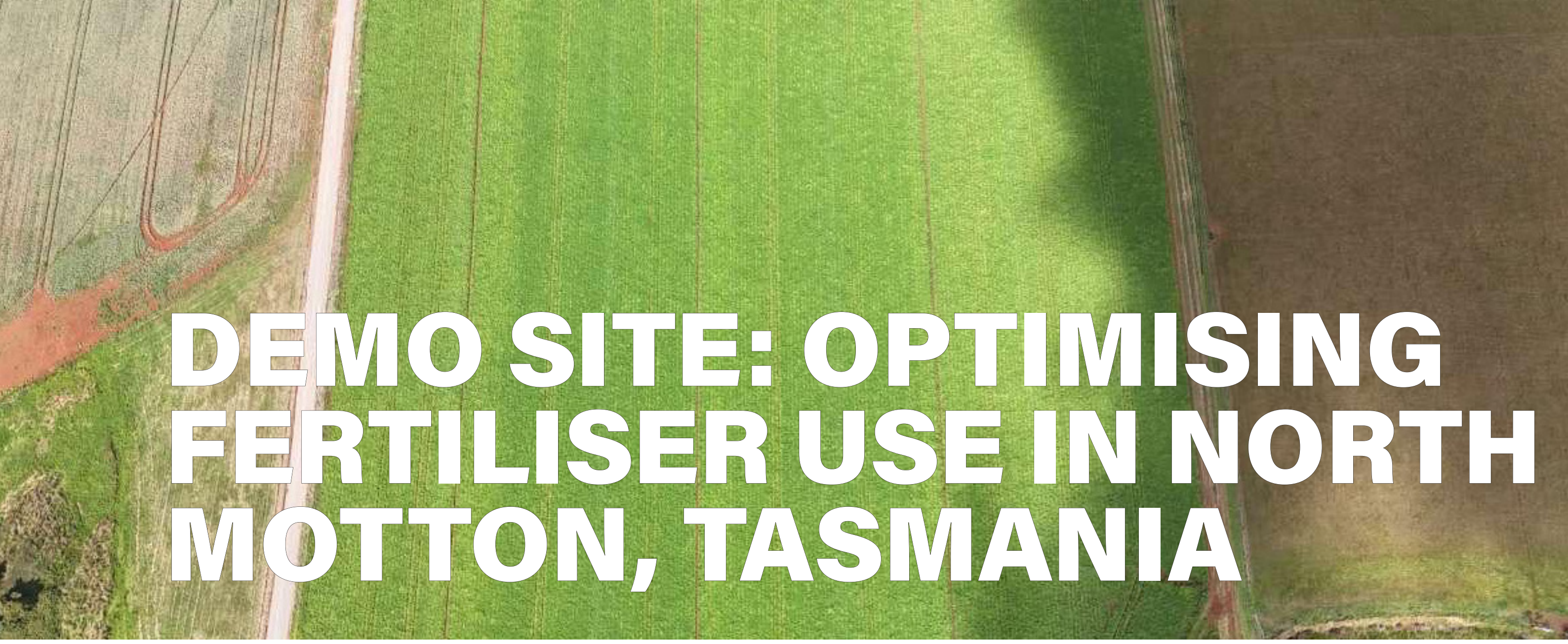

DEMO SITE: OPTIMISING FERTILISER USE IN NORTH MOTTON, TASMANIA

As fertiliser prices fluctuate and environmental scrutiny tightens, the need for informed, adaptive nutrient strategies in potato farming has never been greater.

At our demonstration site in North Motton, Tasmania, the PotatoLink team partnered with local grower Coby Badcock and agronomist and regional representative for PotatoLink Tim Walker to explore the question at the heart of every fertiliser program: How much is enough without compromising quality and yield?

This case study – running from October 2024 to April 2025 – compared conventional, high-input methods against crop sampling-guided approaches in Innovator potatoes.

The objectives of the trial were to:

- Evaluate the impact of varying fertiliser rates and timings (pre-spread, at planting, and top-dress) on potato crop yield, quality (size distribution and specific gravity), and gross margins.
- Compare a crop sampling-based (sap test) fertiliser program with a conventional fertiliser program to evaluate their effectiveness in optimising fertiliser use, yield, nutrition uptake, and input cost efficiency over a single growing season.

THE TRIAL

Four 1 ha treatment blocks were allocated within a commercial potato crop. Single Superphosphate (SSP) with Muriate of Potash (MOP) was applied across all four blocks as a pre-spread. The four blocks were then treated as follows:

T1 – Minimum + pre-spread: Low-rate fertiliser program with an additional pre-spread application of SSP + MOP. Top-dressed based on sap test results.

T2 – Conventional – high: High-input program with an additional pre-spread application, full-rate DAP/MAP at planting, and top-dressed by a conventional program (no sap testing).

T3 – Conventional – moderate: A more moderate program using standard planting fertiliser (no additional pre-spread). Top-dressed based on sap test results.

T4 – Minimum: The lowest-input program (no additional pre-spread) and compound fertiliser at planting. Top-dressed based on sap test results.

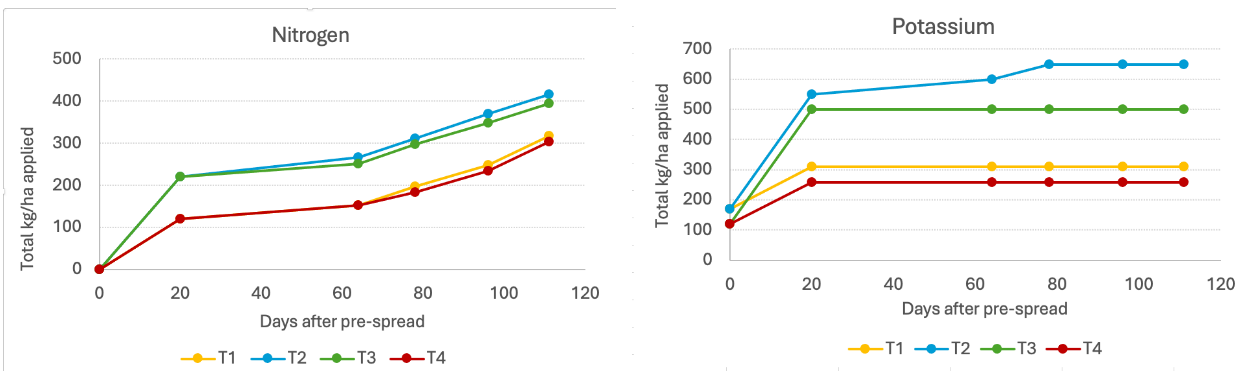

Figure 1. Cumulative total applications of nitrogen and potassium to treatment blocks T1 to T4. Initial application was a pre-spread. Fertiliser was then applied in furrow at planting, then as four side dressings. For T1, T3 and T4, top dressing applications were based on sap test results.

	T1	T2	T3	T4
Pre-spread	500 kg × (80% SSP + 20% MOP)	500 kg × (80% SSP + 20% MOP)	700 kg × (67% SSP + 33% MOP)	700 kg × (67% SSP + 33% MOP)
In furrow at planting	1,000 kg × Compound	2,000 kg × DAP + MAP	2,000 kg × DAP + MAP	1,000 kg × Compound
	Sap test x 4		Sap test x 4	Sap test x 4
Top dressing 12.12.24	150 kg × SOA	200 kg × Urea + Potash	150 kg × SOA	150 kg × SOA
Top dressing 26.12.24	100 kg × Urea	200 kg × Urea + Potash	100 kg × Urea	150 kg × SOA
Top dressing 13.01.25	150 kg × Urea + SOA	125 kg × Urea	150 kg × Urea + SOA	150 kg × Urea + SOA
Top dressing 28.01.25	150 kg × Urea	100 kg × Urea	100 kg × Urea	150 kg × Urea
TOTAL kg/ha	N:P:K:S 316:127:309:208	N:P:K:S 416:337:649:114	N:P:K:S 393:302:499:123	N:P:K:S 302:92:259:199

Figure 2. Summary of fertiliser applications by treatment. NPKS ratios as follows; Compound – 12:5:14:6; DAP + MAP – 11:13:19:1; SOA – 21:0:0:24; Urea – 46:0:0:0; Urea + Potash – 23:0:25:0; Urea + SOA – 33:0:0:12

PLANT SAP TEST RESULTS

Plant sap testing offers a real-time snapshot of nutrient levels within plants. It can help fine-tune fertiliser programs by identifying where nutrients are deficient or excessive.

However, sap testing should not be used in isolation; it is most effective when combined with soil test results, crop growth stage knowledge, and visual assessments.

Sap test results indicated that most macro and micronutrients remained within the target range for the majority of the cropping cycle (Table 1).

Sap levels of **nitrate** (NO_3) were relatively constant over the cropping cycle, occasionally exceeding recommended levels. However, sap concentrations of **ammonium** (NH_4) decreased over time. While they remained within range, levels fell close to minimum recommendations during tuber bulking, especially for T1 and T4.

While high nitrate levels can potentially reduce uptake of **calcium**, in this trial, sap concentrations of calcium remained within the desirable range or even higher.

Although **phosphorus** started low across the treatments, all were within range during tuber bulking.

Potassium levels generally exceeded the ideal range, even with reduced inputs, suggesting possible over-application. Side dressing with **sulphur** at early bulking was also reflected in overly high levels in sap.

Of the micronutrients, zinc, copper, sodium, iron and magnesium were all within range. Manganese was marginally low early, with levels increasing as the crop developed. Boron also increased, with overly high levels recorded in sap during tuber bulking across all treatments.

SITE AND ASSESSMENTS AT A GLANCE

- Location: North Motton, Tasmania
- Trial site: 4-hectare paddock
- Variety: Innovator (for processing)
- Irrigation: Pivot
- SAP tests collected four times during growth: tuber initiation, tuber development, early tuber bulking and mid tuber bulking
- The following were harvested and assessed to determine the effects of each treatment:
    - Sampled 5 x 3m plots of each treatment, recording:
        - Stems and tubers / plant
        - Weight of tubers by size: <50mm; 50-100mm; 100-150mm; 150-200mm
        - Yield / plot
- Total yield data was collected by excluding edge rows and spray runs, then using GPS-tracked harvesting distances to calculate the harvested area per truckload, with final yield determined from load weights and area harvested.
- Specific gravity was provided by the processor

Table 1. Summary of key results from sap tests. Colour indicates whether result was below (red), within (green) or above (purple) recommended levels.

	Nitrate (NO_3)				Phosphorus				Potassium				Calcium				Sulphur			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
Tuber initiation	Above	Above	Within	Above	Below	Below	Below	Below	Within	Within	Within	Within	Within	Within	Within	Within	Within	Within	Within	Within
Tuber development	Above	Within	Within	Above	Below	Within	Within	Below	Above	Within	Within	Within	Above	Within	Above	Within	Within	Within	Above	Within
Early bulking	Within	Within	Within	Within	Within	Within	Within	Within	Above	Above	Above	Above	Within	Within	Within	Within	Above	Within	Above	Above
Mid bulking	Within	Above	Within	Within	Within	Within	Within	Within	Above	Above	Above	Above	Within	Within	Within	Above	Within	Within	Within	Above

KEY
- Below normal range
- Within normal range
- Above normal range

DID ADDITIONAL PRE-SPREADING BOOST YIELD AND PROFIT?

T1 and T2 received an additional pre-spread application of SSP and MOP before planting, while T3 and T4 did not.

- The extra pre-spread fertiliser did not translate into yield gains.
- T2 had a similar fertiliser program to T3, with the exception of the additional pre-spread application. Yields from the two treatment blocks were not significantly different at 69 and 68 t/ha.
- Similarly, T1 had a similar fertiliser program to T4, with the exception of the additional pre-spread application. Both blocks yielded 62 t/ha, so there was no benefit from the pre-spread.
- While a trend was noted to an increased percentage of large (150 to 200mm) tubers in T1 and T2, this difference was not statistically significant.

As yield was not increased, T1 and T2 had higher fertiliser costs as a percentage of total revenue, ranging from 10.4% to 12.4%, compared with 9.4% to 11.0% for T3 and T4.

Most importantly, profitability was higher in the no-pre-spread treatments. T3 achieved the highest net return, while T4, despite receiving fewer inputs, outperformed T1 in both margin and efficiency.

In summary

Under the trial conditions, additional pre-spread fertiliser was not economically justified.

More efficient nutrient use and better margins were achieved without this treatment.

HOW DID THE RATE AND TYPE OF FERTILISER APPLIED AT PLANTING IMPACT YIELD AND PROFIT?

- The higher input treatments T2 and T3 produced higher yields (69 t/ha and 68 t/ha), compared with 62 t/ha for T1 and T4.
- This suggests that, under the conditions in this trial, increasing fertiliser at planting improved productivity.
- However, this finding is complicated by the fact that both fertiliser type and application rates varied between treatments. For example, the compound fertiliser used in T1 and T4 was only tested at the lower rate, while DAP/MAP was used exclusively at the higher rate. As a result, it is not possible to isolate the effect of fertiliser type from that of fertiliser quantity.

In terms of $/ha:

- T2 and T3 achieved net returns approximately $2,200 to $2,500 per hectare higher than T1 and T4.
- However, these gains came at a cost. Fertiliser spending was $500 to $1,200 per hectare greater in the high-rate treatments.
- When fertiliser cost was factored in, the increase in net return was around 8–10% higher.

Figure 3. Example of one of the digs used to assess tubers/plant, tuber size, defects, and yield variability

IMPACT OF FERTILISER REGIME ON YIELD AND INPUT COST EFFICIENCY

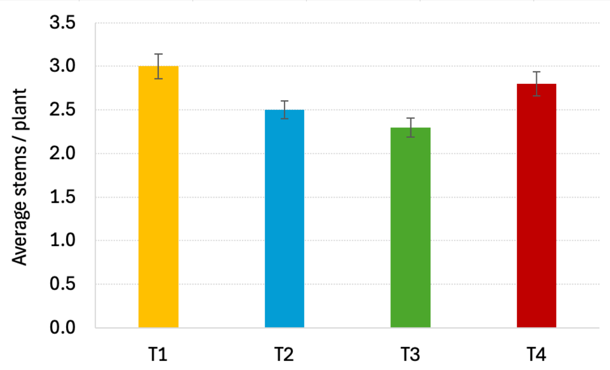

Figure 4a. Average stems per plant, calculated from 5 x 3m digs per treatment. Bars indicate the standard error of each mean value.

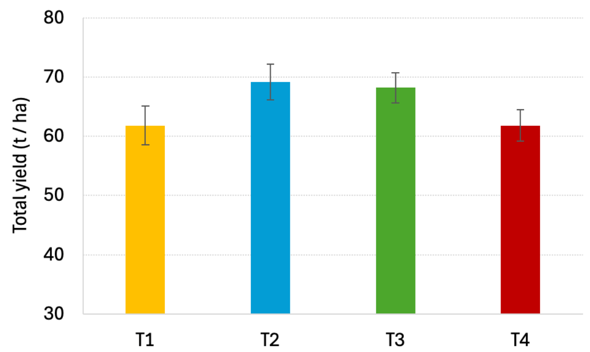

Figure 4b. Total yield at harvest from each treatment block. Bars indicate an estimated variability for each block based on harvested yield.

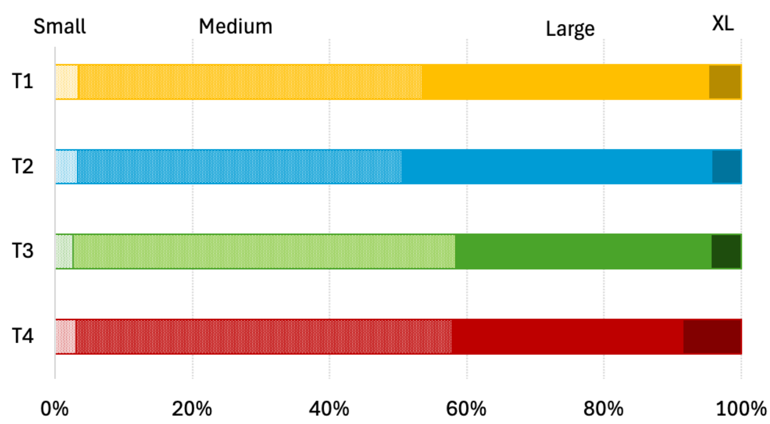

Figure 4c. Proportion of tubers that were small (<50mm), medium (50 to 100mm), large (100 to 150mm) or extra large (>150mm) within each treatment block. Data calculated from 5 x 3m digs per treatment. Note that although more large tubers were recovered from T1 and T2, this difference was not statistically significant.

In summary

In this cropping situation, the use of higher fertiliser rates appears justified. In other situations benefits may not outweigh the extra input costs. Even in this case the return on investment was limited, and it seems likely that not all of the additional fertiliser was utilised by the crop.

Future studies would benefit from comparing different fertiliser types at similar rates to better identify the most cost-effective option.

Table 2: Fertiliser cost as percentage of revenue. While T2 and T3 achieved the highest yield, T4 provided the best returns on fertiliser investment.

Treatment	Fertiliser cost as a percentage of revenue
T1: Minimum + Pre-spread	10.4
T2: Conventional - High	12.4
T3: Conventional - Moderate	11.0
T4: Minimum	9.4

HOW WELL DO POTATOES PERFORM WITH MINIMAL FERTILISER INPUT?

T4 represented the low-input approach, receiving the smallest amount of fertiliser across all treatments.

In terms of t/ha:

- T4 had the lowest yield of the trial at 62 t/ha, 10.6% lower than T2, the conventional high-input program.
- Fertiliser costs for T4 were reduced by 32% relative to T2, with the result this treatment achieved the best fertiliser cost efficiency in terms of input compared to revenue.

In terms of $/ha:

- T4 delivered $2,160 per hectare less than T2, but still offered strong economic performance for a low-input system.

- For growers operating under cash flow constraints, or in environments where heavy fertiliser application is not warranted, such an approach may provide a more sustainable and financially viable alternative.

In summary

While higher fertiliser rates can boost yields and returns, they come with greater financial risk and environmental impact. Lower input systems may not maximise yield, but they can minimise input costs and reduce over-fertilisation.

SOIL AND NUTRIENT STATUS AFTER HARVEST

Soil testing across the trial site following harvest provided important insights into the growing environment. These factors potentially affected how the fertiliser regimes trialled impacted crop performance.

- **Soil pH ($CaCl_2$)** was 5.9 at the start of the cropping season, well within the optimal range. After harvest, pH had fallen to 4.9. Soil pH ($CaCl_2$) below 5.5 reduces availability of nutrients including phosphorus, magnesium, calcium and molybdenum (Figure 5).
- **Low pH** could explain why phosphorous levels in sap remained at the bottom of the normal range across all treatments, despite high rates of P application in T2 and T3.
- **Cation Exchange Capacity (CEC)** is the measure of a soil's overall nutrient storage and exchange capacity. In this case, it was below desirable levels. This means the soil cannot hold more nutrients, especially when combined with low pH.
- **Organic matter** was very high (>5% carbon) at the trial site. While good for soil structure and microbial health, high levels of soil carbon can potentially bind nitrogen, delaying availability to the crop. High carbon soils require careful nitrogen management, particularly around timing and formulation, to ensure nutrient release coincides with crop demand.
- **Salinity levels and problem cations** remained within safe limits throughout the trial period.
- **Macronutrient** levels showed a mix of favourable and excessive values.
  - Total nitrogen and phosphorus were within satisfactory ranges across treatments.
  - Potassium was high to very high in all treatments, exceeding the optimal range for potatoes. Excess potassium can lead to nutrient imbalances, particularly in magnesium and calcium uptake.
  - Sulphur levels were satisfactory in T1 to T3, but unusually high in T4.
- The **calcium-to-magnesium ratio** exceeded target levels in all treatments. A high calcium dominance in the soil can interfere with magnesium availability. Magnesium is critical to photosynthesis and some enzymes. Fortunately, in this trial, sap magnesium levels remained within the target range.
- **Micronutrient** analysis showed that most elements were within acceptable ranges, with the exceptions of boron and copper, which were low to very low across all treatments. Despite low levels in soil, concentrations of boron were high across all sap tests.

SO, WHAT HAVE WE LEARNED?

The trial highlighted the importance of nutrient uptake dynamics and the limitations of relying solely on fertiliser application rates to predict crop nutrient status.

How crops take up nutrients is influenced by multiple interacting factors beyond just fertiliser inputs. Timing, fertiliser form, pH, and crop demand all play a role.

For example, even though significantly more N was applied to T2 and T3 than T1 and T4, sap tests indicated nitrate levels were generally similar across all treatments. Similarly, although more than twice as much potassium was added to T2 compared to T4, potassium levels in sap were higher in the latter.

These inconsistencies demonstrate the complexity of nutrient uptake. Simply adding more fertiliser to the soil does not mean it will be taken up and used by the plant.

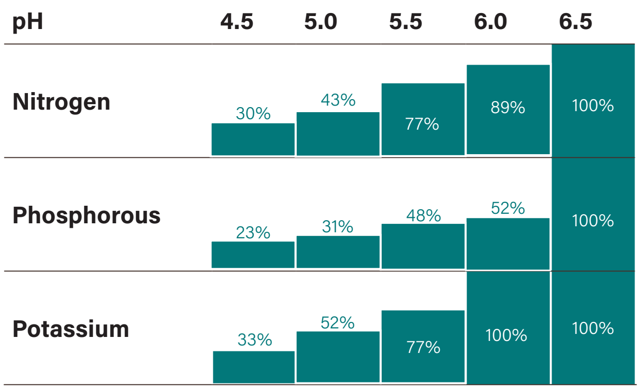

Figure 5. Effect of pH on NPK assimilation. (adapted from https://omya-agriculture.com/au/omyaproducts/calciprill)

Nutrient interactions affect uptake efficiency

Balancing nutrients is very important as there are many interplays going on.

Some examples are:

- Excess potassium can inhibit magnesium uptake due to competitive absorption.
- Too much nitrate can reduce calcium and boron levels – key nutrients for tuber quality and plant integrity.
- Sulphur and nitrogen must also be balanced, as low sulphur can restrict nitrogen efficiency, while excessive sulphur may suppress other nutrients.

Addressing one nutrient in isolation can create deficiencies in others. An integrated approach to nutrition is therefore always best.

Soil pH affects nutrient availability

Soil tests conducted after harvest indicated that soil pH ($CaCl_2$) fell to 4.9 during the cropping cycle. It is likely that these somewhat acidic conditions impacted nutrient uptake.

It is possible that the same fertiliser treatments could produce a very different result at a more neutral soil pH, especially if combined with a higher CEC. In particular, the lower fertiliser regimes tested in this trial may not have incurred the same yield penalty observed here had the soil conditions been optimised for efficient uptake of nutrients by the plants.

LOOKING AHEAD AT FUTURE TRIALS

The grower is keen to further refine nutrient management to improve efficiency and crop health. The immediate priorities are addressing low soil pH and improving CEC.

A soil test will be conducted to guide lime applications ahead of the next potato crop. The focus is on using finely ground lime products to ensure quicker effectiveness.

Strong interest remains in reducing fertiliser inputs. Future trials will explore applying less fertiliser at planting and again tailoring nutrition based on real-time sap and soil test results throughout the season.

Other refinements include:

- Revisiting topdressing strategies, as the additional pre-spread in this trial did not improve yield.
- Increasing planting-time compound fertiliser rates to create more consistent comparisons across treatments.
- Trialling wider seed spacing; this may support lower input growing strategies by reducing competition and improving fertiliser use efficiency.

The grower's long-term goal is to demonstrate that high-quality crops can be produced with fewer inputs by adjusting product types and timing and focusing on crop demand rather than calendar-based application.

KEY POINTS

In this trial

- Extra pre-spread fertiliser didn't improve yield.
- Although higher fertiliser rates at and after planting increased yield and, in this study, profitability, increased production costs were significant.
- Sap test results did not always align with fertiliser rates applied.

In general

- Applying more fertiliser does not mean it will be used by the plant; nutrient uptake is affected by many factors.
- Imbalances between nutrients can limit plant uptake and reduce efficiency.
- Soil pH is a key driver of nutrient uptake efficiency and fertiliser effectiveness.

FURTHER READING

- **FACT SHEET:** The changing nutrition needs of a growing crop
- **MAGAZINE ARTICLE:** Petiole testing for nutrient analysis
- **FACTSHEET:** Interpreting soil test reports

ACKNOWLEDGEMENTS

The PotatoLink team would like to thank grower Coby Badcock for access to his farm and ongoing assistance in the trial, and congratulate him for being nominated for Syngenta Grower of the Year and Corteva Agriscience Young Grower of the Year at Hort Connections 2025. Additionally, thank you to PotatoLink regional representative Tim Walker who has worked with us to carry out the trial and interpret the results.