2018 Field Walk Notes

- Grower Talk -

John Sarup

***Spud Agronomy*, UK**

18 January, Pukekawa - *Jay Master*

18 January, Matamata - *AS Wilcox*

19 January, Opiki - *Mike Moleta*

21 January, Andrew Scott, *Somerton*

22 January, Lauriston - *Tim Pike*

22 Seadown - *Morgan Bowles*

Health and safety

These events are being held on working farms. Please take appropriate care and be aware of potential hazards. For your safety, please:

- Follow instructions from FAR staff, or other event manager, at all times.
- Stay within the areas specified by FAR/event staff.
- Stay out of trial plots unless invited by FAR/event staff.
- Report any hazards noted directly to a member of FAR/event staff.

Specific hazards to be aware of:

- ***Vehicles:*** Take care when moving across or through the car parking, entry and exit areas.
- ***Trips and falls:*** Watch out for uneven ground.
- ***Weather:*** Sun block is available on site.
- ***Electric fences***

First aid and emergencies

FAR staff are qualified First Aiders and have First Aid kits on site. Should you require any assistance, please ask a member of FAR staff. In case of emergency call 111 and notify a FAR staff member. Events sites are:

- Pukekohe Indian Association Centre, 57 Ward Street, Pukekohe
- 236 Hopkins Road, Matamata
- 264 Ashlea Road, Opiki

Vehicles

Vehicles will not be permitted outside of the designated car parking areas.

Smoking

No smoking permitted on these property.

2017/18 Potato Research Programme

Jen Linton, Potato Research Manager, FAR

Research for the 2017/18 season is well underway with trials planted and research programmes half way through their investigation. Research is being undertaken with both processing and seed crops and in Canterbury, Manawatu and the wider Pukekohe region.

Progress with the main research areas for the upcoming season is as follows:

Increasing potato yield through understanding the impact of crop rotation and soil compaction (Sustainable Farming Funding, FAR project P15-01)

- This year will be the third and final year of the project.
- One aspect not addressed in Years 1 and 2 was the effect of pre-plant (potato) cultivation on the soil quality. By the time these questions were posed, cultivation work for spring 2017 potato crops was well underway, and some early passes (including those in autumn 2017) already completed, therefore the timeline needed to undertake this research would not fit into the third year of this SFF project. It was decided to save this work for a future project and instead continue to pursue the seed health issue, which left some unanswered questions from Year 2.

Hot and cold psyllids (FAR project P17-04)

- The aim of the investigation is to provide data on TPP trapping numbers across a range of sites in Canterbury and Pukekohe and from those traps, to test TPP for the presence of CLso. From this we will be able to provide growers with data on any developing hot spots and where in Canterbury they originate.
- Fruitfed are responsible for trapping and counting TPP, native psyllids and beneficial insects. Psyllids will then be extracted from sticky traps and sent to Hill Labs as composite samples for CLso testing through qPCR.

Mesh coverings for pest management (FAR project P17-06)

- Project to commence in the upcoming weeks. Trial site and external collaborative parties have been confirmed.
- Two aspects will be investigated this season:
    - The commercial viability of mesh under a pivot irrigator
    - Whether or not desiccation is still effective under mesh in a seed crop

Improving the quality of seed potatoes using precision agriculture (Sustainable Farming Fund, FAR project P17-01)

- *Improving the quality of seed potatoes using precision agriculture* is a three year, FAR-led MPI SFF project looking at improving the quality of seed potatoes in New Zealand. Desiccation and re greening is a major problem for our seed growers, as is controlling virus and CLso infected tubers. The project will evaluate ways to overcome these issues.

Formalin efficacy (FAR project P17-05)

- The aim of the trial is to evaluate different formalin concentrations to understand their impacts on yield. Both whole and cut seed is being used to determine the role of cutting of seed also. Four formalin strengths are being investigated in both cut and whole seed.

Nutrient use efficiency (FAR project P17-03)

- The nutrient use efficiency indicator, NUE%, is the ratio between the amount of fertiliser nitrogen (N) removed with the crop and the amount of fertiliser N applied, expressed as a percentage. It is only a partial nutrient balance because it does not measure the soil nitrogen supply and removal processes, but nevertheless, it can provide useful information about N management in the crop. This approach has been used successfully for the Tasmanian potato industry. It has been proposed as an agro-environmental indicator because it is based on easy to collect farm information and farmers can understand where the efficiency percentages have come from.

- Objectives for the project include:
    - Is NUE percentage a useful indicator for NZ potato growers?
    - What can we learn from a set of grower NUE pecentages?
    - How do farmers make their fertiliser decisions? – Opportunity to look at GMPs for nutrient management and link directly to Quick N project.
    - Is the Tasmanian tool useful for NZ growers? If so does it need to be New Zealand-ised and what can we learn from it?

Fluxmeter results for the Waikato and Auckland sites

Diana Mathers, FAR

The following summaries are from the 3 Northern fluxmeter sites from installation in 2015 to June 2017.

Site 10 — Matamata/Pukekohe is a mixed cropping and livestock grazing enterprise on a Waihou silt loam. The rotation since the fluxmeters were installed was Italian ryegrass sown in May 2015, potatoes sown in October 2015, onions sown in July 2016 and Italian ryegrass (the current crop) sown in March 2017

In Year 1, RF was 1081 mm and 80 mm of irrigation was applied. There were 4 drainage samplings between July and September totalling 280 mm. Mineral N and total P losses in drainage totalled 48 kg N/ha and 0.15 kg P/ha respectively.

In Year 2, RF was 1095 mm and no irrigation was applied. There were 6 drainage samplings, most collected between mid-July and mid-September totalling 261 mm. Mineral N and total P losses in drainage totalled 20 kg N/ha and 0.04 kg P/ha respectively.

In year 3, RF 1041mm and 42 mm of irrigation was applied There were 3 drainage samplings totalling 378 mm. Mineral N and total P losses in drainage totalled 130 kg N/ha and 0.19 kg P/ha respectively.

Soil mineral N concentrations (0–100 cm depth) at the most recent sampling occasion in July 2016 were high (346 kg N/ha) while Olsen P concentrations (0–20 cm depth) were moderate (41 mg/L).

Site 11 — Matamata/Pukekohe is an intensive vegetable cropping enterprise on a Patumahoe clay loam. The rotation since the fluxmeters were installed was potatoes sown in June 2015, onions sown in May 2016 and potatoes (the current crop) sown in June 2017. There have been problems with flooding at this site, so the following results need to be interpreted with caution.

In year 1, RF was 1166 mm and no irrigation was applied. There were 4 drainage samplings between July and October 2015, with drainage estimated to be 477 mm. Modelled mineral N and total P losses in drainage totalled 142 kg N/ha and 0.11 kg P/ha respectively.

In year 2, RF was 1273 mm, and no irrigation was applied. There were 4 drainage samplings with most collected between July and October 2016 with drainage estimated to be 430 mm. Most Modelled mineral N and total P losses in drainage totalled 84 kg N/ha and 0.12 kg P/ha respectively.

In year 3, RF was 1071mm and no irrigation was applied. There were 4 drainage samplings with drainage estimated to be 493 mm. Modelled mineral N and total P losses in drainage have totalled 104 kg N/ha and 0.10 kg P/ha respectively.

Residual soil mineral N concentrations (0–100 cm depth) at the most recent sampling occasion in May 2017 were moderate (83 kg N/ha) while Olsen P concentrations (0–20 cm depth) were high (197 mg/L).

Site 12 — Matamata/Pukekohe is a mixed cropping and livestock grazing enterprise on a Patumahoe clay loam. The fluxmeters at this site had to be reinstalled in June 2016 because of flooding. The replacement site is located in the same field but approximately 150 m further east in an area of the field less prone to flooding. Since installation there have been two crops including potatoes sown in November 2015 and a mustard green crop sown in November 2016. The site is currently fallow and due to be planted to potatoes in July 2017.

In Years 1 and 2 RF was 1166 mm and 1273 mm, Rainfall for the current Year 3 monitoring period has totalled 1069 mm, 25% above the LTA (853 mm). Irrigation was only applied in Year two (total of 140 mm).

In the period between reinstallation of the site (15 June 2016) and 30 June 2017 there were 4 drainage samples collected with a total drainage volume of 1303 mm. Comparison of the captured volumes and the modelled volumes (1116 mm over this period), are favourable indicating the re-install was successful. Mineral N and total P losses in drainage for this period totalled 76 kg N/ha and 1.05 kg P/ha respectively.

Soil mineral N (0–100 cm depth) and Olsen P concentrations (0–20 cm depth) at the most recent sampling occasion in November 2016 were high (172 kg N/ha and 101 mg/L respectively).

General trends from all the 12 sites comprising the fluxmeter network:

1. Phosphorus losses in the drainage water are low. Across the sites the range is 0.19 -<0.05 kgP/ha

2. Irrigation is being managed very efficiently in most sites, often with no drainage at all.

3. Nitrogen losses in the drainage water vary. Across the sites the range over all sampling periods is: 240 – 1 kgN/ha

4. At some sites there were no nutrient losses from the farm because there was no drainage.

5. Soil mineral N levels across the sites vary between high and low values; 346 kgN/ha – 34 kgN/ha

6. The risk of nitrogen leaching is the interaction between soil N levels and drainage. If the soil N levels are high, there is an increased risk of nitrogen leaching.

Varying potato bed architecture to improve crop water use dynamics

***Alex Michel, Sarah Sinton and Steven Dellow*,**
Plant & Food Research (PFR)

Potato crops require high water supply and are often competing with other crops on the farm for irrigation through the summer months, when demand is high and supply can be limited.

In the 2015-16 season, an experiment was run on a PFR experimental block with a deep (2 m to gravel) Templeton silt loam soil (190 mm/m of depth available water holding capacity). Treatments consisted of 2 bed shapes (ridge/furrow and flat-bed) and 2 irrigation regimes (full irrigation, which was irrigated twice weekly to replace soil water deficit, and low irrigation, which was irrigated when soil water deficit in the top 400 mm of soil was close to wilting point).

Plots were 12 rows by 10 m long. Whole seed 'Bondi' was used and planted 200 mm deep. Seed and row spacing were, respectively, 280 mm and 0.8 m for both bed shape treatments. Irrigation was applied using a single span lateral irrigator.

There were some indications of a yield increase (7 t/ha) in the flat-bed plots compared to the ridge/furrow plots under full irrigation. This was supported by measurements of soil water storage and drainage properties under the different bed shapes, which showed that flat-bed plots had higher storage of available water for crop growth and that drainage was faster in the ridge/furrow plots. WUE was not much affected by bed shape.

In the current season (2017-18), a bed shape experiment is being conducted in a commercial 'Russet Burbank' crop located on a shallow (30-40 cm to gravel), well-drained Lismore silt loam soil.

The treatments are:

- 2 bed shapes:
    - Flat-top ridge/furrow
    - Flat-bed
- 2 seed depths:
    - Shallow: 15 cm for flat-top ridge/furrow, 10cm for flat-bed
    - Deep: 20 cm for flat-top ridge/furrow, 13 cm for flat-bed
- A grower comparison (part of the commercial crop): ridge/furrow shape and 20 cm seed depth

The trial was planted using a modified two row planter (Figure 1) and the same seed material as for the rest of the crop. Crop management for the trial is the same as the rest of the crop and carried out by the grower. Plots are 6 rows (3 beds) by 20 m.

Figure 1. Formation of two row flat-bed (left) and flat-top bed (right, using a modified Grimme planter.

Soil water content is recorded every 15 minutes down to 35-40 cm using automated sensors (TDR) installed in the beds. Rainfall and irrigation are recorded using plastic rain gauges.

Figure 2 shows the bed shape and soil profile information for the different treatments: bed architecture relative to ground zero, seed position and depth to gravel.

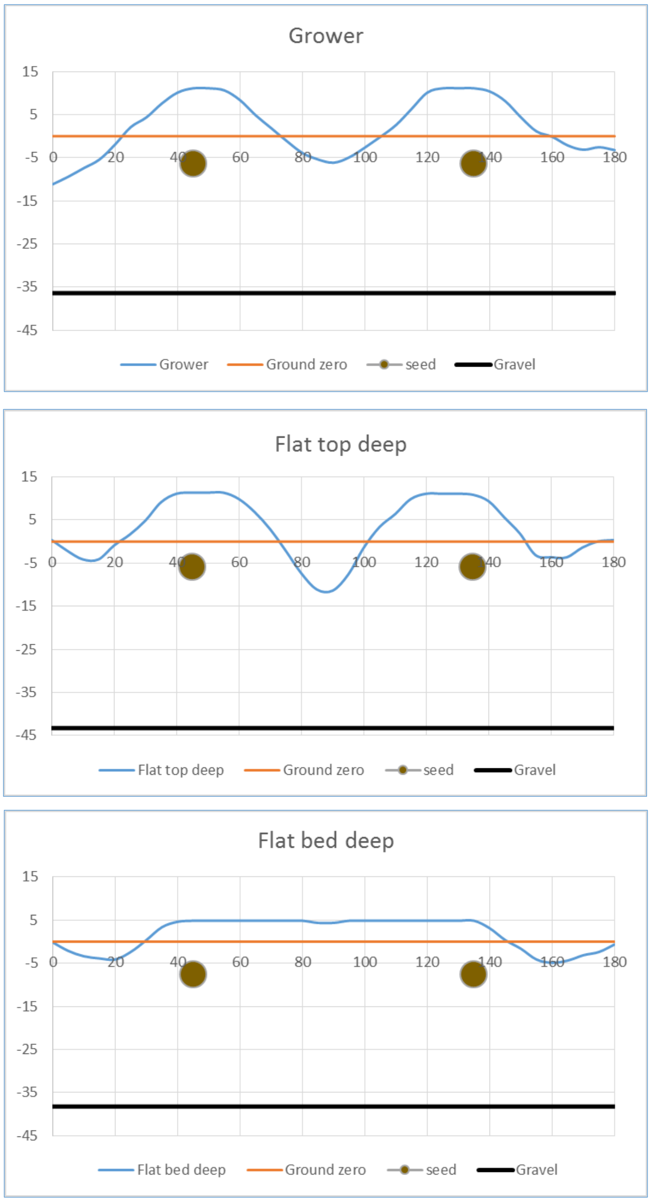

Figure 2. Graphically represented cross sections of three bed-shape treatments: flat-bed 'deep' planted seed, flat-top 'deep' planted seed, grower bed shape (measurements are cm). The blue line represents the average measured bed shape, the red line represents ground zero, the brown circles represent seed placement, and the black line represents the start of a gravel layer.

At crop maturity, the crop performance under the different treatments will be assessed by measuring yield, tuber size class distribution, tuber disease and defects level, and any other relevant crop parameters.

For more information please contact
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Acknowledgments

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Thanks to Andrew Scott for hosting this trial.

August 2017

Potato Update

Issue 9

Potatoes NEW ZEALAND Growing together

Year 3 progress report: Evaluation of seed tuber and in-furrow fungicides on the control of soil-borne diseases in potatoes

Introduction and methods

In New Zealand potato crops, control of the two dominant soilborne pathogens, *Spongospora subterranea* and *Rhizoctonia solani*, has remained difficult, despite the wide range of fungicides and pesticides that are registered for controlling them.

The severity of seed and soil-borne diseases varies by site and season. This update provides further information from one high risk site in South Canterbury.

This trial is the fourth over three seasons. In a trial conducted in the 2015-16 season testing seven fungicides, only one (Nebijin) was reported to have any effect, lowering powdery scab incidence and severity at harvest. This work was continued in the 2016-17 season, and additional treatments were tested in order to identify potential new strategies for disease management.

A replicated trial was set up in a commercial potato crop at Levels, South Canterbury with the cultivar Russet Burbank (planted 1 November 2016). The trial site had been in potatoes six years ago so disease pressure was likely to be high.

The chemical treatments were applied either directly to the seed tubers or as in-furrow sprays at planting, prior to closing the furrows. Eight products were investigated, both with and without formalin, totaling 16 treatments. Standard crop management was undertaken by the grower for the remainder of the season. Disease assessments on the underground stems and tubers were carried out at two crop growth stages (full canopy, 10 weeks after planting and late canopy, 14 weeks after planting) and at harvest (tubers only). A final yield assessment based on marketable tubers (t/ha of tubers >65 mm) was carried out at crop maturity.

Key points

- To date this project has not identified any new control strategies which are more effective than commonly used treatments.
- A replicated trial was set up in a commercial crop in South Canterbury with the potato cultivar Russet Burbank. The trial site had been in potatoes previously, so disease pressure was likely to be high.
- *Rhizoctonia* stem canker and *Spongospora* root galling and tuber powdery scab were the predominant diseases found on the sampled plants. There was no significant difference between any of the treatments for the control of *Rhizoctonia*, apart from formalin, which increased rhizoctonia stem canker severity by 12%.
- *Spongospora* root gall severity and incidence increased as the season progressed, however there were no differences between treatments.
- Plants grown from formalin treated seed developed more severe root galling than those from untreated seed. Formalin reduced yields by 6 t/ ha.
- There was no significant yield difference between the control, Amistar × 2 rate, Pinnacle, Monceren or Monceren × 2 rate treatments (yields range 73-82 t/ha).
- Yields were reduced by the treatments Maxim, Monceren × 2 rate + Amistar × 2 rate and Nebijin (average 66 t/ha).
- No fungicide treatment increased yield in this trial, or in the three trials in the previous two seasons.
- The lack of efficacy of fungicides is a major concern, particularly if they are reducing yields. There is a significant cost associated with applying fungicides and if, at a number of sites in New Zealand, they are providing no control and potentially reducing yield then the reason needs to be understood.

FAR

Table 1. Treatments, their active ingredients, target disease and application methods (either applied to the potato seed or in-furrow at planting) assessed in South Canterbury in the 2016/17 season.

Fungicide treatment (+ and - Formalin)	Active ingredient	Application method	Rate of product
*Nil (control)	-	-	-
*Monceren®	pencycuron	seed tuber	2 kg/t
*Monceren® × 2 rate	pencycuron	seed tuber	4 kg/t
*Amistar® × 2 rate	azoxystrobin	in furrow	20 mls/100 m row
*Monceren® × 2 rate + Amistar® × 2 rate	pencycuron + azoxystrobin	seed tuber + in furrow	4 kg/t + 20 mls/100 m row
*Nebijin®	flusulfamide	in furrow	4 mls/100 m row
*Maxim®	fludioxonil	seed tuber	250 mls/t of potatoes
*Pinnacle®	fluazinam	pre-planting incorporated	4 L/ha

*Note all treatments were repeated with Formalin (formaldehyde 40%) added taking the above 8 treatment to a total of 16 treatments in the trial.

Results

Different diseases were detected on stems and tubers from the harvested plants, but *Rhizoctonia* stem canker and *Spongospora* root galling and tuber powdery scab predominated.

There was no significant difference between any of the treatments for the control of stem canker, apart from formalin, which increased severity by 12% (P = 0.002). Stem canker severity developed through the season with 25% stem coverage (average of all treatments) at full canopy, increasing to 36% at late canopy. This follows the typical pattern of disease progression in many New Zealand potato crops.

The nature of *Rhizoctonia* symptoms observed on the potato plants may have reflected the contribution of both the seed- and soilborne forms of this pathogen. The appearance of symptoms consistent with soilborne infection was evident (Figure 1, Figure 2), indicating that the previous cropping sequence favoured the survival of *Rhizoctonia* in the field. Seedborne disease incidence was less than soilborne disease incidence, and not related to the treatments, suggesting that the seed (whole) may have been only lightly infected with the disease.

Spongospora root gall severity and incidence increased as the season progressed, and plants from formalin treated seed developed more severe root gall symptoms than those that were not formalin treated. At the final assessment there was a small difference in powdery scab severity between the formalin treatments, where the use of formalin reduced the severity score from 0.45 to 0.38, where a score of 1 = 5% coverage.

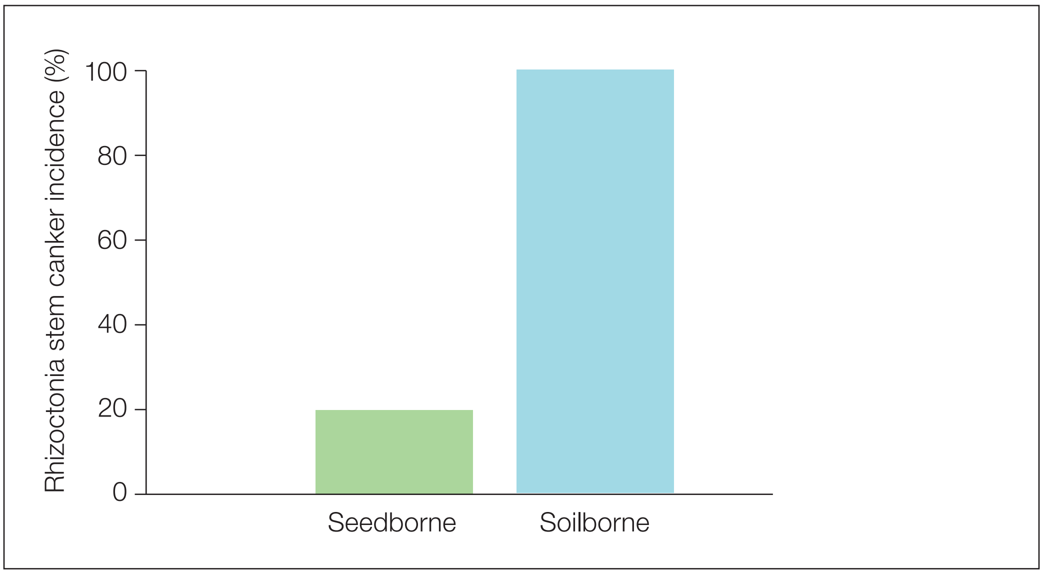

Figure 1. Incidence of seed-and soil-borne *Rhizoctonia* stem canker symptoms at full canopy, average of all treatments.

Figure 2. Soil-borne *Rhizoctonia* stem canker symptoms (left), seed-borne symptoms (right).

Table 2. Treatment effect on potato tuber mean marketable yield (t/ha) at Levels, South Canterbury in the 2016/17 season.

	Marketable yield (t/ha)		
	Mean over formalin treatment	+ Formalin	- Formalin
Nil (control)	82	76	89
Monceren® × 2 rate	76	73	79
Amistar® × 2 rate	75	70	80
Monceren®	75	70	80
Pinnacle®	73	77	69
Nebijin®	68	65	71
Monceren® × 2 rate + Amistar® × 2 rate	68	70	66
Maxim®	61	55	68
Mean	**72**	**70**	**75**
LSD (P < 0.05)	**10**	**14**	

For marketable yield, there was no evidence of a treatment interaction between formalin seed tuber treatment and fungicide treatment. There was no significant difference in yield between the control, Amistar® × 2 rate, Pinnacle®, Monceren®, Monceren® × 2 rate (yield range 73-82 t/ha) treatments. Yield was significantly less with the Maxim®, Monceren® × 2 rate + Amistar® × 2 rate and Nebijin® (yield range 61-68 t/ha). In this trial, the use of formalin decreased the marketable yields by 6 t/ha.

All treatments that exceeded label rate had tubers tested for residues. None of these exceeded New Zealand residue levels.

Discussion

Although *Rhizoctonia* and *Spongospora* diseases were widespread (and in some cases severe) in the trial area, none were controlled by any of the chemical treatments. In some cases, yield was reduced by these treatments.

These results are comparable to findings from similar trials conducted in the previous two seasons. Formalin treatment of seed tubers is becoming more popular with potato growers, but results from the present trial show that this treatment may also cause yield reductions.

To date this project has not identified any new control strategies which are more effective than commonly used treatments. Responses to fungicides may need evaluation at a wider range of sites and under different disease pressures.

Acknowledgments

Plant & Food Research provided expertise with disease assessments, data analysis and interpretation of results, and to the FAR team who carried out establishment of the trial and yield assessments. Morgan Bowles provided land, and helped to plant the trial.

September 2017

Potato Update

Issue 10

Potatoes NEW ZEALAND Growing together

FAR

Year 2 of SFF project: The effects of soil quality and seed health on potato yields

Introduction and methods

In year one of this three year Sustainable Farming Fund project a nationwide survey of 18 potato crops (Pukekohe, Manawatu and Canterbury) indicated that soil compaction and presence of soil- and seed-borne pathogens were likely to be the main factors limiting yield.

Year two of the project focused on defining the impact of seed health and soil quality on potato crop performance. This required careful management of potential sources of variability (cultivar, soil type, climate and crop management). This was achieved by hosting all trials in one region (Canterbury) and planting the same seed lines in four-plots (Russet Burbank and Innovator, treated and untreated with formalin) in each of 15 potato fields. The fifteen fields were grouped into four field categories related to paddock history and soil health:

1. Diseased - previous potato crops within the last 10 years, **'good' soil structure** - at least 5 years grass in the 10 year history (1 field).

2. Diseased - previous potato crops within the last 10 years, **'poor' soil structure** - at least 5 years arable crops in the 10 year history (6 fields).

3. Clean - no previous potato crops within the last 10 years, **'good' soil structure** - at least 5 years grass in the 10 year history (4 fields).

4. **'Clean'** - no previous potato crops within the last 10 years, **'poor' soil structure** - at least 5 years arable crops in the 10 year history (4 fields).

Crop histories were collated for a 10 year period (2005/06 to 2015/16) for each field, and a crop score applied to each main

Key points

- Year two of this three year SFF project focused on soil structure and rotation history for 15 sites in Canterbury. There were four-plot trials at each site (Russet Burbank and Innovator, treated with formalin and untreated).
- The major influence on yield was soil quality, and seed-soil borne disease had little impact.
- The crop history score x soil structural condition score factor explained 39% of the yield variation for Innovator and 52% for Russet Burbank. If soil quality is poor then growers should consider growing Innovator in preference to Russet Burbank.
- There was a good correlation between yield and a 10 year crop history score, and between yield and a one-off soil structural condition score, showing that these two independent methods could be useful for gauging paddock suitability for growing potatoes.
- More grass in a ten year history improved soil resilience and enhanced rooting hospitality for potatoes, thus enabling the crop to access more resources. For Russet Burbank, this equated to an average 3.5 t/ha lift in yield for every year in the previous ten year history a field was in grass.
- Formalin dipping did not significantly control these diseases in the glasshouse or the field.
- Seed could have transferred *Rhizoctonia solani*, causing stem canker, and *Spongospora subterranea*, causing root galls, to the field, as all glasshouse plants were infected with these diseases.
- Stem canker and root gall incidence and severity was greater from an ex-potato paddock history compared with no potato history, but yield was unaffected.
- Disease severity was higher in fields with predominantly grass histories, compared with mainly cropping histories. However, gross yield was greater from ex-grass (86 t/ha) than from ex-crop fields (75 t/ha).

annual crop, depending on its ability to help maintain or restore soil structure (fallow = 0, 1 = weak rooted crop e.g onions, 4 = strongest rooting crop e.g grass. Maximum score = 40). The sum of the ten crop scores made up the crop history score. Potato plant health in each plot was monitored four times during crop growth, with soil aggregate stability (testing soil impact resilience) and soil structural condition score (a visual test for root hospitality) measured once in mid-season, and final yield measured at harvest.

Whole seed from the same Russet Burbank and Innovator seed lines, either dipped or undipped in formalin, were grown out in potting mix (low disease risk) in a glasshouse to check for the presence of viable seed borne diseases. The temperature in the glasshouse was set at 16 ºC, optimal for soil-borne disease development, and there were 10 single plant replicates. No diseases were visible on the tubers at planting.

Results

Seed and soil health

Commercial formalin dipping had little effect on controlling seed-borne disease in the glasshouse plants, as all plants developed symptoms of *Rhizoctonia* stem canker and *Spongospora* root galls. However, Russet Burbank seed was less diseased than Innovator, and formalin slightly reduced stem canker severity, although not significantly.

Formalin dipping did not reduce the incidence or severity of the two diseases in the field trials. This meant that it was not possible to complete one of the objectives of the trial, to define the relative contribution of seed-borne and soil-borne disease to the incidence and severity of disease in the field. However, the combined effect of any seed- and soil-borne pathogens affected disease expression differently for crops in the various field categories.

The risk of stem canker incidence increased from 70% to 83% when more than five years of grass was included in the 10 year paddock history. The risk of *Spongospora* diseases increased from 24% to 73% where potatoes had been grown once before, and increased from 3% in paddocks with a mainly crop history, to 46% for paddocks with a mainly grass history (Table 1).

Table 1. Chance (%) of disease occurring for the diseases *Rhizoctonia* stem canker and *Spongospora* root galls, under contrasting cropping histories averaged for all 15 sites.

Disease	Crop History			
	No potatoes in 10 year history	Previous potato crop in 10 year history	> 6 years crops	> 7 years grass
Rhizoctonia stem canker	75	92	70	83
Spongospora root galls	24	73	3	46

Soil physical quality

Soil from most fields with a long term grass history, i.e. a crop history score of > 28, 7 years grass, had a higher soil aggregate stability (range 1.8 to 2.2 mm Mean Weight Diameter (MWD). Based on a PFR study of 105 arable crops, these levels were over the threshold of 1.5 mm MWD needed to grow crops that are likely to at least equal the regional average yield (Figure 1a).

Soil structural condition score was closely associated with crop history score (Figure 1b). This shows that much of the improvement in the ability of the soil to provide an adequate environment for optimum potato root growth was provided by the long term grass history. This was even after the intensive cultivation used to plant potatoes, when the soil condition score measurements were taken.

Greater values of aggregate stability, soil structural condition score and crop history score all indicate improved potential root hospitality.

There was a strong correlation (P = 0.012 for Innovator and P = 0.002 for Russet Burbank) between gross yield and a factorial of crop history score and soil structural condition score. When combined, they helped to describe the influence of soil quality on yield (Figure 2). For Innovator, about 39% of the yield variation was explained by the soil physical state; whereas Russet Burbank was more sensitive to poorly structured soil, with yield increasing more strongly in response to improved soil structure (52% yield variation explained). For Russet Burbank, this translated into an extra 3.5 t/ha yield for every year a paddock was in grass during the previous ten years.

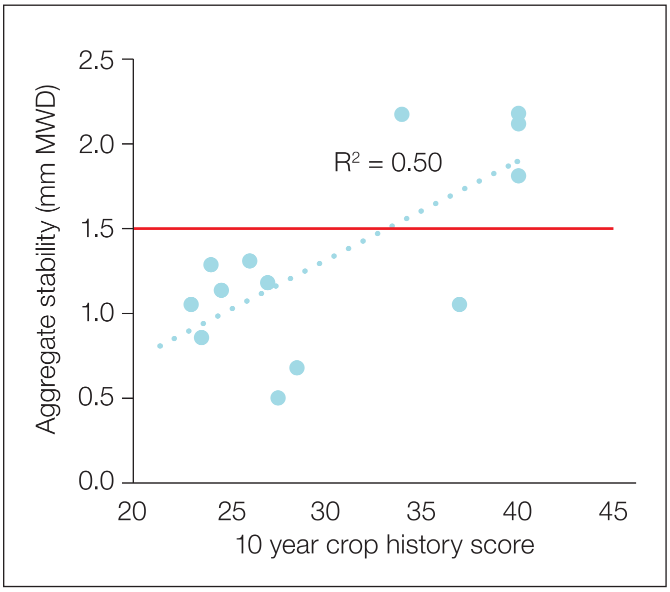

Figure 1a. The relationship between crop history score and aggregate stability. The greater the R2 value the stronger the relationship between the two variables. The red line is the aggregate stability value below which crops are likely to yield below the regional average.

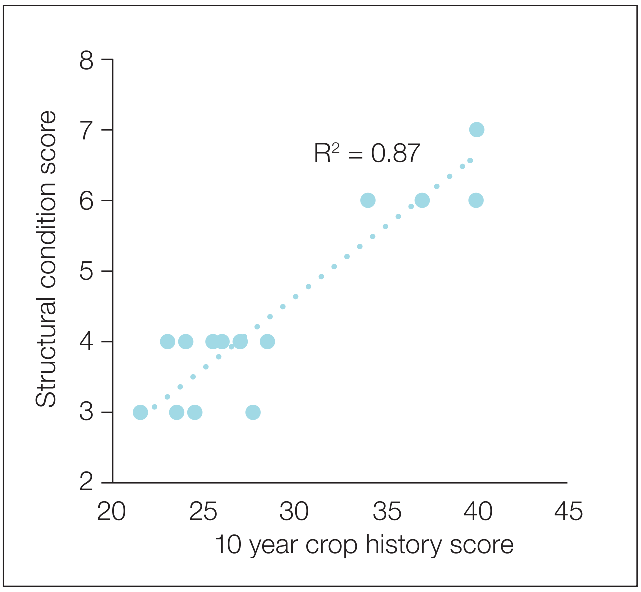

Figure 1b. The relationship between crop history score and soil structural condition score.

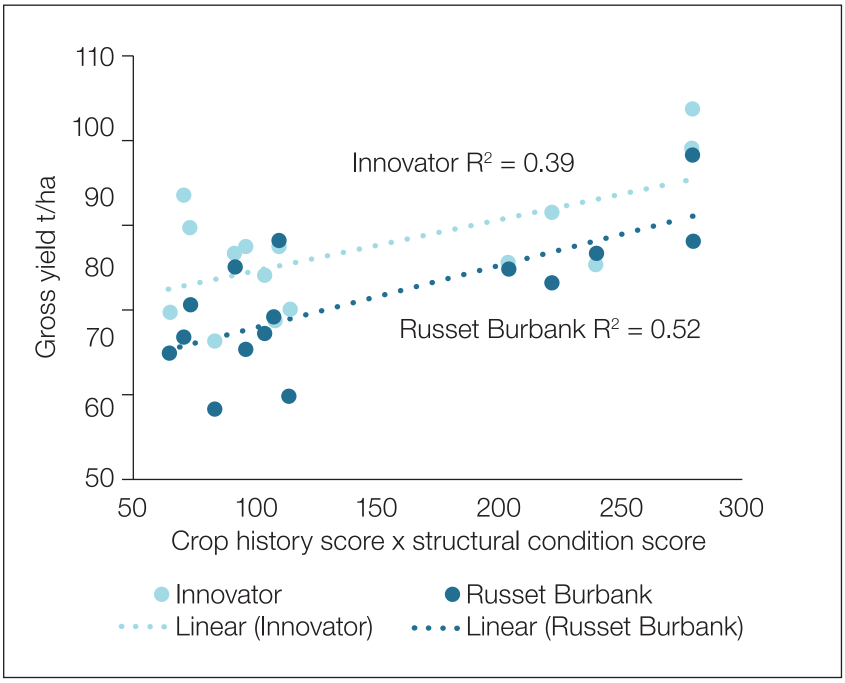

Figure 2. The relationship between a factorial of crop history score and soil structural condition score and gross yield. The greater the R2 value the more of the yield variation that can be explained by the physical state of the soil.

Potato yield

For marketable yield, Innovator yielded 81 t/ha, (P = <0.001), 14t/ha more than Russet Burbank (67 t/ha). Irrespective of cultivar, potatoes grown in ex-grass fields yielded more (79 t/ha, P = 0.024) than those grown in ex-crop fields (69 t/ha). Yield was unaffected by formalin treatment and whether or not potatoes were one of the crops in the cropping history.

Summary

This year research aimed to determine the influence of crop history, soil quality and soil/ seed-borne disease on potato yield. Results indicated that improvements in soil structure, resulting from a grass-dominant history, were synonymous with higher yields. This was despite that fact that soil-borne disease incidence was higher in the ex-grass fields. This indicates that more emphasis could be placed on scrutinizing cropping history and soil structural quality, before selecting a particular field for growing potatoes.

Disease risk also increased in paddocks where potatoes had been grown in the last 10 years, but this factor did not result in reduced yield. Formalin dipping of seed did not assist with seed-borne disease control, and all seed used in the experiment had a high incidence of disease present. Further investigation is needed to determine how seed health may be limiting yield potential.

In the final year of this project, we hope to explore the link between crop history, soil physical quality and potato yield for a wider range of crops in major potato growing regions. Extension will also be a major focus. We will look at developing or refining field soil tests and/or calculators or apps, along with information packages to quickly inform a grower of the physical state of a paddock prior to sowing the crop.

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Potato Update

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Growing together

FAR

Year 1 results for potato growers Nitrogen – Measure it and manage it

Background

The industry agreed good management practice for nutrient management is to match the nutrient supply from the soil and fertiliser to the demand from the crop to reach its yield. To do this with a degree of confidence, farmers require reliable information and methods for working out how much fertiliser to apply to their crops.

Nitrogen (N) losses to fresh water are a focus of many regional plans as councils develop rules to manage environmental losses. Managing N supply to the crop has become increasingly important as yield potential must be maintained and the risk of environmental losses reduced.

A nitrogen mass balance budget is an efficient way to determine how much nitrogen fertiliser should be applied to the crop to achieve its potential yield. However, for the budget to be developed, estimates are required for how much N the crop will need and how much N will be supplied by the soil.

Measuring the soil N supply depends on soil testing; mineral N tests give an estimate of how much N is immediately available and AMN tests estimate the potential for N to become available in the future as organic N is mineralised. However, as soil testing can be time consuming and results are not immediately available, quick, cheap methods for estimating soil N levels throughout the season are useful.

Previous work in New Zealand has shown that nitrate quick test strips can be used successfully as a cost effective and reliable substitute for the mineral N test. Based on previous work comparing nitrate quick test and mineral N test results, a three year project has been implemented to develop a simple Quick Test Mass Balance (QTMB) method to help cropping farmers manage their N applications.

In Year 1, the work has focused on side-dressing decisions.

Two potato sites, where nitrogen side-dressings were planned, were selected for this trial. At each site a replicated paired-plot experimental design was used to compare two N management treatments. These were:

- The grower's planned amount of N, to be applied at side-dressing.
- A QTMB treatment, where the side-dressing N application was based on a mass balance budget calculation using Nitrate Quick Test strips to estimate the soil mineral N supply just prior to side-dressing.

Key points

- This three year programme of work focuses on nitrogen fertiliser decisions for maize, potato and leafy green crops. This Update summarises the potato component of the project.
- The Quick Test Mass Balance approach is an effective method for informing in-season N management decisions for potato growers.
- Nitrate Quick Test strips can be used to estimate mineral N levels in the soil at any time during the crop's growth. They may be used as a cost effective substitute for the mineral N test, particularly for top soil samples (0–30 cm depth), where nitrate-N is the predominant form of mineral N.
- Quick Test estimates of soil mineral N levels can be used for fertiliser mass balance calculations to inform in-season N management decisions.
- The mass balance calculation for a side-dressing decision is: $N\ Fert_{SD} = [Crop\ N_{Total} - Crop\ N_{SD}] - Soil\ Min\ N_{SD} - Soil\ Org\ N_{mineralised}$. Information about the potential crop demand and the soil nitrogen supply is required.
- The mass balance calculation can either verify the fertiliser plans for the crop are correct, or support less fertiliser being applied. It can also indicate more fertiliser should be applied to reach the potential crop yield.

Experimental Sites

Site 1: Manawatu process potatoes

Site 1 was located in the Manawatu region near Opiki. Soil coring revealed an organic topsoil (0–30 cm) with a loam texture overlying an organic-sedimentary subsoil intergrade (30–60 cm) with a silty, clay-loam texture. The site had been under long term dairy pasture for more than five years prior to a process potato crop being planted on 24 October 2016. The crop was harvested on 2 April 2017.

The grower's planned seasonal N application rate was; 79 kg N/ha, applied as 52 kg N/ha at sowing and 27 kg N/ha at side dressing (44 days after planting). Fertiliser applied at cultivation was incorporated and fertiliser applied at side dressing was broadcast. The site was not irrigated.

Site 2: Timaru process potatoes

Site 2 was located in the Canterbury region near Timaru. The soil was a Templeton silt loam. The site had been under long term pasture for more than five years prior to a process potato crop being planted on 3 November 2016. The crop was harvested on 27 April 2017.

The grower's planned seasonal N application rate was 188 kg N/ha. 36 kg N/ha was applied at cultivation, 48 kg N/ha at sowing, 47 kg N/ha at the first side dressing and 57 kg N/ha at the second side dressing. Fertiliser applied at cultivation and planting was incorporated, fertiliser applied at side dressing was broadcast. The site was irrigated.

Soil samples for nutrient analyses, including basic fertility (pH, Olsen P, exchangeable cations, cation exchange capacity and percentage base saturation), AMN and mineral N, were taken prior to crop establishment, at side dressing and at harvest. In all cases this was before the application of any base, planting and side dressing fertiliser.

Using the Mass Balance Equation to calculate the side dressing amount.

The mass balance equation to calculate the side dressing requirement for N is:

$$\mathbf{N\ Fert_{SD} = [Crop\ N_{Total} - Crop\ N_{SD}] - Soil\ Min\ N_{SD} - Soil\ Org\ N_{mineralised}}$$

N $Fert_{SD}$	Nitrogen fertiliser requirement at side dressing,
Crop N_{Total}	Seasonal whole crop N uptake. The crop N uptake values (total seasonal and uptake at side dressing) were derived using the Potato Calculator tool (Jamieson *et al*. 2005) using 'Umatilla Russet' as the cultivar to approximate the grower's moderately late maturing varieties. Respective seasonal crop N uptakes at Sites 1 and 2 were estimated to be 289 kg N/ha and 227 kg N/ha respectively.
Crop N_{SD}	Whole crop N uptake measured just prior to side dressing.
Soil Min N_{SD}	Soil mineral N at side dressing, measured at a depth of 0–90 cm at Sites 1 and 2. Mineral N was quantified using the Quick N Test strips.
Soil Org $N_{mineralised}$	Amount of mineral N predicted to mineralise from the soil organic N pool over the course of the season. This was estimated using the AMN test.

A number of assumptions have had to be made to develop the N mass balance. These include:

- Plant N uptake is based on the highest yield potential.
- Plant N uptake efficiencies are assumed to be 100%.
- Conversion of applied fertiliser N to plant available N is assumed to be 100%.
- Losses of mineral N in drainage over the growing season were not accounted for.

Results

The mass balance calculations for QTMB treatments based on the results from Quick N Strip mineral N estimates taken just prior to side-dressing were:

Site 1: Side-dressing N was withheld from the QTMB treatment. For the season, 44% less N was applied to the QTMB compared to the grower treatment.

Site 2: Side-dressing N was withheld from the QTMB treatment. For the season, 55% less N was applied to the QTMB compared to the grower treatment.

At crop maturity a 3 m x 2 m bed area (5.5 m^2) was harvested. Population, total tuber number and total tuber fresh weight were recorded. Tubers were separated into either marketable or non-marketable product. At Site 1, the marketable component was defined by the grower as being non-rotten and greater than 30 mm diameter. At Site 2, the marketable component was defined by the grower as greater than 60 mm diameter.

At each site a visual disease assessment was carried out using the 10-point tuber disease scale method (Falloon *et al*. 1995).

A subsample of 20 tubers was taken for DM% and plant tissue N analysis.

Table 1. Nitrogen applied, yields and plant N uptake for potatoes.

Site	Treatment	Nitrogen applied KgN/ha				DM yield (TDM/ha) and P Value	Fresh yield (TFW/ha) and P Value	Plant N uptake kg N/ha and P Value
		Base	Planting	Side dressing	Total			
1	Grower	0	52	27	79	12.3	57	197
	QTMB	0	52	0	52	13.3	58	190
						P = 0.31	P = 0.69	P= 0.71
2	Grower	36	48	104[1]	188	22.3	100	332
	QTMB	36	48	0	84	20.0	89	273
						P = 0.03	P =0.04	(0.05 < P < 0.10)

[1] Split application of 47 kg N/ha and 57 kg N/ha.

Site 1 Manawatu process potatoes

The QTMB approach correctly predicted that yields equivalent to the grower treatment could be achieved without the need for any side-dressing N (Table 1). The tuber dry matter yields were comparable, 12.3 t DM/ha for the grower treatment and 13.3 t DM/ha for the QTMB treatment, despite the QTMB treatment receiving 44% less fertiliser N.

There was no statistical difference in total tuber N uptake between treatments which totalled 197 and 190 kg N/ha for the grower and QTMB treatments respectively. However, N uptake in both treatments was lower than the 289 kg N/ha, predicted by the Potato Calculator and used in the QTMB mass balance calculation. This difference probably reflects the fact that an alternative cultivar was used in the Potato Calculator to estimate tuber yield and crop N uptake.

The fresh yields for both treatments, 56.7 and 58.1 t FW/ha, were lower than the Potato Calculator's predicted yield (65.5 t FW/ha) and potential yield (94.6 t FW/ha) yield.

There was evidence of common scab on most of the harvested tubers, however the incidence was generally below a disease score of 3, (Falloon et al. 1995). There was no statistical difference in disease incidence scores between the treatments.

Site 2 Timaru process potatoes

Tuber DM yields were significantly higher in the grower treatment, 22.3 t DM/ha, compared to the QTMB treatment yield of 20.0 t DM/ha.

At 99.8 and 89.1 t/ha respectively, the fresh yields for both the grower and QTMB treatments, were higher or comparable to the Potato Calculator's predicted maximum potential yield of 90.5 t FW/ha. This shows the QTMB did correctly predict that a maximum yield potential could be achieved without the need for side dressing fertiliser N, however, the crop under the grower's N management exceeded the yield prediction from the Potato Calculator.

N uptake for the grower treatment was 332 kg N/ha and 273 kg N/ha for the QTMB treatment. Overall, these N uptakes were higher than the crop N uptake value of 227 kg N/ha used in the QTMB calculation, probably reflecting the substitution of an alternative cultivar in the Potato Calculator to predict tuber yield and crop N uptake.

At final harvest, tubers showed no visible symptoms of two common soil borne pathogens (*Spongospora subterranea* and *Rhizoctonia solani*). Only low levels of Rhizoctonia stem canker were observed on the underground stem samples at the late canopy growth stage. These levels of disease probably did not affect crop growth and yield.

Conclusions

These results have demonstrated that the Quick Test Mass Balance approach is an effective method for informing in-season N management decisions for potato growers and Quick N Strip testing is an appropriate method for estimating the soil N supply for the mass balance calculation.

Both experimental sites were cultivated out of long-term pasture phases and Mineral N and Quick N strip testing at different stages of the crop's growth confirmed that mineralisation processes after the cultivation of long term pasture provide high levels of soil nitrogen to the crop. This is a dynamic process and soil testing with Quick N strips just prior to side-dressing is an efficient way of the assessing mineral N levels before the side-dressing decision needs to be made.

The Quick Test Mass Balance budget can either confirm a fertiliser decision is correct or indicate that too much or too little is being planned.

At Site 1, the QTMB treatment received 44% less fertiliser N with no yield penalty to the crop.

At Site 2, 55% less N was applied to the QTMB compared to the grower treatment, but the grower treatment yield was higher by 10.7 t/h and out-performed the potential yield predicted by the Potato Calculator by 9.3 t/ha.

It must be recognised that the mass balance budget is drawing on two important variables that are estimated and therefore there is a degree of uncertainty in the calculation. In this case the Potato Calculator was used to estimate the crop's potential yield but this is not the only way. An experienced grower can also closely estimate the crop's potential yield drawing on their knowledge of the soil, climate and paddock history. The accuracy of the soil test result, whether it is for a conventional lab test or a Quick N Strip test, depends on the how well the paddock has been sampled. Despite these uncertainties, four out of the six crops in this project used less N with no yield penalty, one agreed with the farmer's plan and the sixth, at potato site 2, was incorrect, because the crop demand was under-estimated.

The key focuses for the Years 2 and 3 of the project will include:

- Developing the QTMB approach to inform N fertiliser applications at pre-planting as well as side-dressing.
- A literature review on N uptake dynamics for potatoes to confirm crop N requirements.
- Further development and validation of conversion factors for converting quick test nitrate values from a volumetric to a gravimetric basis.
- More intensive disease-monitoring throughout the season.
- A study on partial nitrogen use efficiency; N fertiliser applied/crop yield, as an environmental indicator for the potato industry.

The QTMB approach has also been used successfully for fertiliser management for maize and leafy green crops within this project.

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