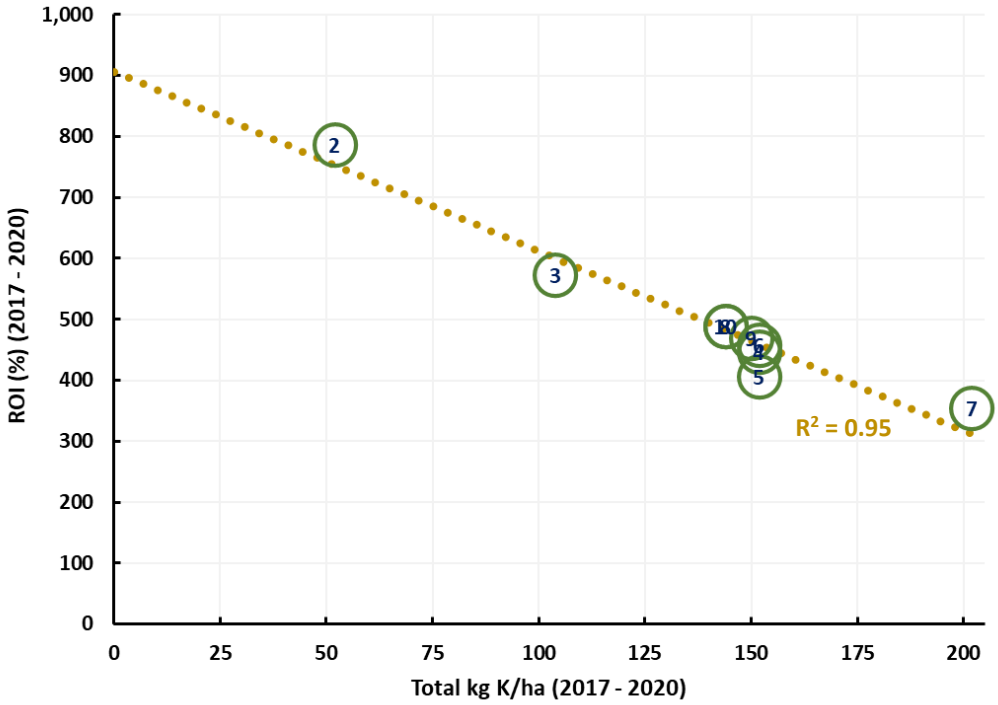

Figure 7. ROI (%) for the total K applied in each treatment. The treatment numbers displayed in each data point correspond to those in Table 1. Treatments 4, 5, 6, 8, 9 and 10 (all about 38 kg K/ha/year) had a similar ROI.

Although there were diminishing marginal returns with increasing fertiliser rate, ROI was exceptional across all treatments, buoyed by good responses in the lupin years. Over the four years, a total K rate of about 150 kg/ha (about 38 kg K/ha/year) achieved a ROI of around 450% regardless of the K timing strategy (Figure 7). For example, while the one-off application of 150 kg K/ha in 2017 followed by no K for the next three years (Treatment 9) was too much in that first year, over the four years it was as cost-effective as equal applications of 38 kg K/ha each year (Figure 7).

The trial results suggest that margin is maximised by applying about 40 kg K/ha/year (equivalent to 80 kg muriate of potash/ha/year). Even if 60 kg K/ha/year (equivalent to 120 kg muriate of potash/ha/year) is applied, ROI on K is still 200% ($3 back per $1 invested). These types of rates might be considered bullish by many.

As many questions as answers?

Very profitable responses to high fertiliser rates in trials like this one raise many intriguing questions, including:

- Are advisers and farmers confident enough to recommend and apply bullish fertiliser rates based on results of trials conducted by others? If they are not, is it safe to assume their conservative approach is costing farmers money?
- Unless they test their fertiliser rate decisions for themselves, how will advisers and farmers know if they're right or wrong? Do they subjectively gauge responses while remaining objectively unaware of the consequences of their decisions?
- How transferrable is a result from a plot trial on a quarter of a hectare of a paddock to the rest of the paddock, to another of the farmer's paddocks, to other lupin crops, to other farmers' paddocks in the region and to other regions?
- How transferrable are small plot research trials to practical farming, given they are conducted under different conditions with different management and equipment to what each farmer uses?
- Where do rules of thumb for fertilisers, that become ongoing habits, have their origins? How often are rules of thumb tested in farmer paddocks?

Results in your paddock

The best way to prove and improve fertiliser profitability is by measuring fertiliser response in the farmer's own paddock. Laconik enables farmers and their advisers to seamlessly embed multiple "swarm" trials into paddocks and the farmer's normal operations to see if current fertiliser rates are on the mark or need adjusting (Figure 8).

Figure 8. One traditional plot trial vs Laconik swarm trials embedded during fertiliser application.

Multiple trials embedded in the paddock:

- Give more detailed data on ROI and optimum fertiliser rates across whole paddocks, and
- Are more valuable to the farmer and adviser because the farmer conducted the trials with their own equipment within their own farming system and management style.

Good scientific methods and analysis of results from Laconik trials provide information that is independent, accurate, reliable and useable. Fertiliser efficiency metrics (agronomic, financial and environmental) from trials allow farmers to confidently maintain or change their fertiliser strategy because decisions are based on sound, tailored data. Maps of measured optimum fertiliser rates across paddocks are the ideal starting point for variable rate fertiliser prescriptions for farmers to use with their precision agriculture technology to increase returns on fertiliser investments.

Acknowledgements

Thanks to CSBP for their open access to the trial data used to run the analyses. Trial details available from https://www.csbpresults.com.au/trials/long-term-potassium-strategies-investigating-residual-potassium-benefits-after-a-long-term-trial