Plant & Food RESEARCH
RANGAHAU AHUMĀRA KAI






Maximising potato yield in Canterbury

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Contents

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From left to right: Richard Falloon, Alex Michel and Steve Dellow identifying disease.

Introduction

Potato yields in Canterbury have remained static at 50 to 60 t/ha (paid yield), and crop production at this level is becoming uneconomic. Computer-based modelling predicts that yields of 90 t/ha are theoretically possible in most years.

A project was conducted by the NZ Institute for Plant & Food Research, during the 2012/13 growing season. The field research project aimed to identify factors responsible for the reduced yields (the "yield gap"). The project was funded by Potatoes NZ, the McCain growers group, Ravensdown Fertiliser and Plant & Food Research.

Findings

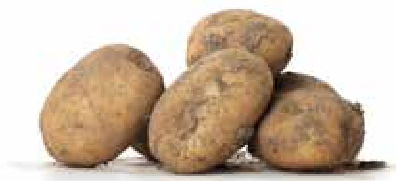
- → Current yields of processing potatoes in Canterbury were 20 to 42 t/ha less than yield potential.
- → Seed- or soil-borne diseases, in particular, Rhizoctonia stem canker, and *Spongospora* root infection were prevalent in the crops.
- → Diseases probably reduced yields by restricting water uptake in the plants and causing premature canopy death.
- → In all crops, healthy plants were producing close to potential.
- → Paddocks not previously producing potatoes ("new") had less pathogen inoculum than those including potatoes in their cropping histories in the last ten years ("old"). However, previous cropping history was not a good predictor of soil-borne disease incidence and severity.
- → Soil compaction reduced soil water-holding capacity and root growth.
- → Current fertiliser rates are near optimum for growth and production.
- → Other factors (e.g. seed tuber quality) could be limiting yield.

Approach

Eleven commercial potato crops were included in the study. They were planted with either 'Russet Burbank' or 'Innovator' cultivars. Paddocks were selected to also examine the effect on yield of including potatoes in their cropping histories. A representative site was chosen in each crop after planting, and soil structure, the presence of soil-borne pathogens and crop characteristics were measured. Every 10 to 14 days throughout the season, each crop was checked for growth and development, and any inconsistent areas were marked for later yield assessments.

Fertiliser trials were established in four of the crops, where grower rates of nitrogen, phosphorus and potassium were doubled, and calcium was also added. Further applications of nitrogen during the season conducted as part of commercial practices, were also doubled for some treatments in the fertiliser trials. Yield was measured at crop senescence.

Three measures of tuber yield were used for each crop; "potential yield" from a yield simulation model (using 2012-13 climate data) and "paddock yield" from the whole paddock as measured by the grower. These two yield types were expressed as paid yield and did not include tubers less than 67 mm in length. A third measure was "plant yield", the gross tuber yield per plant (including all tubers). This was used to compare yields between individual healthy or unhealthy plants within a crop.



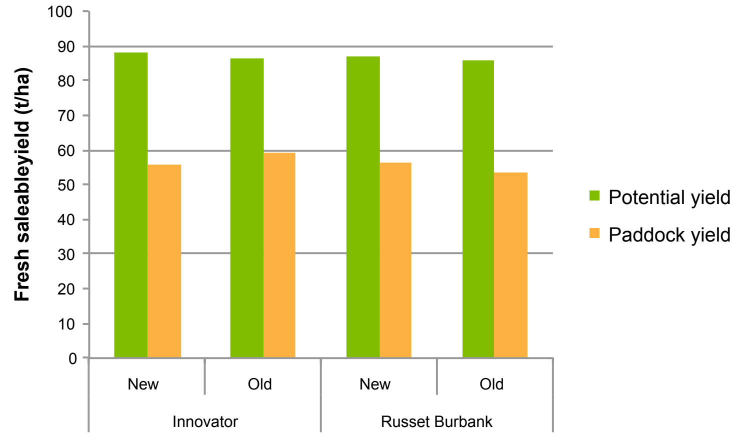


Figure 1: Average fresh "potential" and "paddock yields" (t/ha, tubers < 67mm removed) for potato cultivars 'Innovator' and 'Russet Burbank' in new and old ground, for 11 crops monitored during 2012/13.

Results

A yield simulation model, conducted for each season from 2002-2013, showed that the 2012/13 season gave the greatest "potential yield" at all sites and this was used as a baseline. High winds damaged some crop canopies in January 2013, which probably reduced final yields.

Averaged over the 11 crops, "potential yield" was 87 t/ha and "paddock yield" was 54 t/ha (Figure 1). 'Russet Burbank' and 'Innovator' had similar yields. There was no effect of previous history of potatoes on the yield difference. However, initial soil pathogen levels were significantly greater in paddocks with previous histories of potatoes.

The yield gap between a "potential" yield of 87 t/ha and "paddock yield" ranged between 20 and 42 t/ha (Figure 2). Yield gaps were greatest where water uptake was restricted in the plants, due to damage to roots and underground stems by diseases, and through poor soil structure and compacted layers limiting soil water storage. Yield was also reduced through foliar diseases shortening canopy duration to less than optimal for completion of tuber bulking.

The presence of disease was an important factor associated with variability of "plant yield" within individual paddocks (Figure 3); similarly, soil compaction produced variability between paddocks. Plants that were less severely affected by soilborne diseases, and in the absence of soil compaction yielded up to the equivalent of 90 t/ha. However, in other paddocks where plants were affected by these diseases and the soil was compacted, yield was reduced to less than the equivalent of 30 t/ha.

Six crops had root-limiting soil compaction (Table 1). All of the crops had Rhizoctonia stem canker symptoms, and six crops had root galls caused by *Spongospora* infection. Five crops had the two soil-borne diseases but no soil compaction. Three crops had the two diseases and compaction, and four crops had shortened canopy duration. Six crops also had significant wind damage.

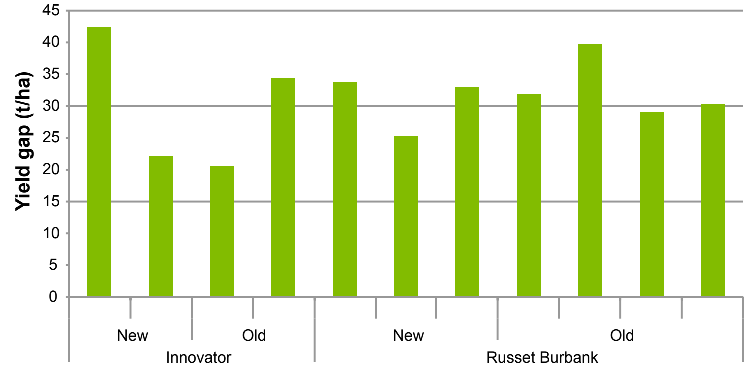


Figure 2: The yield gap (t/ha, fresh, tubers < 67mm removed) between "potential" and "paddock yields" for 11 potato crops, of 'Innovator' or 'Russet Burbank', planted, respectively, into "new" or "old" paddocks.

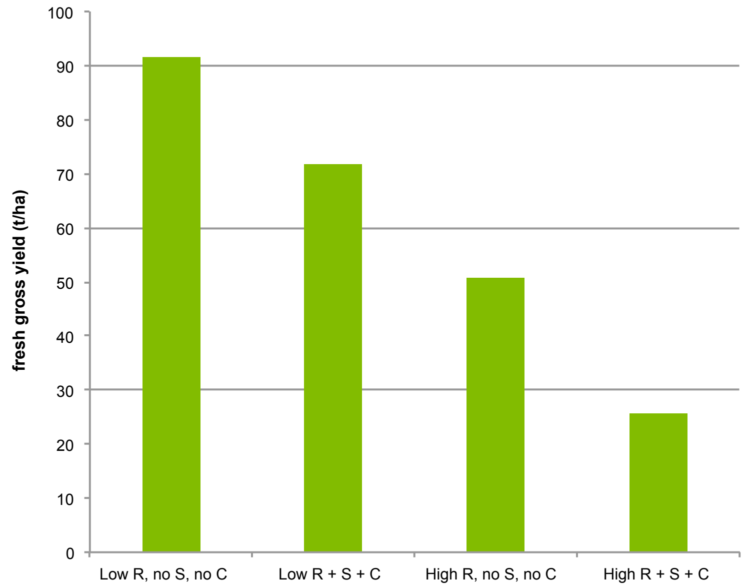


Figure 3: Averaged "plant yield" from targeted areas in 11 potato crops, categorised as having: low Rhizoctonia stem canker incidence, no *Spongospora* (root galls) and no soil compaction (Low R, no S, no C); low Rhizoctonia stem canker incidence, with *Spongospora* (root galls) and soil compaction both present (Low R + S + C); high Rhizoctonia stem canker incidence, no *Spongospora* (root galls) and no soil compaction (High R, no S, no C); and high Rhizoctonia stem canker incidence, with *Spongospora* (root galls) and soil compaction both present (High R + S + C).

Rhizoctonia stem cankers on underground potato stems (mid January 2013).

PADDOCK	FACTORS
1	Soil compaction, Rhizoctonia stem canker (RSC), Spongospora (root galls), uneven irrigation (waterlogging and dry spots), wind damage
2	Soil compaction, RSC, root galls, shortened canopy duration, uneven irrigation (waterlogging and dry spots), wind damage
3	Soil compaction, RSC, root galls, waterlogging, wind damage
4	RSC, wind damage. Seed or psyllid problem?
5	RSC, diseased canopy with low vigour, wind damage
6	Soil compaction, RSC, root galls, uneven irrigation
7	RSC, three spans of irrigator malfunctioning, wind damage
8	Soil compaction, RSC, root galls, shortened canopy duration
9	Soil compaction, RSC, root galls
10	RSC, shortened canopy duration
11	RSC, shortened canopy duration, poor seed quality

Table 1: Factors which may have contributed to yield reductions for each of 11 potato crops included in this study

Spongospora galls on potato roots (mid January 2013)

Fertiliser trial outcomes

- No significant effect on potato yield from doubling the nitrogen rate over that used in commercial practice.
- A small yield gain from doubling the rate of phosphorous and potassium in some cases, but no strong effects.
- No significant response to additional calcium.

Recommendations

- Plant potatoes in soils that have a high water-holding capacity, good drainage and no root restriction zones.
- Choose paddocks that have had long periods (at least 10 years) without potatoes.
- Test soil for pathogen DNA to indicate disease risk.
- Match crop nutrient requirement with supply, which may mean reducing some fertiliser inputs.
- Select disease-free seed tubers with high vigour for strong plant growth.

Future direction

The project team suggests that:

- Further information is needed to quantify effects of diseases on potato yield, for cost/benefit analyses.
- There is consultation between researchers and growers so that current crop management can be better understood.
- Nutrient response curves need to be better defined to quantify the cost/ benefit of fertiliser inputs.

Acknowledgements

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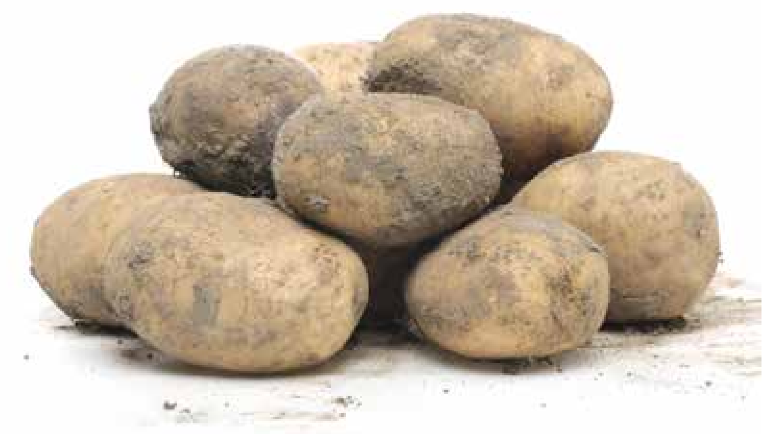






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