FOUNDATION FOR ARABLE RESEARCH

FAR®

Precision agriculture in cropping and Potato research update

8 February 2017

Courtesy of Paul Olsen

Potatoes™ NEW ZEALAND

Growing together

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No smoking permitted on the property.

Potato research update

Jen Linton, FAR and Sarah Sinton, Plant & Food Research

Soil borne disease in-furrow fungicide trial

Soil borne diseases are prevalent in potato crops and are likely to be reducing crop yields. However, due to the wide range of soil-borne diseases occurring in potato crops, it is often hard to identify how much of a role fungicide is playing in suppressing and controlling them. A replicated trial has been set up in a commercial crop at Levels, South Canterbury with the cultivar 'Russet Burbank' (whole seed, planted 1 November 2016). The aim of the trial is to evaluate different fungicides applied either as seed tuber treatments or in-furrow at planting, to evaluate efficacy for control of soil borne diseases. Both treated and untreated seed was used in order to determine the role of seed borne diseases. Standard crop management is being undertaken by the grower for the remainder of the season. Disease assessments are scheduled to be carried out at two crop growth stages (full canopy, 14 weeks after planting, and late canopy, 18 weeks after planting). A final yield and disease assessment (t/ha) of marketable tubers will also be carried out at crop maturity.

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

Treatment	Active Chemical	Application	Rate	Target Disease
Control	-	-	-	-
Monceren	125 g/kg Pencycuron	Seed	2kg/t	Rhizoctonia
Monceren x 2 rate	126 g/kg Pencycuron	Seed	4kg/t	Rhizoctonia
Monceren x 2 rate + Amistar x 2 rate	125 g/kg Pencycuron + 250 g/L Azoxystrobin	Seed + In furrow	4kg/t + 20mls/100m row	Rhizoctonia
Amistar X 2 rate	250 g/L Azoxystrobin	In furrow	20mls/100m row	Rhizoctonia
Nebijin	50 g/L Flusulfamide	In furrow	4mls/100m row	Spongospora
Maxim	100 g/L Fludioxonil	Seed	250mls/t of potatoes	Rhizoctonia
Fluazinam	500 g/L Fluazinam	Pre - incorporated	4L/ha	Spongospora
Formalin	Formaldehyde 40%	Seed	40%	Seedborne
Formalin + Monceren	Formaldehyde 40% + 125 g/kg Pencycuron	Seed	40% + 2kg/t	Seedborne and Rhizoctonia
Formalin + Monceren x 2 rate	Formaldehyde 40% + 126 g/kg Pencycuron	Seed	40% + 4kg/t	Seedborne and Rhizoctonia
Formalin + Monceren x 2 rate + Amistar x 2 rate	Formaldehyde 40% + 125 g/kg Pencycuron + 250 g/L Azoxystrobin	Seed + In furrow	40% + 4kg/t + 20mls/100m row	Seedborne and Rhizoctonia
Formalin + Amistar X 2 rate	Formaldehyde 40% + 250 g/L Azoxystrobin	Seed + In furrow	40% + 20mls/100m row	Seedborne and Rhizoctonia
Formalin + Nebijin	Formaldehyde 40% + 50 g/L Flusulfamide	Seed + In furrow	40% + 4mls/100m row	Seedborne and Spongospora
Formalin + Maxim	Formaldehyde 40% + 100 g/L Fludioxonil	Seed	40% + 250mls/t of potatoes	Seedborne and Rhizoctonia
Formalin + Fluazinam	Formaldehyde 40% + 500 g/L Fluazinam	Seed and Pre-incorporated	40% + 4L/ha	Seedborne and Spongospora

Soil borne disease mid-season results, Rhizoctonia

- At full canopy (16 Jan), there was a high incidence, but only a low to moderate severity, of Rhizoctonia stem canker across the trial area.
- Stem canker symptoms on underground stems mainly showed as lesions around the soil surface area (Figure 1, Figure 2). This indicates that the pathogen may already have been in the soil.
- Some Rhizoctonia infection originated from the mother tuber (Figure 2), but this was relatively sporadic and of low severity. The use of whole seed may have lessened the risk of contaminated seed.
- Rhizoctonia stem canker severity on underground stems was similar for all treatments, although disease pressure was slightly lower than the rest for the Formalin + Monceren x 2 rate + Amistar x 2 rate treatment (Figure 3).
- In the same field, an adjacent potato biofumigation trial had similar background levels of Rhizoctonia already in the soil, but this crop had a much higher incidence and severity of stem canker originating from the mother tuber compared to the fungicide trial (Figure 6). This trial used formalin treated, cut seed, and all in-furrow pesticides were withheld.
- The next underground stem disease measurement will be taken around late canopy, with a final yield and tuber disease assessment taken after crop senescence.

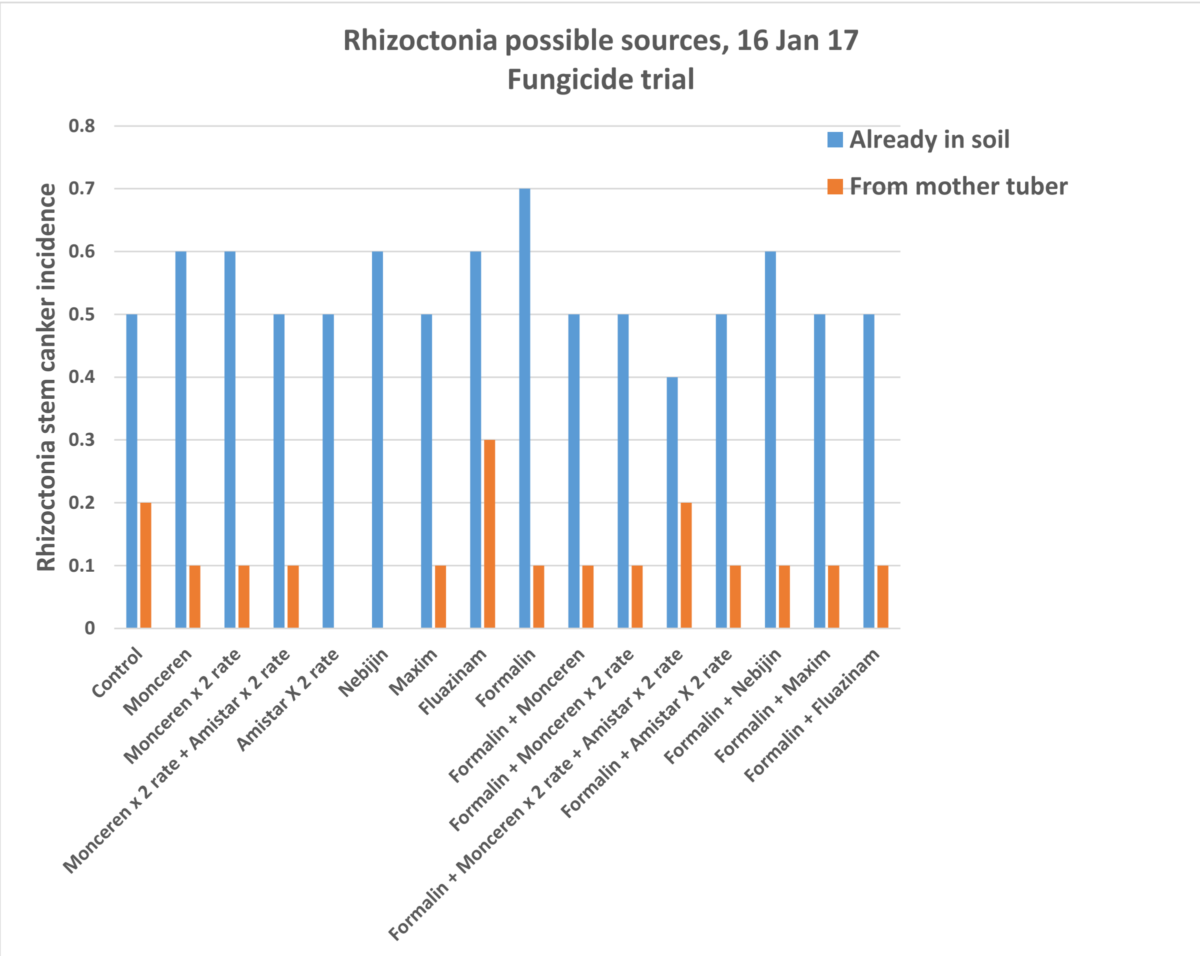

Figure 1. Possible sources of Rhizoctonia infection for a fungicide trial located at Levels, South Canterbury, 16 January 2017. Sample size was 3 plants per plot. 0 = no symptoms seen, 1 = symptoms seen on at least one stem.

Figure 2. Typical Rhizoctonia stem lesions originating from the seed tuber (L) and from the soil (R).

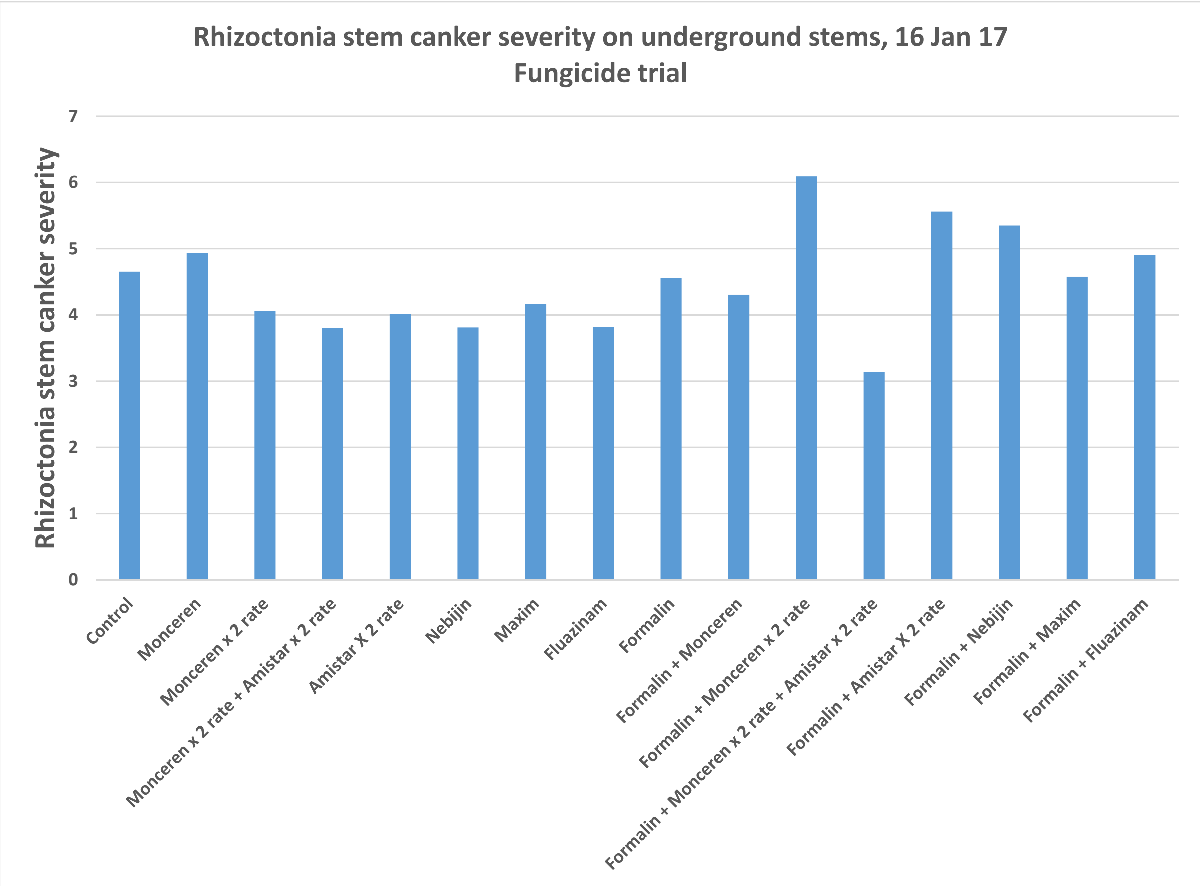

Figure 3. Rhizoctonia stem canker severity on underground stems (3 plants per plot) in a fungicide trial located at Levels, South Canterbury, 16 January 2017. 0 = no infection, 8 = moderate infection, 16 = stem dead.

Soil borne disease mid-season results, Spongospora

- Unlike Rhizoctonia stem canker distribution, Spongospora root galls were mostly found in replicate one, which was nearest the entry area of the field. Previous potato-related activities may have caused this.
- At full canopy, there were no clear indications that the range of targeted pesticide treatments were controlling Spongospora infection differently (Figure 4).
- When present, Spongospora galls were located throughout the root system and did not appear to be necessarily originating from the seed tuber. This contrasts with the Spongospora symptoms observed in the biofumigation trial located in the same field, where there was strong evidence that Spongospora infection had originated from the seed tuber.

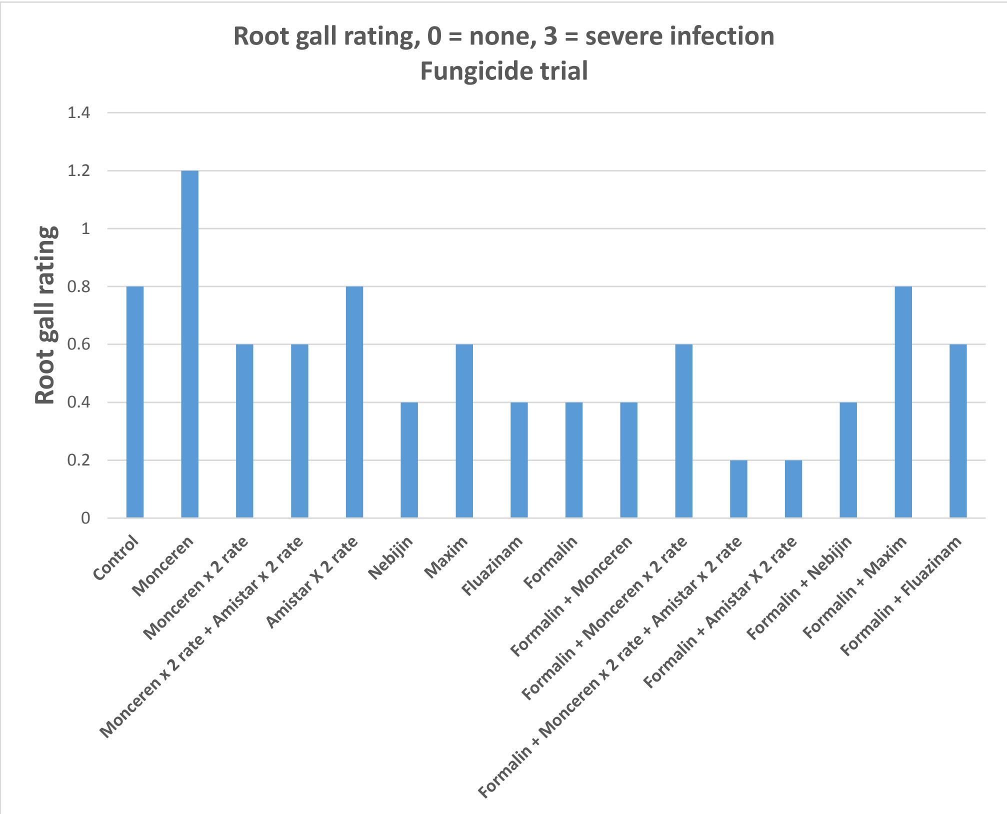

Figure 4. Spongospora root gall severity on root sytems (3 plants per plot) in a fungicide trial located at Levels, South Canterbury, 16 January 2017. 0 = no galls, 3 = >20 galls per 3 plant sample (severe).

Cropping history, soil physical quality and soilborne disease project (Sustainable Farming Fund)

This project has commenced its second year with a trial planted in 15 commercial crops in Canterbury in spring 2016. The focus is to investigate the effect of soil- and seed borne disease and soil physical quality on potato health and productivity. The 15 fields were selected and grouped into four categories based on long term cropping history:

1. Diseased field (potatoes grown in the last 10 years), good soil structure – at least five years in grass in the 10 year history.
2. Diseased field, poor soil structure – at least five years of non-restorative crops in the 10 year history.
3. Clean field (NO potatoes grown in the last 10 years), good soil structure.
4. Clean field, poor soil structure.

Seed tubers from one line each of Russet Burbank and Innovator were either dipped or not dipped in a commercially available formalin solution (one-tonne crate capacity) and planted in a randomised four plot configuration in each field. Collectively, the fields can be seen as replicates which have been blocked for crop history, rather than being a random collection.

Work is still underway in this project (two disease assessments have been completed) and a more complex analysis will be needed before results can be reported.

Biofumigation trial

As part of this same three year SFF project, a multi-season biofumigation trial was set up in autumn 2016 in a South Canterbury field to test the effect of a winter fallow, caliente mustard, radish and oat crops on potato crop health and yield.

Drymatter yield for the three crops was around 3-4 t/ha at incorporation. Crops were worked-in (early September) and the field prepared for planting in October 2016. A formalin-treated, cut Innovator seedline was planted on 19 October. All in-furrow pesticide treatments were withheld in order to test the potential fumigant action of the various winter treatments.

- By 16 January 2017 (full canopy), Rhizoctonia disease incidence and severity on underground potato stems was high and similar for all winter crop treatments (Figure 5).
- The incidence of symptoms indicating infection from the soil (soil surface stem lesions) was at a similar level to the fungicide trial located in the same field (Figure 6, Figure 1).
- However, additional Rhizoctonia infection appeared to be originating from the seed tubers, worsening the levels of infection on most of the observed stems (Figure 6).
- Seed-sourced infection was probably also causing the direct loss of developing tubers through constriction and eventual severing or nipping of stolons (Figure 7).

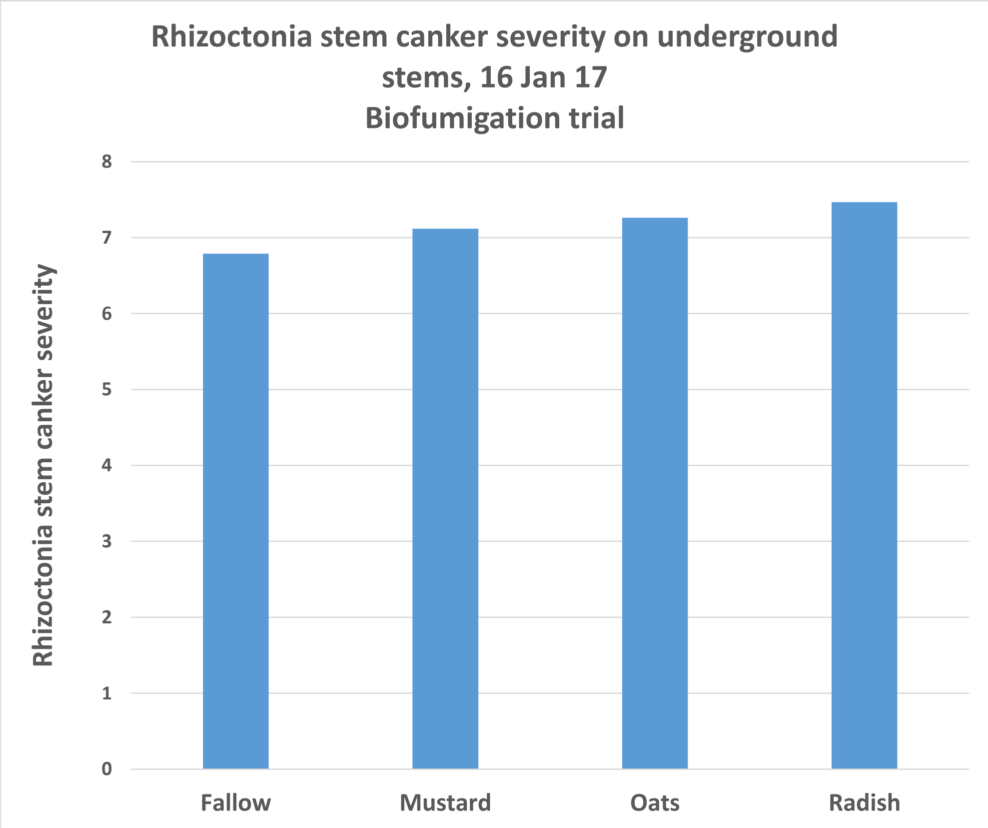

Figure 5. Rhizoctonia stem canker severity on underground stems (8 plants per plot) in a biofumigation trial located at Levels, South Canterbury, 16 January 2017. 0 = no infection, 16 = stem dead.

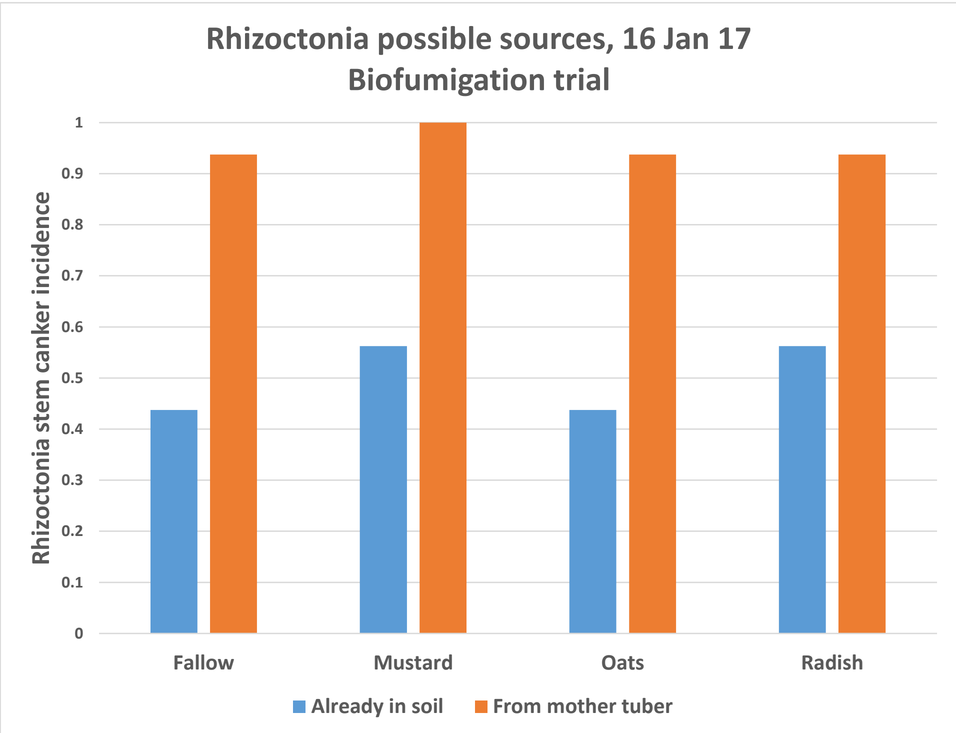

Figure 6. Possible sources of Rhizoctonia infection for a biofumigation trial located at Levels, South Canterbury, 16 January 2017. Sample size was 8 plants per plot. 0 = no symptoms seen, 1 = symptoms seen on at least one stem.

Figure 7. Stolon nipping on a stem at very early tuber growth (L), a healthy stolon (R)

- Spongospora root galls were more evenly distributed throughout the biofumigation trial plots, compared with the nearby fungicide trial (data not shown).
- All winter treatments had similar numbers of galls present on the root systems (Figure 8).
- Laboratory observations showed that many of the galls were radiating out from around the seed tuber.

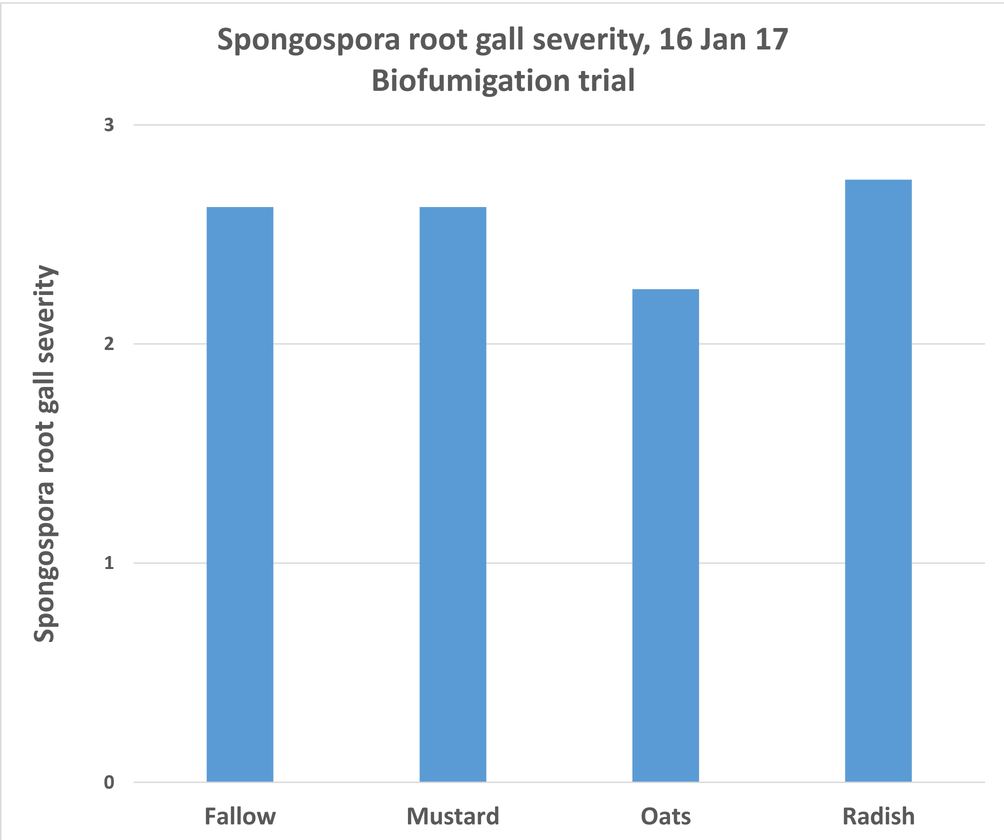

Figure 8. Spongospora root gall severity on root systems in a biofumigation trial located at Levels, South Canterbury, 16 January 2017. 0 = no galls, 3 = >20 galls per 8 plant sample (severe).

End of season TPP management

Consultation with growers and industry has indicated that while most believe spray programmes during the season are keeping tomato potato psyllid (TPP) under control, there are concerns about end of season management of TPP, as this seems to be when population flare-ups are occurring. Desiccation and regrowth were also identified as a late season management problem.

Flowing out of these discussions, research this season will focus on developing and testing a soft insecticide programme along with different ways to destruct the potato haulms (tops and regrowth) whilst controlling TPP. Six commercial fields in Canterbury have been chosen and will all receive the same soft insecticide programme (no OPs or neonicotinoids) before being divided into four desiccation treatments. Desiccation treatments are as follows:

1. Standard desiccation: Reglone plus Methafos twice at 7 day intervals
2. Flail followed by Reglone plus Methafos at 7 day intervals
3. Flail then Reglone plus Methafos, 3 days later an oil, 3 days later Reglone plus Methafos
4. Flail followed by Reglone followed by oil followed by Reglone (over a 7 day period)

Tuber assessments are being taken throughout the season and will be kept for one month before processed to fully assess the impact of zebra chip. Harvest will be done commercially, with yield assessed by the grower and processer, and samples taken at the factory for zebra chip as per factory protocol.

No results to date.

October 2016

Potato Update

Issue 8

Potatoes NEW ZEALAND
Growing together

Evaluation of seed tuber and in-furrow fungicides on the control of soil-borne diseases in potatoes

Introduction and methods

Soil-borne diseases are prevalent in potato crops and are often likely to reduce crop yields. However, due to the wide range of soil-borne diseases occurring in potato crops, it is often hard to identify how much of a role fungicide plays in suppressing and controlling them. In order to investigate this, a replicated trial was set up in a commercial potato crop at Levels, South Canterbury with the cultivar Innovator (planted 12 October 2015). The trial site was last in potatoes four years previously, so disease pressure was likely to be high.

The aim of the trial was to evaluate different fungicides and application methods in order to evaluate their efficacy for control of soil borne diseases (Table 1). The chemical treatments were applied either directly to the seed tubers or as in-furrow sprays at planting, prior to closing the furrows. Standard crop management was undertaken by the grower for the remainder of the season. Disease assessments were carried out at two crop growth stages, full canopy, 14 weeks after planting, and late canopy, 18 weeks after planting. A final yield assessment based on marketable tubers (t/ha of tubers >65 mm) was carried out at crop maturity.

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 2015/16 season.

Treatment	Active ingredient	Application method	Target diseases*
Nil (control)	-	-	-
Monceren®	pencycuron	seed tuber	*stem canker, black scurf
Monceren® + Amistar®	pencycuron + azoxystrobin	seed tuber + in-furrow	*stem canker, black scurf, silver scurf
Amistar®	azoxystrobin	in-furrow	*black scurf, silver scurf
Amistar® × 2 rate	azoxystrobin	in-furrow	*black scurf, silver scurf
F15/02	penflufen	in-furrow	(Experimental black scurf
F15/02 + F15/03	penflufen + *Bacillus subtilis*	in-furrow	(Experimental) black scurf, soilborne diseases
Nebijin®	flusulfamide	in-furrow	*powdery scab

* Indicates registered use.
Nebijin® is a product registered for control of powdery scab.

Key points

- A replicated trial was set up in a commercial crop at Levels, South Canterbury with potato cultivar Innovator, planted on 12 October 2015. The trial site was four years out of potatoes.
- A number of diseases were found in the sampled plants and tubers including *Spongospora* root galling and tuber powdery scab; *Rhizoctonia* stem canker and tuber black scurf; *Sclerotinia* white mould on stems, black leg on stems, and common scab on tubers.
- *Rhizoctonia* stem canker and *Spongospora* diseases predominated, while the other diseases were at very low incidence levels.
- Nebijin® reduced the severity of powdery scab on tubers at both assessment timings and this reduction was statistically significant when compared to the nil treatment. None of the other treatments affected any of the diseases observed in the trial.
- There were no statistically significant differences between the treatments for unmarketable or marketable yields. Overall mean yield of marketable tubers was equivalent to 82.8 t/ha.

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Results

The diseases found in the sampled plants and tubers included *Spongospora* root galling and tuber powdery scab; *Rhizoctonia* stem canker and tuber black scurf; *Sclerotinia* white mould on stems, black leg on stems, and common scab on tubers. *Rhizoctonia* stem canker and *Spongospora* diseases predominated, while the other diseases were at very low incidence levels.

Less *Rhizoctonia* stem canker was recorded for the first (full canopy) assessment than for the late canopy assessment as disease severity increased during the trial. However, this disease was very common and severe on the assessed plants, and severity of stem canker was similar for all of the different treatments, including the nil experimental control. Severity of powdery scab was strongly affected by assessment date, with an overall mean severity score for the first (full canopy) assessment of 1.2 (equivalent to 6% of tuber surface affected), and 1.8 (9% tuber surface affected) for the second (late canopy) assessment. Nebijin® reduced the severity of powdery scab at both assessment timings and this reduction was significant when compared to the nil treatment (Table 2).

There were no statistically significant differences between the treatments for unmarketable or marketable yields (Table 3). Yields of harvested marketable tubers were high, with an overall mean equivalent to 82.8 t/ha.

Discussion

Potatoes had been grown in the field four years previously, and a commercial "Predicta Pt" test on soil from the area used for this trial indicated that the trial site had "medium to high" risk of soil borne diseases. Of the different fungicide treatments applied in the trial, only the Nebijin® in-furrow treatment affected incidence and severity of disease. Effects of Nebijin® were detected at both the full canopy and late canopy disease assessments. Nebijin® did not reduce severity of *Spongospora* root galling, but did reduce incidence and severity of powdery scab on the harvested tubers. None of the other treatments affected any of the diseases observed in the trial, including *Rhizoctonia* stem canker which was of high incidence. Although *Rhizoctonia* stem canker and *Spongospora* root galling were common, the yield assessments indicated that these diseases were not at levels sufficient to reduce tuber yields. Furthermore, although powdery scab was reduced by one of the treatments, this reduction was not manifested in a yield response.

These results are very similar to the results from two trials carried out in the 2014/15 season where a range of fungicide seed and soil treatments did not reduce disease incidence or increase yields. The results from the 2015/16 season indicate that in some situations pre-planting fungicide treatments have limited efficacy for management of soil-borne diseases, and did not increase tuber yields. Further work is needed to identify when and which fungicide seed and soil treatments will reduce disease and increase yields.

Table 2. Mean powdery scab severity scores for potato tubers, grown from different fungicide treatments applied at planting, assessed at full and late canopy at Levels, South Canterbury in the 2015/16 season.

Treatment	Mean powdery scab severity score*	
	Full canopy	Late canopy
Nil (control)	1.1	1.9
Monceren®	1.2	1.9
Monceren® + Amistar®	1.1	1.8
Amistar®	1.3	1.7
Amistar® × 2 rate	1.2	1.8
F15/02	1.1	1.6
F15/02 + F15/03	1.2	1.9
Nebijin®	1.0	1.4
LSR (α = 0.05), df = 75	**0.25**	

* Mean score: 1.0 = 2% tuber surface affected, 1.9 = 5% tuber surface affected.

Table 3. Treatment effect on potato tuber total yield and marketable yield (t/ha) at Levels, South Canterbury in the 2015/16 season.

Treatment	Unmarketable yield (t/ha)	Marketable yield (t/ha)
Nil (control)	2.2	84.0
Monceren®	2.9	80.7
Monceren® + Amistar®	2.6	81.5
Amistar®	2.2	82.5
Amistar® × 2 rate	2.3	83.9
F15/02	2.7	85.1
F15/02 + F15/03	2.6	82.4
Nebijin®	1.9	82.4
Mean	**2.4**	**82.8**
LSD (P < 0.05), df = 35	**1.1**	**7.1**

Acknowledgments

Plant & Food Research for expertise with disease assessments and Morgan Bowles for providing the trial site and assistance with planting the trial.

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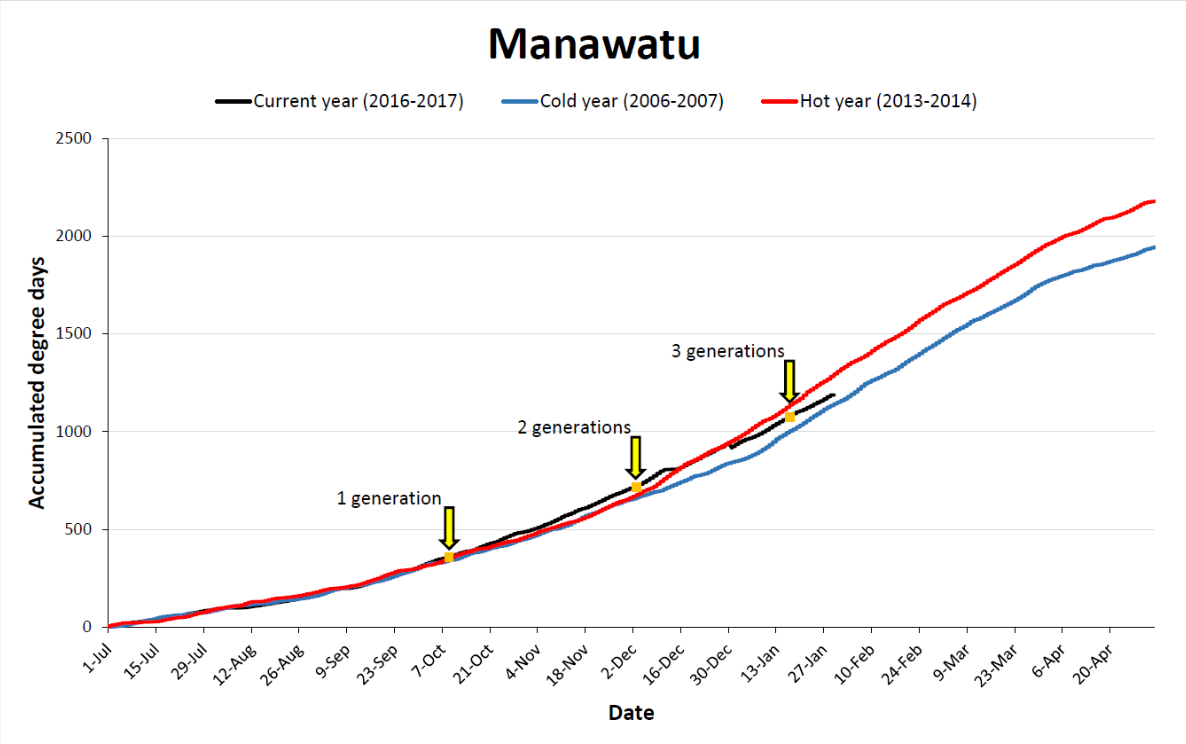
TPP and degree days to 31 January 2017 (from FAR website)



Precision Agriculture for potatoes

Allister Holmes, FAR

Key Points

- In paddock variation in yield and tuber size occur in potato crops.
- Yield and tuber size variation can lead to large differences in profitability within the paddock.
- Data from yield monitors fitted to potato harvesters can help identify areas where specific management practices will improve profitability.

Precision agriculture has had good uptake in cropping in New Zealand, providing tools that can help manage production issues as well as environmental concerns regarding inefficient use of crop inputs. Some of the most easily gained benefits include auto-steer, which leads to work efficiency and fuel saving, and section control of planters and sprayers, which results in more efficient application of inputs, and associated savings.

Yield monitors are common on combine and forage harvesters, and the use of the data obtained from these is a good beginning point to create zone maps to identify spatial areas of high and low yield, and temporal variation over different seasons

FAR was successful in 2015 in being awarded a Sustainable Farming Fund project named "Transforming Variability to Profitability". This project aims to develop a simple way to integrate geospatial soil, plant and crop harvest characteristics so profitability can be analysed, and aid in decision making processes to improve profitability in future years. This will reduce the amount of wasted inputs entering the environment, as well as maximising profit.

Yield Monitors

As part of this work we fitted yield monitors to two potato harvesters, one each in the North and South Islands. From these we have found there are large spatial variations in the yield of potatoes across paddocks, as can be seen in figure below:

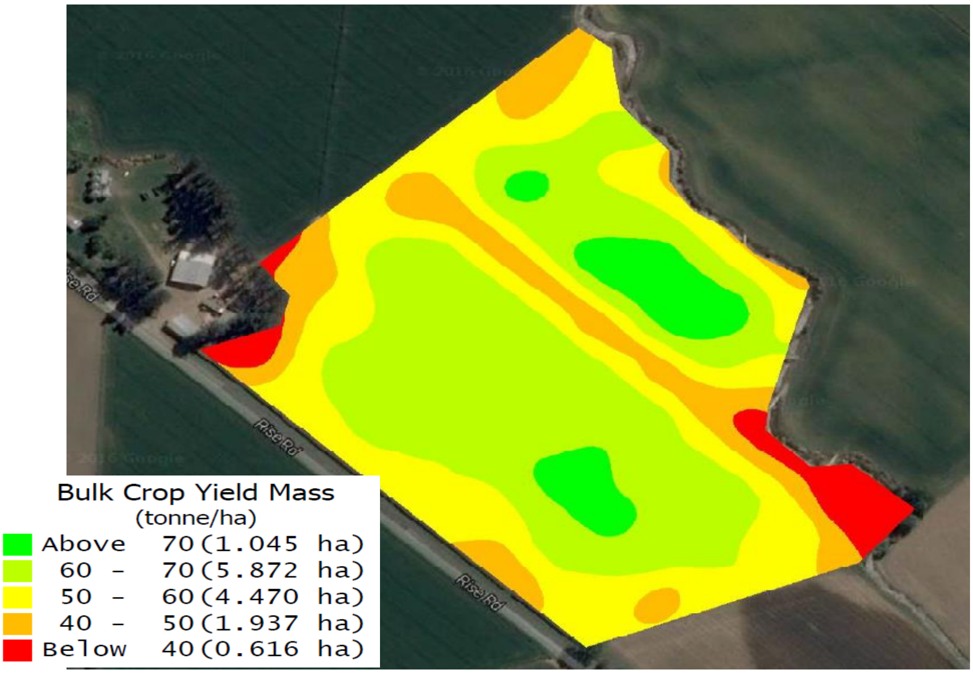


Figure 1 Spatial yield variation in potato harvest

While yield is critical, so is the profitability of the crop. Using this harvest data we can generate spatial profit and loss maps, using fixed values for income and expenses per hectare, as shown in Figure 2 below:

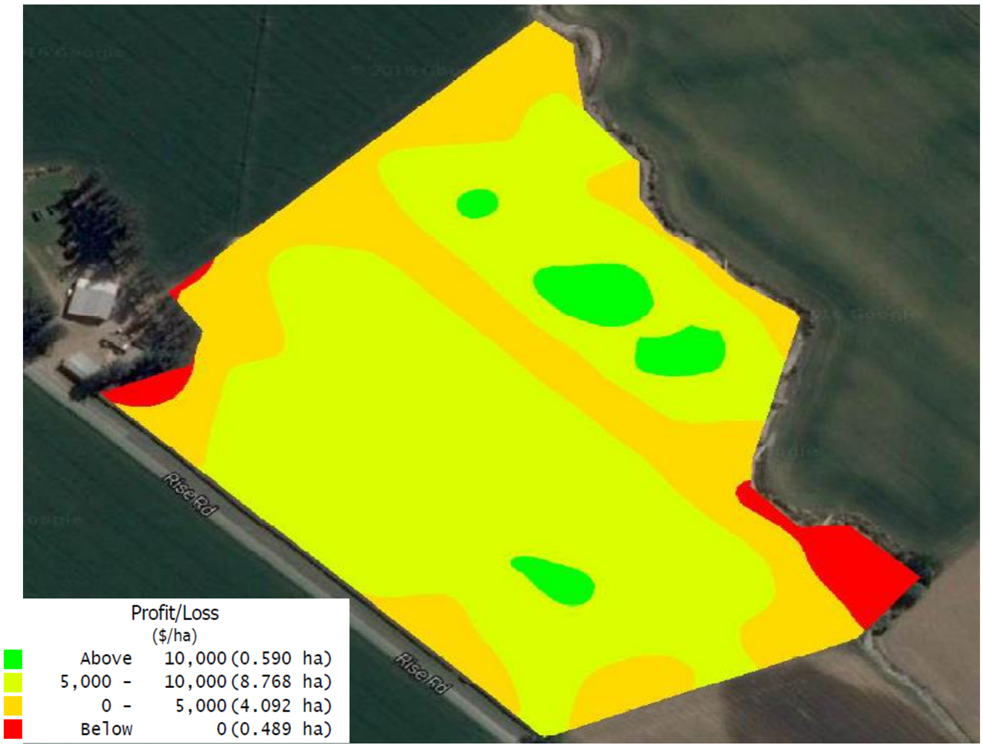


Figure 2 Spatial Profit/loss map for potato crop

For the majority of arable crops yield is the only real driver of income, as providing the crop meets a minimum quality standard, the income per tonne of product is fixed. However, with potatoes the size of the tuber greatly affects the value of the harvested crop. We have undertaken hand harvests from areas across potato blocks and measured all the tubers from the hand harvested zone to identify variations in tuber size.

Results from one of these hand harvests is shown in Figure 3 below showing the variation in tuber size. Each point was approximately 50 metres apart down a single row of potatoes.

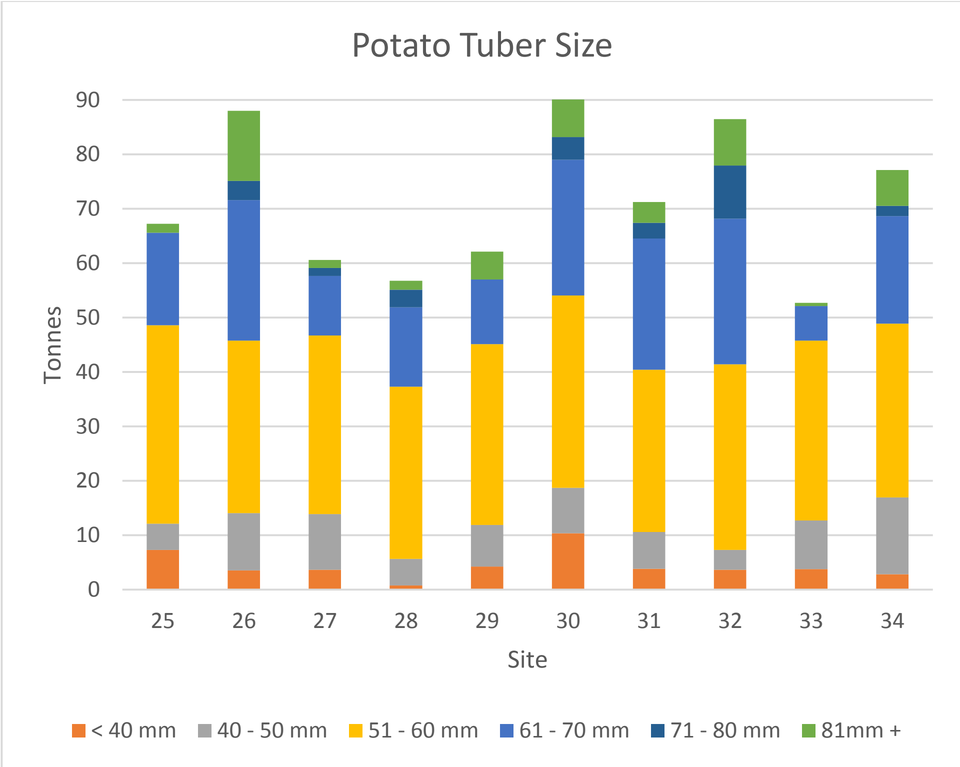


Figure 3 Potato tuber size variation at different locations in potato paddock

In Figure 3 above the height of the total column gives the total yield per hectare of potato tubers at each location, while the different colour components of the column give the tonnes per hectare of the individual size range. Large variations can be seen within the different bands.

Depending on the market for the potatoes, there is also likely to be a different income per tonne for different tuber sizes, which will multiply the effect of the yield and tuber size variation.

So what?

Now that we have identified these variations, we need to try and understand what is driving the variation, and what we can do to alter the performance of the crop. There are two types of variability:

1. Management Induced Variation, which includes variability caused by management factors such as previous crop history, uneven application of fertiliser or lime, and different cultivation techniques i.e. ripping compacted areas.
2. Inherent Variation, which includes site variations caused by different soil textures, depths, paddock aspect etc. These can be managed by variable rate irrigation adjusted to different soil textures etc.

This SFF project is to be completed by June 2018, and we will provide a final report on our findings then.

Acknowledgements

MPI SFF, Potatoes NZ, AS Wilcox & Sons Ltd, Tayler & Sons Ltd

Managing yield variability – Example of profitability using variable rate seeding in maize

Allister Holmes, FAR

Key points

- Eight years of harvester yield data from one field was studied in order to understand the impacts of maize yield variability on profitability.
- Maize grain yields varied from 6-20 t/ha and profitability from nil to $1500+/ha.
- Management zones within the paddock can be used to manage this variability.
- Variable rate seeding could increase paddock gross margin by $212/ha vs constant seed rate.

Introduction

Crop yields often vary considerably between areas within a paddock. Managing this variability through the analysis of yield monitor data can improve profitability. Many combine and forage harvesters have yield monitors installed that record GPS location, yield and other data every second they are in the paddock. Work was undertaken on a typically variable long-term maize paddock in the Waikato using eight years of harvester yield data.

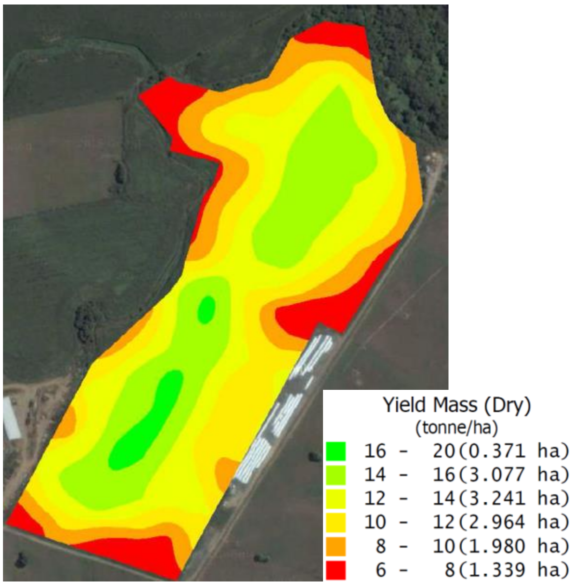


Figure 2 Maize grain yield over a paddock in 2016 (t/ha @ 14% DM).

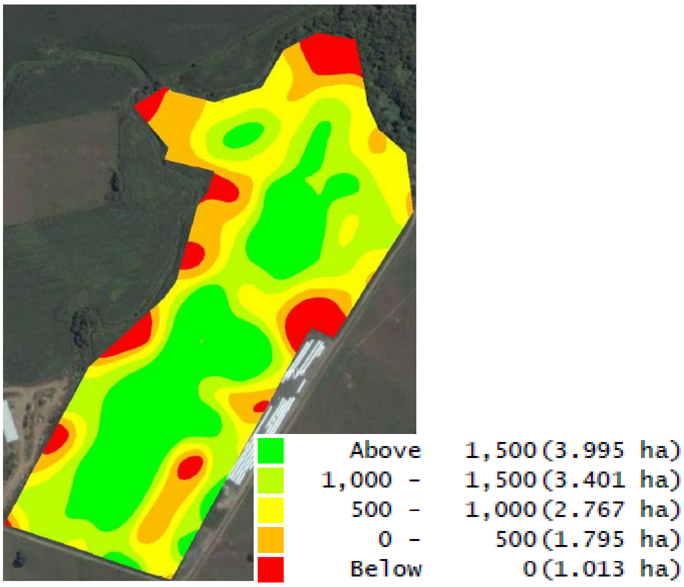


Figure 1 Gross Margin generated from the paddock in Figure 1 ($/ha).

Grain yields in the paddock averaged 10.8 t/ha of grain Figure 1), with some areas yielding less than 8 t/ha, and others yielding more than 16 t/ha. Using standard practices, all of these areas receive the same seed populations and rates of starter fertiliser at planting, and side-dressed nitrogen. Therefore, the Gross Margin generated from each part of the paddock varied widely (Figure 2).

For the trial paddock shown in Figures 1 & 2, combine harvester yield data files were obtained for eight years and analysed for spatial trends across the paddock, and temporal (time) variability over the different years.

From this data, three management classes were established. These were unstable, stable low yield and stable high yield (Table 1 and Figure 3). Stable zones had less than 30% coefficient of variance over the eight years, while those where the coefficient was greater than 30% were considered unstable. Areas with a normalised yield higher than 100% were defined as high yielding and those with less than 100% of normalised yield were low yielding. Normalized yield is the ratio of the actual yield at a point in the paddock to the field average i.e. if paddock average is 10 t/ha, and an area yields 12 t/ha, it is 120% of normalised yield.

Table 1 Average normalised yield and CVs in three management zones

	Unstable	Stable low yield	Stable high yield
Normalised yield (%)	84.8	90.2	114.3
CV (%)	38.1	24.2	19.5
Area (Ha)	0.9	2.9	8.2

From this definition of management zones we can identify the zones shown in Figure 3.

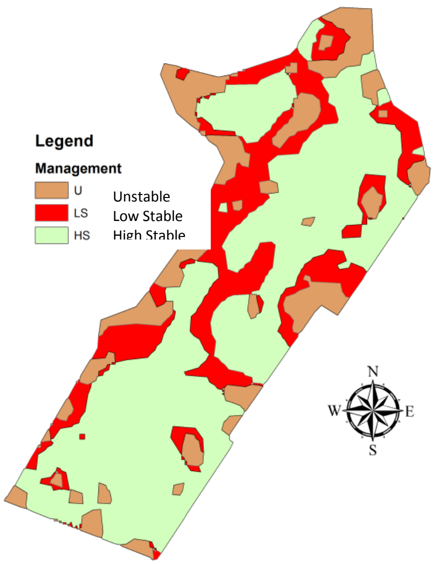


Figure 3 Zone management map

For the 2015/16 maize season, a seed rate trial was established in part of the paddock, to investigate the effect of different populations in the different management zones of the paddock. Four replicated strips of 75, 90, 105 and 120 thousand seeds per hectare were planted across the three zones established in the paddock. Plant counts showed populations were close to the planted rates.

Maize harvest results

The maize grain crop was harvested using a combine harvester with yield monitor and GPS. Data was recorded and analysed for the different management zones and seed planting. Using the management zone map, we were able to calculate what the yield and gross margin would have been for the different management zones, if we had planted using Variable Rate Seeding. Gross margin results are given in Table 3.

Table 3 Gross margin generated from different zones and seed rates ($/ha)

Yield Zone	Planting rate ('000's / hectare)				
	75	**90**	**105**	**120**	**Average**
Unstable	n/a	$591*	n/a	$72	**$332**
Low Stable	$803*	$598	$619	$447	**$617**
High Stable	$936	$968	$1,013*	$554	**$868**
Average	**$870**	**$719**	**$816**	**$358**	

* Highlighted figures are the highest value for that management zone.

Conclusion

If the entire paddock was planted at 90,000 seeds per hectare, the total paddock GM would be $8,628.

If planted using Variable Rate Seeding, the paddock GM would be $11,167, an increase of $212 per hectare over the constant seed rate.

Where to from here?

FAR is happy to work with growers who have five or more years of harvest data from a grain combine or forage harvester for a specific paddock, to help identify management zones on their properties. From those you can either:

- Establish a population trial, with the ultimate aim being to identify the most profitable seed rate for different management zones
- Set different seeding rates for the different management zones

This season we have established a VRS trial at NCRS to confirm the benefit form VRS, as shown in Figure 3 below.

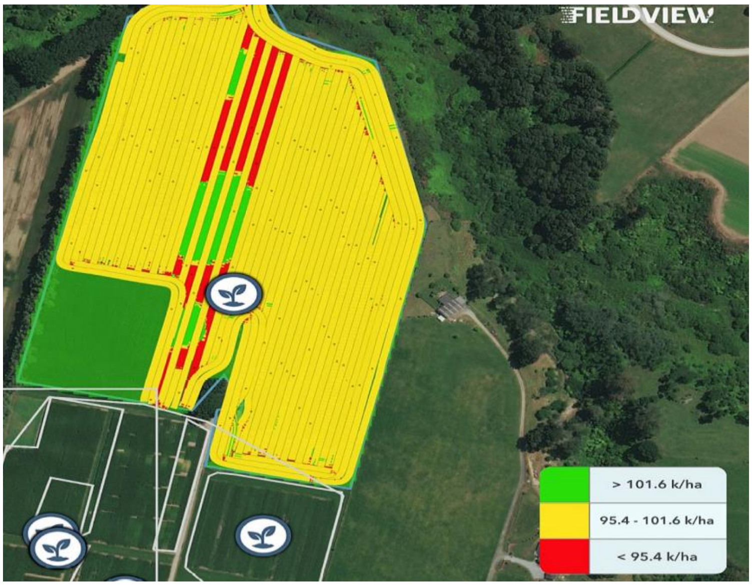


Figure 3 Variable Rate Seed trial planted October 2016

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