CROPS Annual Expo 2018

Wednesday 5 December 2018

9.00am-5.00pm followed by a barbeque dinner, FAR Arable Site, SH1, 2km north of Chertsey

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CROPS Annual Expo 2018

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Welcome to CROPS 2018, FAR's key South Island field event

Please take this opportunity to view the FAR and industry trials, and hear up-to-date research findings from New Zealand and overseas experts. The programme is broad, touching on seed, cereal and potato productivity, biosecurity and environmental issues around water and nutrients.

International perspective will come from Australian academic and consultant Dr Peter Boutsalis, who provides herbicide resistance support and extension to Australian growers, agronomists and the chemical industry. He will discuss what lessons New Zealand cereal growers can learn from the way herbicide resistance has developed, and been managed, in Australia.

What's on?

The programme and map over the page outline the titles, times and locations of all of today's presentations. Each speaker will give their presentation twice - once in the morning, and again in the afternoon. Talks are 20 to 30 minutes long which means there is plenty of time for questions and discussion.

Sponsor's presentations

Our Platinum sponsors are also giving talks and demonstrations throughout the day. Our gold sponsors also have a wealth of information and material on display. Please support all our sponsors, by visiting their sites, talks and demonstrations.

Dinner

A complimentary dinner will be held in the large marquee after the outdoor presentations finish at 5.00pm. Please stay and chat with friends, neighbours and research staff.

Questions?

Should you require any assistance throughout the day, please don't hesitate to contact a member of the FAR team who will be more than happy to help.

Speakers and talks:

1. **Ramularia in barley – trials and tribulations**
   Rob Craigie, FAR and Soonie Chng, Plant & Food Research

2. **High yielding cereals in Tasmania - learnings for New Zealand**
   Nick Poole, FAR Australia

3. **Environmental benefits of arable feeds**
   Pablo Gregorini, Lincoln University and Ivan Lawrie, FAR

4. **Catch crop mixes and establishment - learnings from FRNL**
   Shane Maley, Plant & Food Research

5. **Aerial imagery for profitable crop management**
   Dr Ben Jones, ProductionWise/FluroSat

6. **The evolution of wheat – genetics and agronomy for improved productivity**
   Jo Drummond, FAR and Bill Griffin, Wheat breeder

7. **Optimising cocksfoot seed yield with PGRs and herbicide**
   Phil Rolston, Richard Chynoweth, and Matilda Gunnarsson FAR and SIRC

8. **Farming with herbicide resistance – how do you manage it?**
   Dr Peter Boutsalis, Adelaide University & Plant Science Consulting

9. **Weed control and desiccation in white clover**
   Richard Chynoweth, FAR and SIRC

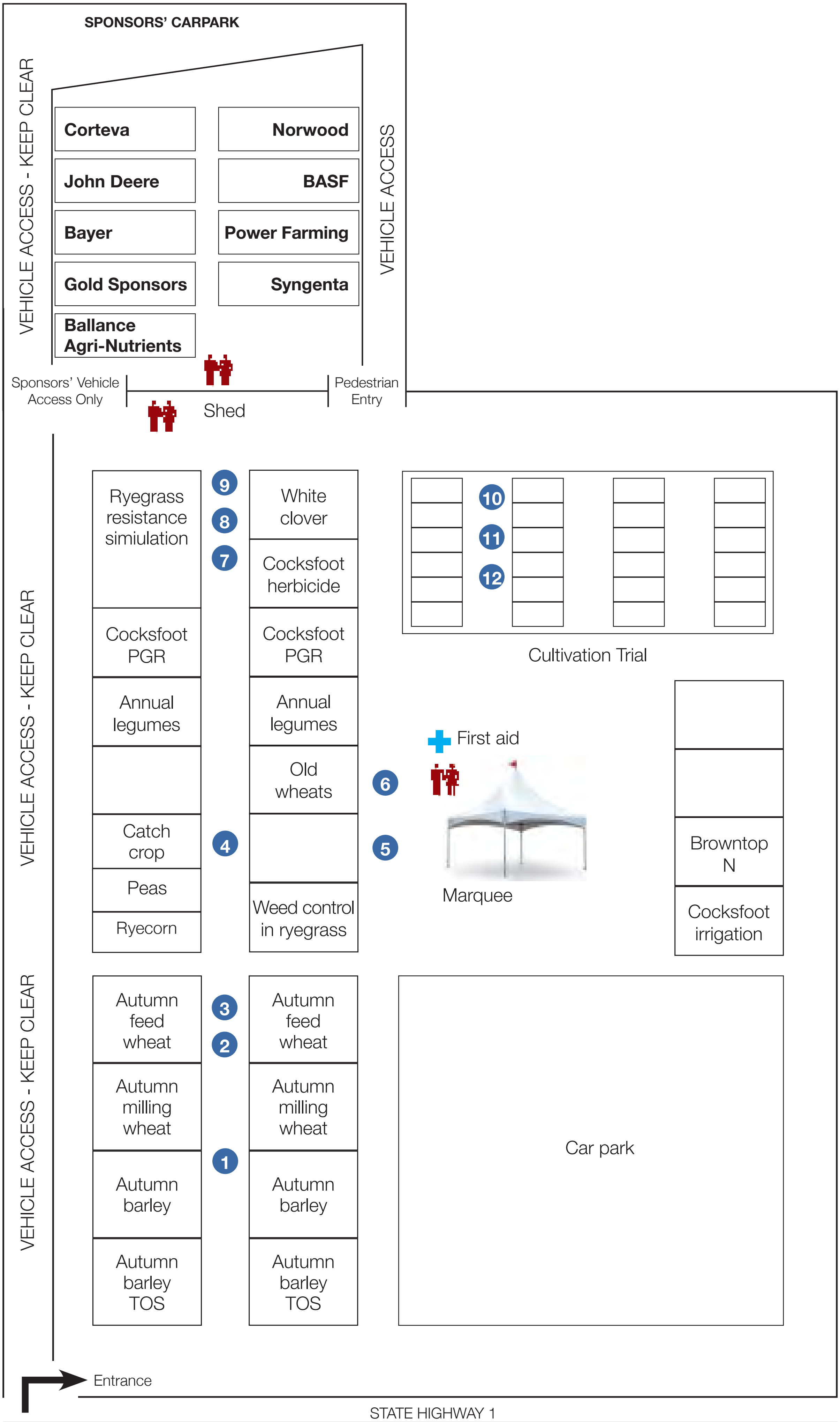
10. **Integrated pest management for clover and brassica crops**
    Abie Horrocks, FAR and Scott Hardwick, AgResearch

11. **Emissions trading and greenhouse gases – what do they mean for cropping?**
    Tim Brooker, FAR

12. **Soil health in cropping systems**
    Abie Horrocks, FAR

We are confident that you will leave the event with valuable information to will assist you in making farm management decisions and improving the economic and environmental performance of your crop production systems. Enjoy your day!

Crops 2018 site plan



Topics

1	Ramularia in barley - trials and tribulations. *Rob Craigie, FAR; and Soonie Chng, Plant & Food Research.*
2	High yielding cereals in Tasmania - learnings for New Zealand. *Nick Poole, FAR Australia.*
3	Environmental benefits of arable feeds. *Pablo Gregorini, Lincoln University.*
4	Catch crop mixes and establishment - learnings from FRNL. *Shane Maley, Plant & Food Research.*
5	Aerial imagery for profitable crop management. *FAR and ProductionWise staff.*
6	The evolution of wheat - genetics and agronomy for improved productivity. *Jo Drummond, FAR; and Bill Griffin.*
7	Optimising cocksfoot seed yield with PGRs and herbicide. *Richard Chynoweth, Matilda Gunnarsson and Phil Rolston, FAR.*
8	Farming with herbicide resistance - how do you manage it? *Dr Peter Boutsalis, Adelaide University.*
9	Weed control and desccation in white clover. *Richard Chynoweth, FAR.*
10	IPM for clover and brassicas. *Abie Horrocks, FAR; and Scott Hardwick, AgResearch.*
11	Emissions trading and greenhouse gases - what do they mean for cropping? *Tim Brooker, FAR.*
12	Soil health in cropping systems. *Abie Horrocks, FAR.*

Morning

	9.30am	10.00am	10.30am	10.50am	11.05am	11.35am	12.05pm	12.35pm
1	1		Sponsors	Sponsors				
2		2						
3			Ballance Agri-Nutrients	Bayer New Zealand	Break	3		Lunch
4	4							
5						5		
6							6	
7						7		
8							8	
9		9						
10	10							
11							11	
12		12						

Afternoon

	1.30pm	2.00pm	2.30pm	2.50pm	3.10pm	3.30pm	4.00pm	4.30pm	5.00pm
1	1		Sponsors	Sponsors	Sponsors				
2		2							
3			Corteva Agriscience	BASF	Syngenta	Break	3		Dinner
4	4								
5							5		
6								6	
7							7		
8								8	
9		9							
10	10								
11								11	
12		12							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Ramularia in barley – trials and tribulations

Soonie Chng, Plant & Food Research; Rob Craigie, FAR

Key points

- Ramularia is one of the key diseases impacting barley production, reducing grain yield by up to 30%.
- Ramularia is resistant to the strobilurins and has recently become less sensitive to the SDHI fungicides.
- The new multi-site fungicide Phoenix® has shown good control of Ramularia when used in a mix with Proline.
- Barley cultivar resistance ratings are inconsistent.
- Seed-borne inoculum and air-borne spores can contribute to the disease.
- Ongoing research monitors Ramularia sensitivity to fungicides, identifies effective fungicide programmes and investigates the importance of seed-borne and airborne inoculum and cultivar resistance.

Ramularia leaf spot (Ramularia) is caused by the fungus *Ramularia collo-cygni*. The fungus grows from infected seed and moves systemically as the plant grows. Airborne spores from barley volunteers, grasses and crop debris can also infect plants. Infected crops do not display visible symptoms initially. Senescing leaves may show signs of infection early in the season, but the main damage occurs on the top leaves after flowering, when rows of white spores can be seen with a hand lens on the undersides of affected leaves. Crop stresses, including waterlogging and prolonged rainfall after flowering, are thought to be some of the triggers for the development of disease symptoms. Even stress associated with flowering may be sufficient to initiate symptoms.

Early symptoms comprise of small brown pepper spots on the upper leaves. These spots develop quickly into typical Ramularia lesions (Figure 1). Mature Ramularia lesions can be distinguished from other foliar symptoms by applying the '5Rs'; ringed with yellow margin of chlorosis, rectangular shape, restricted by the leaf veins, reddish-brown colouration and right through the leaf.

Figure 1: Mature Ramularia leaf spots.

Arable growers have experienced difficulty in controlling Ramularia in recent years and are concerned with the significant yield losses caused by the disease. The pathogen is resistant to the

strobilurins and has recently become less sensitive to the SDHI fungicides. Although the trizaole fungicides are still effective in controlling Ramularia, they remain at risk of becoming ineffectual given that resistance to this fungicide mode of action by *R. collo-cygni* has already occured in other countries, such as Scotland and Germany. Attempts to develop reliable cultivar resistance ratings has also proven to be rather difficult. Many factors including varying crop maturity (early maturing vs. late maturing), amounts of seedborne and airborne inoculum, presence of other diseases and varying seasonal susceptibility, have all contributed to the inconsistent ratings. Recent analyses of *R. collo-cygni* DNA on pre-sown and harvested grains from the same plants have shown that despite the absence of *R. collo-cygni* DNA in the pre-sown seed, the pathogen's DNA was detected in all the offspring (harvested grains) when the disease was present in the field. This suggests that airborne inoculum may contribute substantially towards the infection of the offspring (harvested grains) in the field. When a similar seed line with known amounts of seedborne *R. collo-cygni* DNA was sown at two different sites, Ramularia only developed on the plants at one of the sites, indicating that site/weather variation may be an important factor for disease development.

Autumn sown barley – Fungicide programmes 2018-19

Objective: To investigate effective disease management programmes for the control of *Ramularia collo-cygni*.

Cultivar: Laureate; **Sowing date:** 10 May 2018; **Treatment list:** (L/ha)

Trt	GS 25-30	GS31	GS32	GS39	GS49	GS55	GS59
1	nil	nil	nil	nil			nil
2	-	Proline 0.4	-		Proline 0.4		
3	-	S.F. 0.6			S.F. 0.6		
4		Proline 0.4 + S.F. 0.6			Proline 0.4 + S.F. 0.6		
5		Proline 0.4 + Phoenix 1.5			Proline 0.4 + Phoenix 1.5		
6		F18-01 1.5			F18-01 1.5		
7		F17-01 1.5			F17-01 1.5		
8		Proline 0.4 + Phoenix 1.5			Proline 0.4 + SF 0.3 + Phoenix 1.5		
9		Proline 0.4 + Phoenix 1.5			Proline 0.4 + SF 0.6 + Phoenix 1.5		
11		Proline 0.4 + Acanto 0.25 + Phoenix 1.5			Proline 0.4 + SF 0.6 + Phoenix 1.5		
12		Proline 0.4 + Acanto 0.25 + Phoenix 1.5			Proline 0.4 + SF 0.6 + Phoenix 1.5		Proline 0.2 + S.F. 0.3
13	Proline 0.2 + Protek 0.5		Proline 0.4 + Acanto 0.25 + Phoenix 1.5		Proline 0.4 + SF 0.6 + Phoenix 1.5		
14	Proline 0.2 + Protek 0.5		Proline 0.4 + Acanto 0.25 + Phoenix 1.5		Proline 0.4 + SF 0.6 + Phoenix 1.5		Proline 0.2 + S.F. 0.3
15		Proline 0.4 +	-	Proline 0.4 +			

		Phoenix 1.5		Phoenix 1.5			
16		Proline 0.4 + Acanto 0.25 + Phoenix 1.5		Proline 0.4 + SF 0.6 + Phoenix 1.5			
17		Proline 0.4 + Acanto 0.25 + Phoenix 1.5	-	Proline 0.4 + SF 0.6 + Phoenix 1.5		Proline 0.2 + S.F. 0.3	
18		Proline 0.6 + Phoenix 1.5		Proline 0.6 + Phoenix 1.5			
19			Proline 0.4 + Phoenix 1.5	-	Proline 0.4 + Phoenix 1.5		
20			Proline 0.4 + Acanto 0.25 + Phoenix 1.5		Proline 0.4 + SF 0.6 + Phoenix 1.5		Proline 0.2 + S.F. 0.3

S.F. = Seguris Flexi

Phoenix has a label recommendation for control of scald and Ramularia in barley, with a maximum of two applications up to GS39.

High yielding cereals in Tasmania - learnings for New Zealand

Nick Poole, FAR Australia

The following summary points are based on observations from the GRDC funded Hyperyielding Cereal (HYC) project in Tasmania. The project is led by FAR Australia in collaboration with the farming group Southern Farming Systems. The irrigated cereal grains project has the objective of making Tasmania less dependent on grain from the mainland, since it is currently a net importer of grain. Please note these observations were recorded overseas and may not, without the appropriate research, be applicable to New Zealand growers.

Key points

- Higher final harvest dry matter is essential for higher grain yields.
- In 2016, wheat crop canopies producing 30-35t/ha dry matter at harvest produced plot yields of 15-17t/ha in research plots using primarily European germplasm.
- Under extremely warm conditions in 2017, wheat yields peaked at 13t/ha with final harvest dry matter production of 20-25t/ha (yields expressed at 12.5% moisture).
- From the 2017 HYC results, it was difficult to establish a clear relationship between optimum flowering date and final yield. This was because cultivars flowering over a three week period all produced yields in the range of 12-13t/ha, although later flowering for longer season germplasm did appear to limit yields to 10-11t/ha in 2017.
- The lack of a clear relationship between optimum flowering window and yield may in part be related to the impact of irrigation, which tends to assist later developing cultivars that might otherwise be penalised in a dryland system.
- Selecting cultivars with the most suitable phenology “development time clock” for particular sowing dates is essential to maximise dry matter production in the most favourable windows for growth.
- Making use of long season UK wheats (Northern European types) has better matched early April sowing, whilst French wheats have performed well in the traditional ANZAC day (late April) sowing window.
- Septoria tritici blotch *(Zymoseptoria tritici)* and leaf rust *(Puccinia triticina)* are key constraints to high wheat yields in Tasmania. Leaf rust development after grain fill can be a significant yield robber.
- High yield potential appears to come from higher fertility where the extra N required to realise that potential is provided by the soil, not by fertiliser.
- Analysis of HYC yields and grain proteins suggest that large quantities of nitrogen, exceeding applied nitrogen fertiliser, are being removed to produce high yields.
- In 2016, yields of 14-17t/ha were achieved with no more than 220kg N/ha applied (similar to FAR NZ findings), yet nitrogen offtakes in the grain alone indicated the removal of approximately 258 – 336kg N/ha (and in the canopy 344 – 446kg N/ha) depending on sowing date (early or late April).
- In the UK, recent analysis of independent UK NIAB TAG trials show similar findings to the Hyper yielding research programme, suggesting that high yield potential usually comes from higher fertility where the extra N required to realise that potential is provided by the soil, such that the total applied N needn’t be significantly higher than for crops with lower potential.

High harvest dry matter is essential for higher grain yields

In order to generate high cereal yields it is essential to generate high harvest dry matters. However, high harvest dry matters alone are not enough, since it is the conversion of that higher dry matter into grain that is equally important. The final harvest dry matters in 2016 HYC research showed that cultivars with the highest biomass at harvest were associated with the highest grain yields (Figure 1).

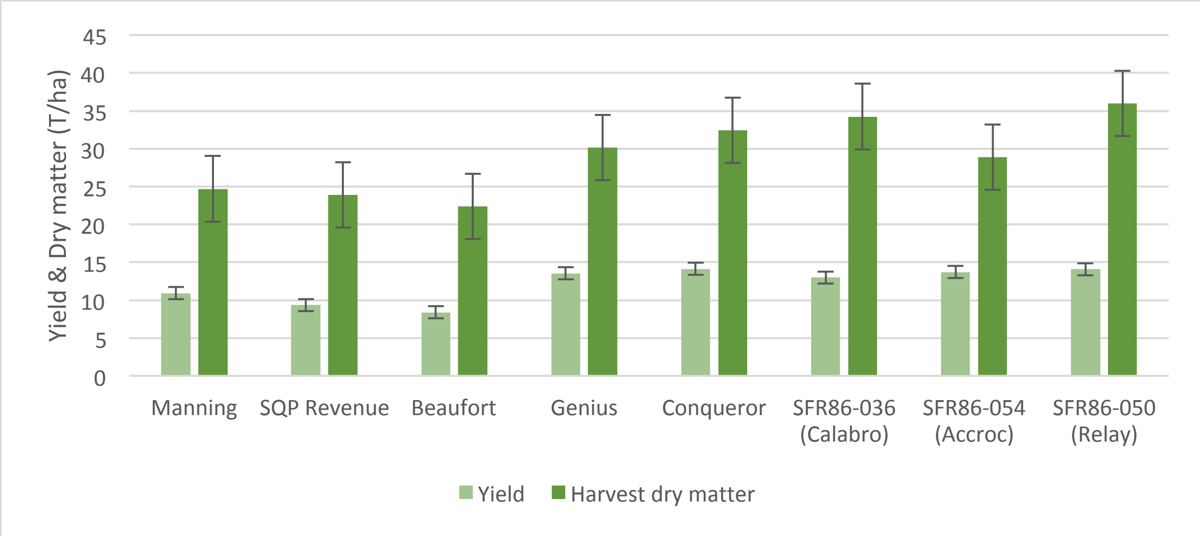

Figure 1. 2016 HYC grain yield & dry matter (t/ha) at harvest from the highest yielding lines versus controls.

Leaf rust (*Puccinia triticina*) is a key constraint to high yields of wheat

Over the last two seasons in Tasmania leaf rust infection has played a major role in restricting the productivity from high yielding irrigated wheat crops. In 2016, early-April sown germplasm susceptible to leaf rust was heavily penalised by this disease, as higher autumn temperatures carried high levels of infection into the winter. In 2017, leaf rust levels were lower in early spring, but early December rainfall and warmer temperatures encouraged the disease in irrigated crops late in the season when with dryland crops green leaf had already senesced. This is a key constraint to productivity in high yielding cereal crops that are susceptible to this disease. The devastating effect of leaf rust on green leaf retention is very evident when recorded using crop reflectance (NDVI) (Figure 2). The differences in reflectance recorded as NDVI resulted in a 2t/ha yield difference in RGT Relay which until mid-flowering GS 65 was relatively disease free.

Nutrition for high yielding cereal crops

In the UK, recent analysis of independent NIAB TAG trials show similar findings to the HYC research over the last two years (Figure 3). Results from a large series of wheat trials indicated that high yield potential usually comes from higher fertility where the extra N required to realise that potential is provided by the soil, such that the total applied N needn't be significantly higher than for crops with lower potential. The analysis of trials on wheat from the UK put forward "that for every tonne of nitrogen fertilised grain/ha, two thirds of a tonne comes from the yield without nitrogen". This was put forward to explain "why the additional amounts of nitrogen required for very high yields in field trials is less than would logically be expected" (NIAB TAG 2018). As the work at HYC has shown yields of 14-17t/ha result in offtakes of 350-450kg N/ha yet there was little need to apply more than 220kg N/ha of nitrogen fertiliser. Similar findings have been found in New Zealand with crops yielding 15-16t/ha sown at Wakanui, Mid Canterbury with harvest offtakes of 450kg N/ha but applied nitrogen optimum rates no greater than 240kg N/ha.

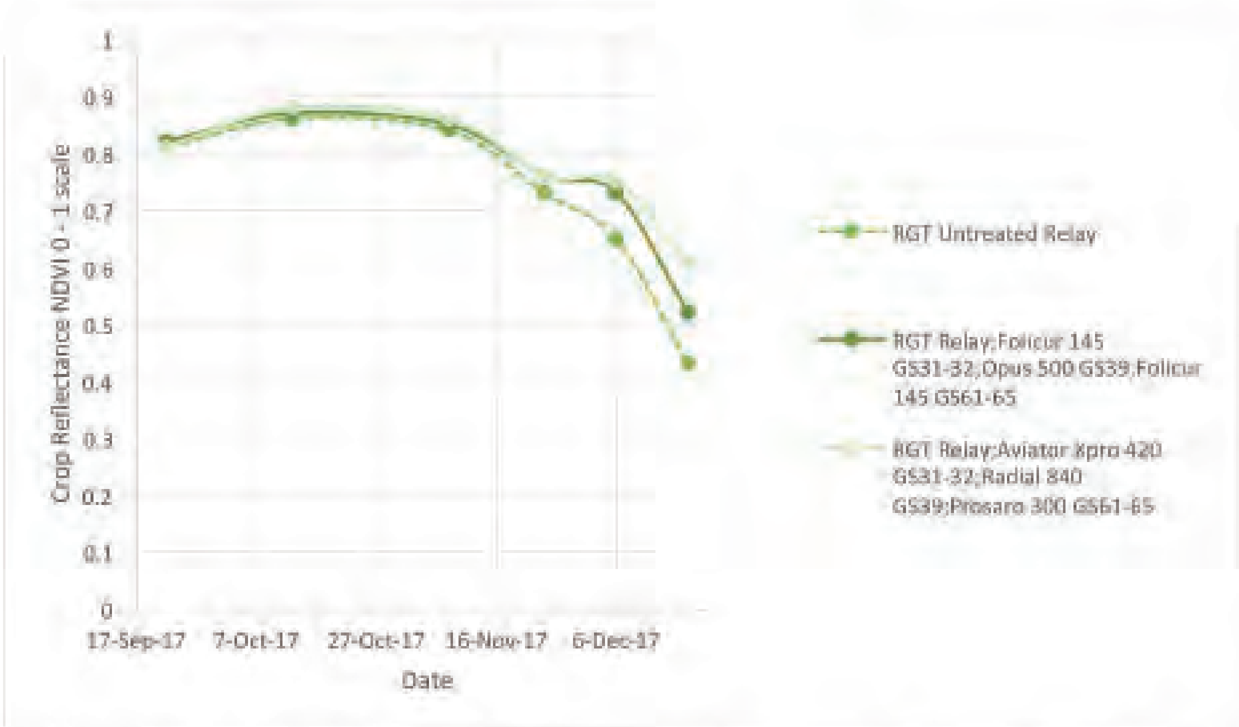

Figure 2. Influence of fungicide application on NDVI readings (Scale 0-1) assessed from 22 September GS37 to the 18 December at GS90. Leaf rust infection became evident from Mid-November onwards (GS65).

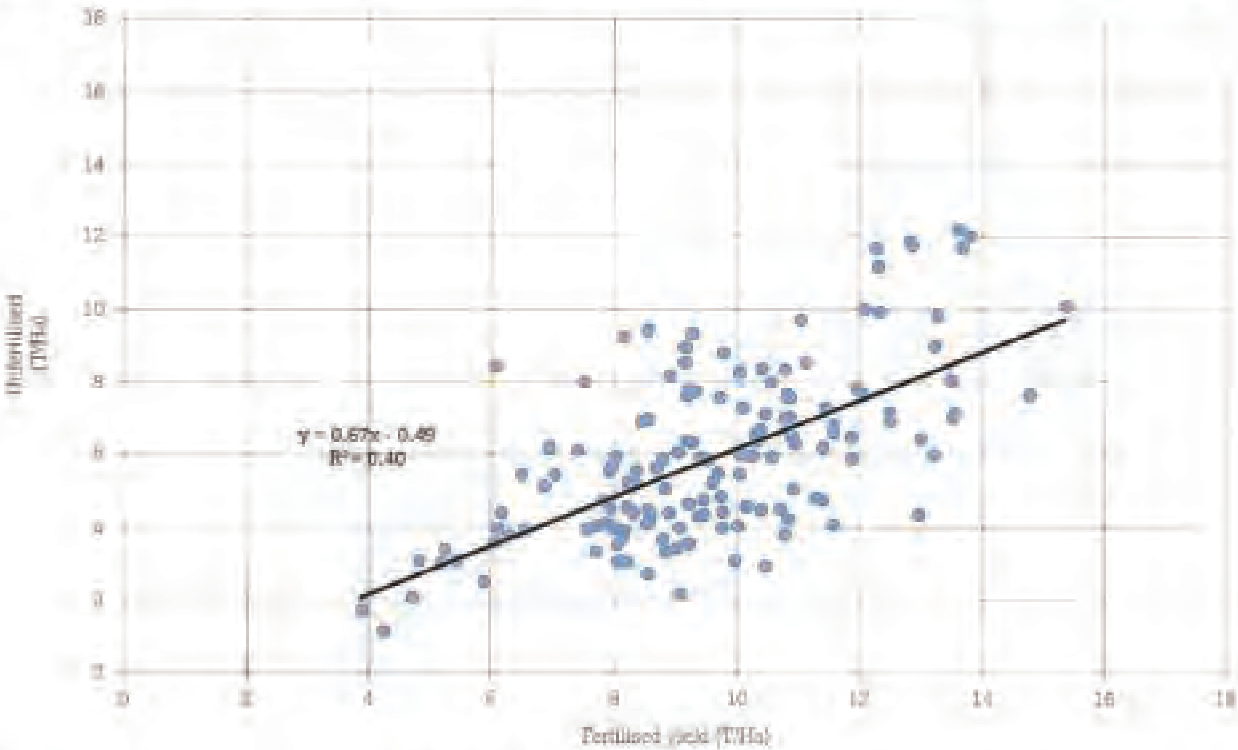

Figure 3 Relationship between yields for fertilised and unfertilised wheat crops – (source NIAB TAG, UK 2018)

Acknowledgement: *FAR Australia gratefully acknowledge the funding support of GRDC for the Hyperyielding Cereal Project.*

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Environmental benefits of arable feeds

Pablo Gregorini, Lincoln University and Ivan Lawrie, FAR

Key points

- The environmental footprint of pastoral livestock production systems is determined by stocking rate and stock class, as well as dietary management.
- Diluting nitrogen intake with high-energy (higher starch and fibre content) supplements has the potential to reduce nitrogen leaching, but increase methane production.
- A range of supplementary forage, silage, grain and bulb mixes were modelled to see if particular combinations could improve environmental outcomes.
- Maize silage, whole crop cereal silage and grain supplements were found to have the potential to reduce both N leaching and methane production in pastoral systems.

Background

Grass, forage and supplements supply energy and essential nutrients in the form of protein, vitamins and minerals. However, as these components vary between feed types, not all feeds are equal in their ability to support animal function. Energy and protein are the factors which impact most on ruminant production, and as such, they have received a lot of attention under several production and evaluation systems. In temperate pastoral livestock production systems, the excess protein supplied by pasture has become the limitation. The nitrogen efficiency of dairy cows rarely exceeds 25%, which means that at least 75% of the N they ingest is excreted, mainly (over 60%) as urinary nitrogen.

Most urinary N (~ 82%) is deposited onto pastures, and of this, around 20-30% is leached and 2% transformed to nitrous oxides. In response to political and public pressures on dairying and dairy farmers, strategies are being explored to reduce the amount of N flowing through dairy cows. However, as some diets aimed at reducing urinary N may increase methane (CH_4) production, it is difficult for farmers to balance environmental, productivity and profitability targets.

A modelling study was run to facilitate feeding decision making by dairy farmers aiming to reduce urinary N and CH_4 emissions while maintaining or increasing animal production. A total of 51 feeds available in New Zealand, including forage crops, silages, grains and bulbs were combined in diets consisting of two feeds varying the proportion of each feed from 10 to 90% in 10% steps. These combinations generated 11,526 dietary mixes.

Results

The following table lists the most environmentally friendly silage, grain and supplement options for combining with a grass based pasture diet, identified in the project.

Station 3: 11.35am & 4.00pm

Table 1 Urinary N and animal production (Liveweight gain and MS during non-lactating and lactating periods, respectively) using diets including ryegrass herbage as the base, i.e. ≥ 50%.

Experimental period	Ryegrass/clover proportion	Supplement	Animal performance		
			Urinary N (g/d)	Methane (g/d)	Animal production (kg/d)
Non-lactating	0.6	Barley straw	219	305	0.6
	0.6	Maize silage	216	218	1.1
Early-lactation	0.7	Oat silage	212	330	1.7
Mid-lactation	0.8	Oat silage	249	372	1.5
	0.7	Oat silage	220	370	1.5
	0.7	Sorghum herbage silage	256	376	1.5
	0.6	Oat silage	192	368	1.5
	0.6	Sorghum herbage silage	238	376	1.5
Late-lactation	0.8	Barley straw	347	364	1.1
	0.6	Maize silage	246	303	0.9
	0.6	Oat silage	263	317	1.0

This work has shown that diluting N with maize silage and or cereal silage considerably reduces urinary N (Figure 1), and that there is scope to formulate binary diets to reduce urinary N while maintaining or reducing methane production (Figure 2), with the potential to increase animal performance.

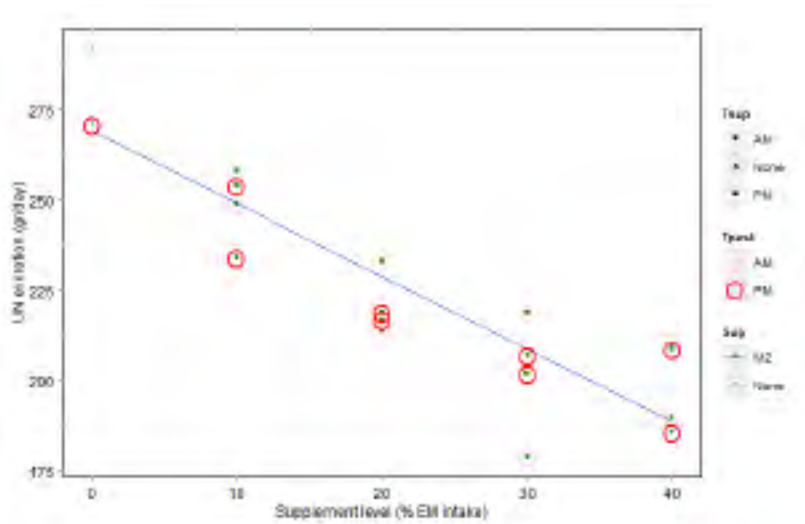

Figure 1 Reduction in urinary N excretion by increasing % supplementary feed.

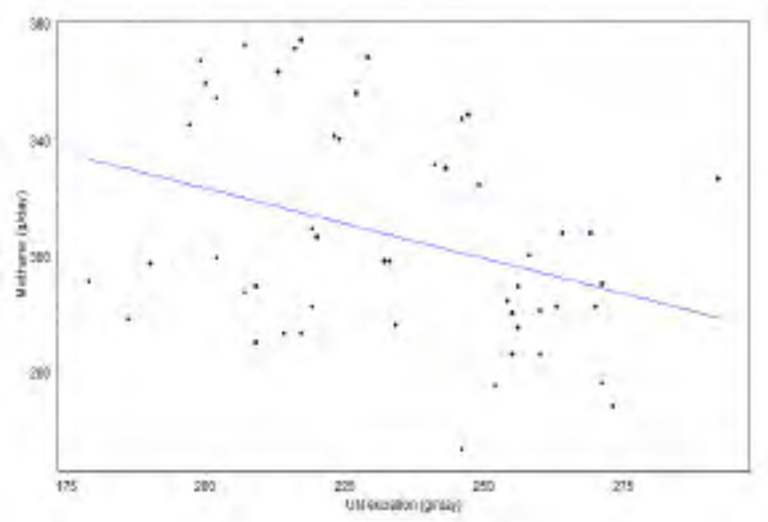

Figure 2 Relationship between methane production and urinary N excretion

Conclusions

Achieving animal production goals while meeting social and environmental constraints is complex. This modelling study tested around 11,000 combinations of 51 feeds and found that dairy farmers wishing to use binary diets to reduce their herd's urinary N, while maintaining or increasing milk production, have surprisingly few options. Most of these come from cereals and beets.

If their criterion is profitability and a pasture-based system, the suitable set of diets is even smaller, being limited to supplementing pasture with low levels of conserved forages with low N content (e.g. maize and cereal silage). There is no perfect diet though to optimise all objectives simultaneously; it is up to farmers to choose among the options that best suit their farming context and local environmental regulations.

Acknowledgement

Environmental Benefits of Arable Feeds is a two year monitoring project led by FAR with funding from MPI SFF. Background information was made possible through outputs from "Forages for Reduced Nitrate Leaching" led by Dairy NZ with funding from MBIE and research collaborators Dairy NZ, FAR, Lincoln University, Ag Research, Plant & Food Research and Landcare Research).

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Catch crop mixes and establishment – learnings from FRNL

Shane Maley and Brendon Malcolm (Plant & Food Research)

Key points

- Cereal catch crops sown in winter take up N and reduce the risk of leaching.
- All cereal species can be used as a catch crop – early establishment is critical.
- Cultivation is likely to be necessary after heavily grazed crops to remediate compaction and/or pugging.

Introduction

Winter forage kale and fodder beet are important single-graze species in livestock production systems. However, fallow periods of three to five months post grazing of such crops are common, posing a risk of nitrate leaching from animal urine patches. Losses from wintering systems have been measured at 50–180 kg N/ha. Catch crops sown after winter grazing can take up significant quantities of N and reduce N leaching losses by up to almost 50%. Catch crops can also increase annual production by reducing fallow periods. Here we report on trial work looking at catch crop species selection and establishment method, and outcomes in terms of N uptake and crop production.

Cereal Species Trial (2017)

Methods

- Field trial was carried out at Plant & Food Research (PFR), Lincoln.
- 400 kg N/ha was applied as urea, prior to sowing, to all plots (simulating urine deposition).
- Catch crops were sown on 20 June 2017, targeting 300 plants/m^2.
- Cereals tested were oats, ryecorn, triticale, wheat and barley, plus a fallow control (Table 1)
- Sequential measurements were performed for:
    - Biomass (DM) and grain production
    - N concentration and uptake
    - Soil N (0–90 cm depth)

Table 1 Crop production data

Catch crop species	Production (t DM/ha)		
	30 Oct (green-chop)	22 Dec (whole-crop)	Late Jan (Grain)
Oats, *'Milton'*	10.6	20.8	5.5
Ryecorn, *'Rahu'*	9.6	19.5	7.5
Triticale, *'WinterMax'*	10.2	18.9	7.8
Wheat, *'Discovery'*	8.2	21.5	8.5
Barley, *'Retriever'*	6.1	17.6	8.3

Results

Of all the species tested, barley was the slowest to establish and remove N, but all showed good potential for use as a winter-sown catch crop with healthy yields achieved at green-chop and whole-chop silage maturity (Figure 1). Most of the activity in terms of N uptake and DM production occurred in spring. The highest grain yields were achieved by wheat and barley at 8.5 and 8.3 t DM/ha, respectively (Table 1). Paddock grain yields by catch crops are expected to be higher; mediocre grain yields in this plot trial were attributed to large, green, heavy stands, given the plots simulated urine patch conditions under relatively high initial residual N levels.

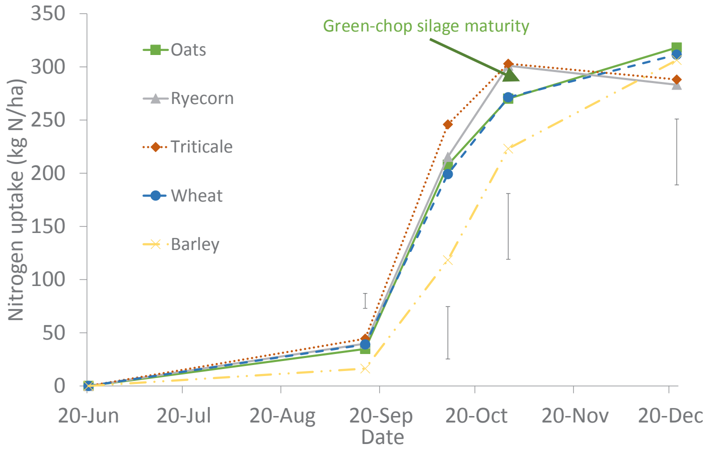


Figure 1 Nitrogen uptake by different catch crop cereal species sown on 20 June 2017.

MPI Sustainable Farming Fund Trial (2018) – Establishment Methods

Methods

- Location - Hororata
- Lismore soil (shallow, well-drained)
- Winter crops – kale (grazed May) and fodder beet (grazed July); two independently-run catch crop trials
- Cultivation treatments occurred mid-June (kale) and mid-July (fodder beet)
- Post-kale catch crops sown July 7; post-fodder beet catch crops sown August 8

Table 2 Treatment details

Winter crop	Catch crop method	Description
Kale	1. Fallow	Remained fallow
	2. Cultivation	Double Disc, Maxi-Till, Triple Disc Drill
	3. Direct drill	No tillage, Triple Disc Drill
F. beet	1. Fallow	As above
	2. Cultivation	
	3. Direct drill	

Results

Biomass production at green-chop silage maturity (11 Nov) ranged between 7.3 and 10.4 t DM/ha. Generally higher yields were achieved after cultivation, which was particularly evident in the ex-fodder beet paddock. Cultivation after fodder beet was likely necessary to remediate a greater degree of soil compaction, caused by a higher stocking density than that of kale.

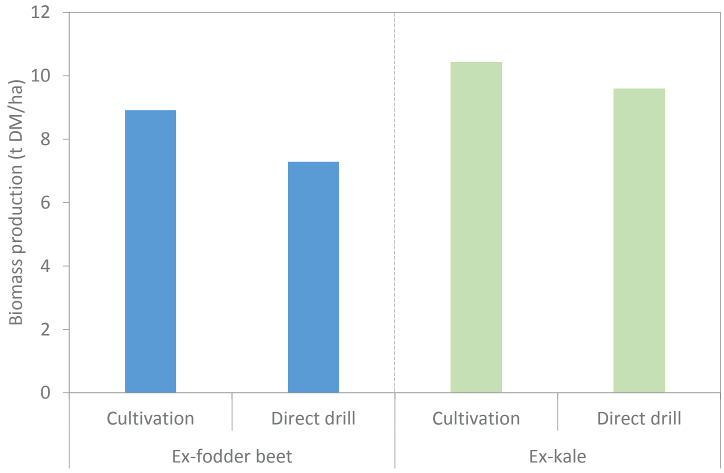


Figure 2 Biomass production of oat catch crops following grazed fodder beet or kale.

Acknowledgements

Research was completed as part of the *Forages for Reduced Nitrate Leaching* programme with principal funding from the New Zealand Ministry of Business, Innovation and Employment and co-funding from research partners DairyNZ, AgResearch, Plant & Food Research, Lincoln University, Foundation for Arable Research and Manaaki Whenua – Landcare Research; and, Ministry of Primary Industries (MPI), Agricom, Luisetti Seeds, Ballance Agrinutrients, Ravensdown, Beef + Lamb NZ, Te Awa Dairy, Craigmore Farming, Dairy Holdings, CSER-Lincoln University, Foundation for Arable Research.

Understanding aerial imagery - An interactive demonstration

Dr Ben Jones, ProductionWise/FluroSat

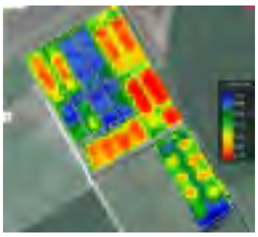
A small plot experiment is the last place you'd expect to find medium resolution satellite imagery useful. The imagery from the Sentinel 2 satellite (10m pixels) we use in the PA Hub in ProductionWise is a good example. It works well in even small fields, but it would be difficult to see a single 1.8m wide plot.

A field day site with many small plot experiments is, however, a good place for understanding how lots of small effects add up to a single pixel. At the FAR Chertsey Arable site there are a range of field experiments, and also some farmer fields adjacent where you can see how imagery works at a larger scale.

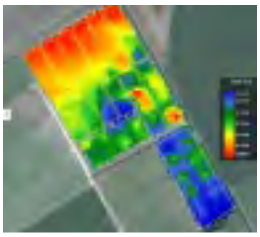
The imagery shows the 'NDVI' index, which is calculated from the difference between near infra-red and red bands of the satellite image. Plant cells reflect most of the near infra-red, and soil reflects more of the red light, so the NDVI index is like 'plant minus soil'. In a single species of crop or pasture, it is often closely related to how much plant material is there, and how healthy it is.

Some things you may see:

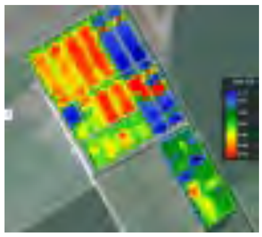
1. If there's cloud, it disturbs the pattern you know is there (compare Figure b below with a).
2. Different crops can look the same in NDVI.
3. A range of treatments that look different to the eye combine to make one pixel, and you can't understand effects smaller than a pixel without being there to see them ("ground truthing").
4. If the legend is stretched across areas that are quite different, it will tend to emphasise the big differences between, but the differences within are difficult to see.
5. Choosing a few similar areas to stretch a legend over shows the within-area variation best.
6. An index like NDVI can be quite responsive to one thing varying within an experiment. This effect also happens with coarser pixels on larger areas and when sowing time, crop etc are comparable. It's the basis for more sophisticated imagery-based products like FluroSat's FluroSense. It allows imagery to be calibrated to measurements on the crop (ie tissue samples). Those relationships are then used to drive fertiliser recommendations, and can be generalised to similar crops nearby.
7. Patterns in crops can be related to many causes, and can be more obvious in the imagery than on the ground. Unless they're intentional, you shouldn't see micronutrient deficiencies, water-logging, or weeds, pests and diseases in a well maintained field experiment. Patterns related to management do show up in crops, often early in the season. Ground truthing the causes and treating them appropriately are the basis for the efficient and profitable use of satellite imagery.



A: July 19 2018. Early crop growth patterns at the site.



B: July 29 2018. Cloud. Quite different pattern from 10 days earlier.



C: November 6. Most recent image at time of writing.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Evolution of wheat – genetics and agronomy for improved productivity

Joanne Drummond, FAR and Bill Griffin, Wheat breeder

Key points

- Septoria tritici blotch (STB) has long been a major disease of wheat.
- Disease control strategies have changed over the last 20 years with the development of STB resistance and reduced sensitivity to some chemical modes of action.
- Growers are taking a more integrated approach to disease management but still rely on chemistry to control disease.

Prior to the 1980s, Septoria tritici blotch (STB) was regarded as a major disease of wheat. Its importance decreased with the introduction of the relatively resistant cultivars, the arrival of stripe rust and the move towards spring sowing. However, since the 1990s the introduction of newer cultivars and a move back into autumn sowing has seen STB become the most important foliar disease of wheat affecting New Zealand growers.

In the early 2000s, FAR fungicide trials typically included two or three fungicide timings and included active ingredients such as kresoxim-methyl, azoxystrobin, carbendazim, tebuconazole, cyproconazole and fluquinconazole and low doses of epoxionazole. The development of STB resistance to strobilurins and reduced sensitivity to triazoles means that nearly all of these chemicals have been removed from disease management programmes.

Today's fungicide programmes still include a strong triazole backbone and, depending on risk factors such as time of sowing and weather conditions from stem extension through to the end of flowering, can see growers spending $300+/ha on up to four fungicide applications a season. Newer modes of action such as SDHIs have been developed, but even these come with a moderate risk of resistance and need to be managed carefully, with no more than two applications allowed in a season. Growers manage their soils, crop residues and green bridges. They use their knowledge of time of sowing, irrigation and cultivar resistance as part of an integrated approach to disease management.

Plant breeders are working to develop cultivars with increasing genetic resistance to disease, but, the STB pathogen is adaptable, so what will disease management look like in the future? Will we all be using biopesticides? Could the use of endophytes be part of the answer? *Epichloë* endophytes have increased agronomic performance in perennial ryegrass and tall fescue through improved tolerance to biotic and abiotic stresses. In a programme led by AgResearch and Grasslanz Technology, *Epichloë* endophytes have been successfully established in ryecorn. FAR trials using endophyte infected ryecorn have shown bioactivity against leaf rust. Ultimately, the goal is to establish endophytes in wheat.

New Zealand wheats over the past 40 years

Prior to deregulation in 1987, all aspects of New Zealand's wheat growing and processing (milling and baking) industries were completely controlled by the NZ Wheat Board. All wheat grown was purchased at a fixed price as long as minimum quality standards were met, and likewise flour production and the supply from mills to bread bakeries was pre-determined and price controlled. There were limited non-bread processed products and the feed industries only received rejected milling wheat lines and milling industry offal.

Deregulation, and the earlier PVR legislation completely changed this landscape, with the processing industries (milling and feed) now able to directly contract and set their own quality specifications, the farmers able to manage their crops to provide this specification with appropriate pricing, and the breeders and seed companies able to protect their investment in new cultivar development, ensuring both local breeding activity and access to overseas genetics.

By the early 1980s, in anticipation of this new landscape, the pace of new wheat cultivar releases was increasing significantly. Yields and quality were improving, and production management options multiplied rapidly, particularly for disease management. In the first years after deregulation, there was a drop in total wheat production, a significant swing to spring planting and a reliance upon the new high bread baking quality cultivar Otane. By the mid-late 1990s, new cultivars allowed production to swing back to autumn planting, a recovery in total milling wheat production and the development of a dedicated new, high-yield feed wheat industry sector.

This breeding activity has continued, and together with improved management has allowed on-going improved yield, quality and diversity within the milling and feed wheat sectors. In 1981 326,000t of wheat were produced in New Zealand at an overall yield average (all potential bread wheats) of 4.0t/ha. In 2016 this had increased to 459,000t at an average of 9.2t/ha (8.3 t/ha for bread wheats and 9.4t/ha for feed wheats).

This demonstration area includes some of these cultivars from the late 1970s, and will show some of the cultivar agronomic and disease resistance characteristics which have contributed to yield improvements over time. Future developments for different protein/carbohydrate wheats targeting special dietary needs and endophyte enhanced wheats will also be discussed.


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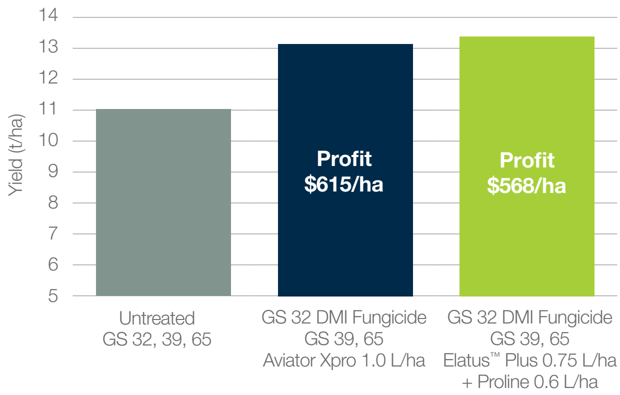
The answer is, very well, which came as no surprise to the Bayer team. Compared against a key competitor SDHI fungicide applied in mixture with Proline®, Aviator Xpro gave almost the same yield whether the target was speckled leaf blotch or leaf rust, but more importantly **it delivered a higher profit due to its cost-effective pricing.**

When should I apply Aviator Xpro?

There is no question that the most important growth stage to apply Avaitor Xpro is GS39, flag leaf emergence. As the flag leaf delivers so much of the crop's yield, it has to be priority No. 1 to protect.

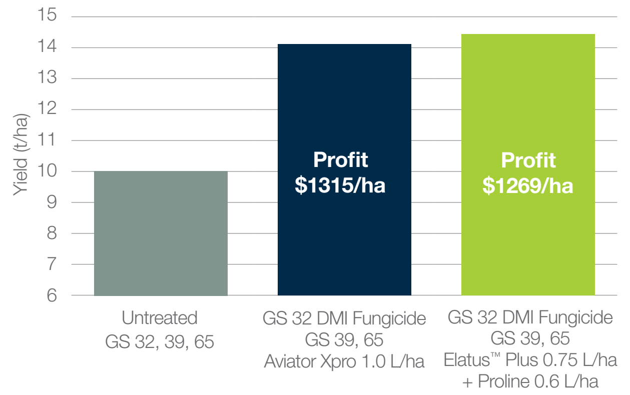
With speckled leaf blotch being such an important disease to control, it makes sense to also apply Aviator Xpro at GS32, second node. Finally, a GS65 application of Prosaro mixed with a strobilurin fungicide will ensure your crops' full yield potential is protected.

WHEAT - YIELD BENEFIT FROM SPECKLED LEAF BLOTCH

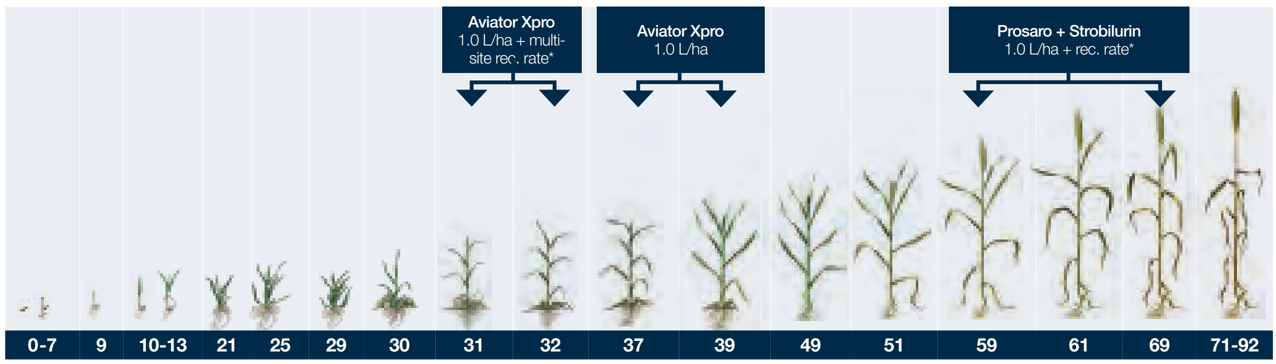


Source: Bayer NZ trial, Canterbury, 2017/18

WHEAT - YIELD BENEFIT FROM CONTROLLING LEAF RUST



Source: Bayer NZ trial, Canterbury, 2017/18



* Apply rate recommended by your advisor.

Optimising cocksfoot seed yield with PGRs and herbicide

Phil Rolston, Richard Chynoweth, and Matilda Gunnarsson FAR and SIRC

Key points

- Cocksfoot tolerance to herbicides is variable depending on cultivar and breeding history.
- PGRs can cause leaf burn in cocksfoot but this may not affect seed yield
- In four trials, optimum spring nitrogen rates for cocksfoot have been approximately 110 kg N/ha or less, this is less than the rates many growers are currently applying.

Background

The cocksfoot seed production area has increased, with many cultivars being multiplied. Growers have commented that not all cultivars respond the same to either herbicide treatments and/or leaf burn following the application of plant growth regulators (PGR).

Herbicide x Cultivar trial: Under the Seed Industry Research Centre (SIRC) banner, a trial evaluated 11 cultivars, plus a turf ryegrass and a hairgrass/annual poa mix. Puma® and Twinax® were very damaging to all cultivars. Kerb™+Quantum® gave excellent grass weed control of ryegrass, hairgrass and poa with almost no crop damage. Prometryn applied early was very safe and gave good weed control. Winter active cocksfoot was more susceptible to some herbicides e.g. diuron at 2 kg/ha. Seed head emergence data is being collected for the cultivars and herbicide treatments.

Plant growth regulator and leaf burn. The standard PGR treatment for cocksfoot is a double application of TE (trinexapac-ethyl) at 100 g TE/ha (equivalent to 400 mls/ha of Moddus®) tank mixed with 1.0 L/ha of Cycocel®, applied at GS32 and again at GS37. In some seasons, cocksfoot can lodge and this reduces seed yields significantly (Fig. 1.).

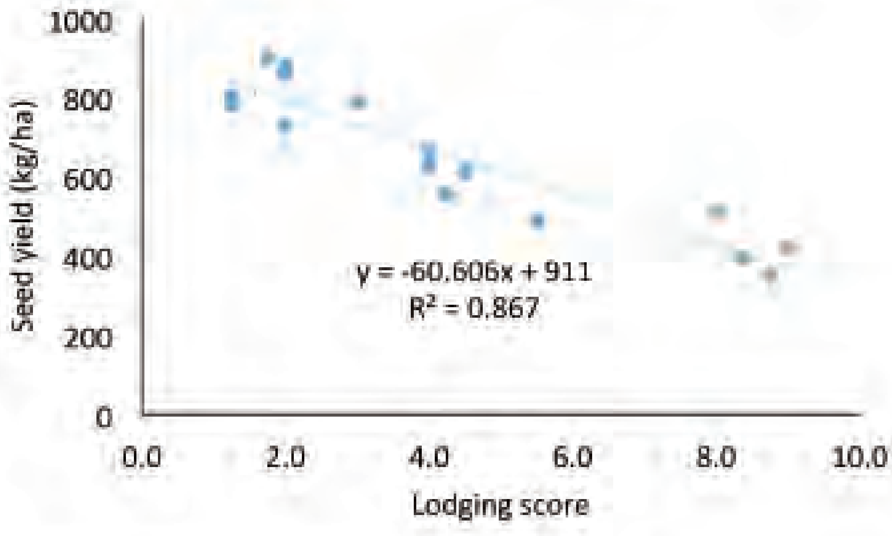


Figure 1. Effect of lodging on seed yield of cocksfoot at Methven, where lodging score 10=severe lodging and 0=nil lodging.

Growers comment that they see excessive leaf burn in some cultivars and in some years, especially on dryland crops. In 2016/17 a higher rate of Cycocel mixed with Moddus was applied on cultivar 'Savvy' and caused severe leaf burn, but did not reduce seed yield (Table 1). This year we are trying to create leaf burn using PGR under irrigation and dryland with two cultivars, 'Greenly' and 'Savvy'.

On 7 November, following PGR application, either once at GS32 or two times at GS32 & GS37, we observed the development of leaf burn from the double application in both dryland and irrigated blocks. Seed yield will be assessed.

Spring N. Seed yield responses to spring nitrogen (N) are being compared in parallel trials located in Oregon and New Zealand. In the three New Zealand trials, the responses to N have been small and with maximum N rates of between 50 and 100 kg N/ha; much less than most growers are using. In Oregon a classic response curve also had a low total N spring N requirement (Fig 2). In 2018/19 SIRC is running two spring N rate trials at Methven, plus large plots (0.5 ha) with two N rates: (i) farmers spring N rate (approx.150 kg N/ha) and (ii) a rate that is 40 kg/ha lower. These plots will be harvested using the growers own combine and the yield determined using a weigh wagon.

Table 1. Seed yield of 'Savvy' cocksfoot following single and double PGR application with TE (Moddus) and CCC (Cycocel) (litres/ha) applied at two growth stages (GS) in 2016/17 at Seafield. Seed yields are the mean of 5 nitrogen rates and 4 replicates.

GS 31/32	GS 33/37	Leaf burn	Seed yield (kg/ha)
0	0	nil	540
TE 0.42+CCC 2.0	0	minor	660
TE 0.42+CCC 2.0	TE 0.42+CCC 2.0	severe	690
		LSD 5%	50

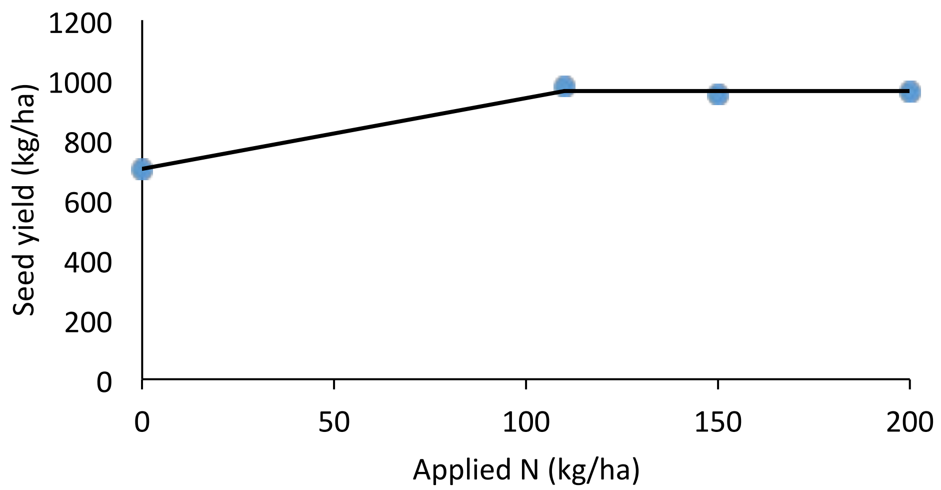


Figure 2. Seed yield of 2nd year cocksfoot, cv. 'Aurus' grown at Hyslop Farm, Corvallis, Oregon. Breakpoint N = 110 kg spring applied /ha. Seed yield is a mean of four PGR rates.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Management of herbicide resistance in cereals in New Zealand - lessons learnt from Australia.

Dr Peter Boutsalis, Plant Science Consulting and The University of Adelaide, South Australia

Key points

- Some weed species have the propensity to develop resistance to herbicides more easily than others.
- Over reliance on a narrow range of herbicides in the 1980s and 1990s resulted in the initiation of the widespread resistance occurring in Australia today.
- Cross-resistance is also becoming problematic.
- Herbicides remain the main method of weed control, but other methods are being incorporated into farm systems.
- Whole plant (Quick-Test) and seed testing is frequently used to determine the cross-resistance patterns of suspected resistant weeds.

Background

Across southern Australia, annual ryegrass (*Lolium rigidum*) is the most problematic weed to control, particularly with post-emergent herbicides. Causes of resistance include:

- Ryegrass is genetically diverse- even before herbicides were available, certain resistance mechanisms were present. Pre-existing resistance mechanisms in other weed species including wild oats and chickweed are also common.
- Ryegrass cross-pollinates so resistance genes spread via pollen. If pollen from a resistant plant fertilises a susceptible mother plant, the seeds set by the mother plant are resistant. Therefore weak resistance mechanisms can accumulate increasing resistance levels. Cross-pollination in wild oats is rare therefore resistance spreads predominately by seed movement.
- Large population sizes in the range of 1000-5000 plants/m2 can occur if left uncontrolled- the greater the population size, the greater the chance of resistant individuals existing.
- The repeated application of similar or the same herbicide to control large plant densities increase the chance of selecting for resistant individuals.
- Resistant individuals not controlled, surviving and setting seed.

Table 1: Incidence of herbicide resistance in annual ryegrass. Data from seeds collected from 2000 randomly chosen fields across southern Australia over 10 year period and tested in pot trials. Research funded by the Grains Research and Development Council (GRDC).

Herbicide	Fields with resistance (%)
Group A e.g. Twinax®	60
Group A DIM e.g. clethodim (Arrow®)	15
Group B sulfonylurea e.g. Glean®	65
Group B Imidazolinone	52
Trifluralin	23
Prosulfocarb	3
Pyroxasulfone	0
Glyphosate	5

The origin of herbicide resistance in Australia

The over reliance on a narrow range of herbicides for weed control in the 1980s and 1990s resulted in the initiation of the widespread resistance occurring today. Herbicides used included Group A herbicides such as diclofop, haloxyfop, tralkoxydim, clethodim and Group B herbicides such as chlorsulfuron and triasulfuron. Additionally, use of low rates of glyphosate has contributed to resistance in ryegrass, with about 3% of fields across over 10 million hectares of arable cropping containing glyphosate resistant ryegrass.

How resistant weeds are managed today

Herbicides remain the main method of weed control with non-herbicide techniques supporting them. Non-herbicide techniques include capturing seeds at harvest, removing seeds before they mature with hay/ silage and concentrating weed seeds into windrows that are burnt or used as feed.

The change from full-cut cultivation to minimum tillage over the past 30 years has altered the weed seed distribution to the top few centimetres improving the effectiveness of pre-emergence herbicides. Pre-emergence herbicides have diverse modes of action that are effective on Group A and B resistant weeds. These include trifluralin, pendimethalin, triallate, prosulfocarb (not available in NZ), pyroxasulfone (not yet available in NZ), metazachlor (not available in NZ), atrazine, simazine and terbuthylazine. Herbicides with alternative modes of action such as carbetamide (no longer available in NZ) and amicarbazone (not available in NZ). The availability of a large pool of diverse herbicides should reduce the risk of resistance developing to any particular herbicide.

Understanding cross-resistance

Cross-resistance is when the use of one herbicide can cause resistance to other herbicides. Group A herbicides: For example, wild oat resistance to fenoxaprop (Foxtrot® = Puma® = Panther® S) often confers cross resistance to clodinafop (Mandate®, Topik®) indicating that even if you have never used clodinafop, it may fail if used. In rarer cases cross-resistance to pinoxaden (Twinax) can occur.

Even though fenoxaprop, clodinafop and pinoxaden have the same mode of action, ryegrass and wild oats can be resistant to one or more of them. Ryegrass can also develop resistance to other Group A herbicides, such as haloxyfop, fluazifop and quizalofop, which are selective in broadleaf crops only. Furthermore, clethodim (Arrow), also a Group A herbicide, has some unique differences to other Group A herbicides. Arrow will often control wild oats and ryegrass resistance to other Group A herbicides such as clodinafop, fenoxaprop, pinoxaden, haloxyfop (Table 2). Additionally, there is often a rate response with Arrow, with higher rates controlling individuals not controlled with lower rates. This is quite unique to Arrow.

Even though all the above herbicides have the same mode of action, e.g. they inhibit the same target site enzyme (ACCase), they do so slightly differently and this gives the different resistance profiles. The same analogy can be used for Group B resistance in chickweed. There are often subtle differences in the activity between Group B herbicides on Group B resistant chickweed. For example, chlorsulfuron (Glean) resistant chickweed may or may not be resistant to other Group B herbicides including mesosulfuron (Othello®), iodosulfuron (Hussar®) or pyroxsulam (e.g. Rexade™).

In Australia, whole plant (Quick-Test) and seed testing is frequently used to determine the cross-resistance patterns of suspected resistant weed cases to determine if resistance was the cause of a herbicide failure and to identify herbicides that remain effective.

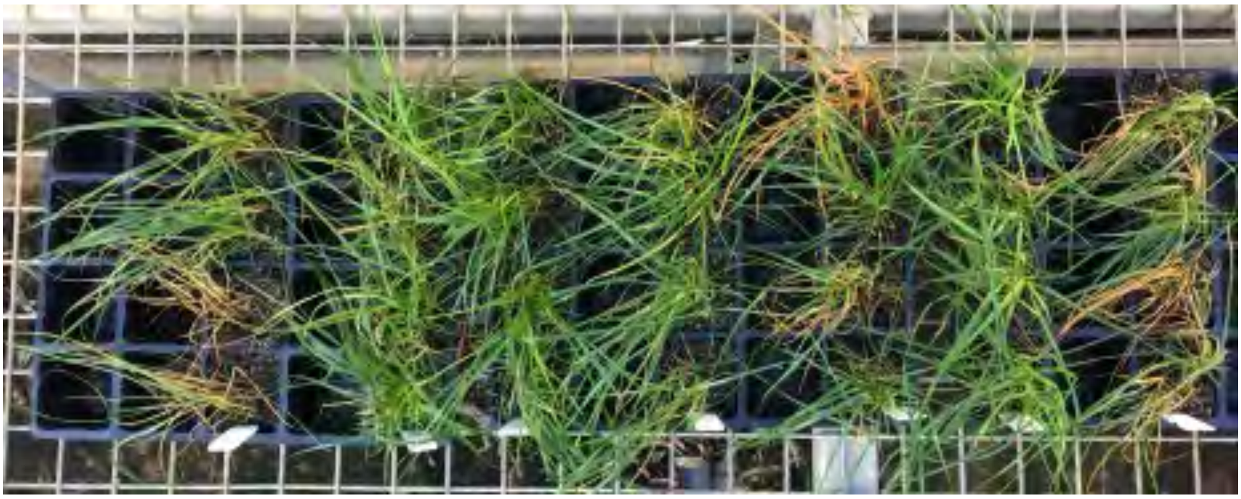
Table 2: Percent survival of 19 wild oat (*Avena sterilis*) farmer samples from northern NSW. Samples were received as seeds. Pot tests conducted by Plant Science Consulting the following season. Red shading represents samples with >20% resistance.

Sample Nr	Topik/ clodinafop	Agpro/ haloxyfop	Twinax/ pinoxaden	Arrow/ clethodim	Atlantis®/ mesosulfuron
1	0	0	0	0	0
2	50	10	10	0	0
3	40	40	30	0	0
4	90	0	0	0	0
5	0	0	0	0	0
6	20	10	15	0	0
7	75	30	20	0	0
8	20	0	20	0	15
9	35	0	20	0	0
10	100	45	90	0	0
11	100	100	75	0	0
12	100	100	10	0	0
13	100	100	0	0	0
14	0	0	0	0	0
15	100	30	80	0	0
16	100	90	5	0	0
17	100	45	0	0	0
18	0	0	0	0	0
19	20	0	10	0	0

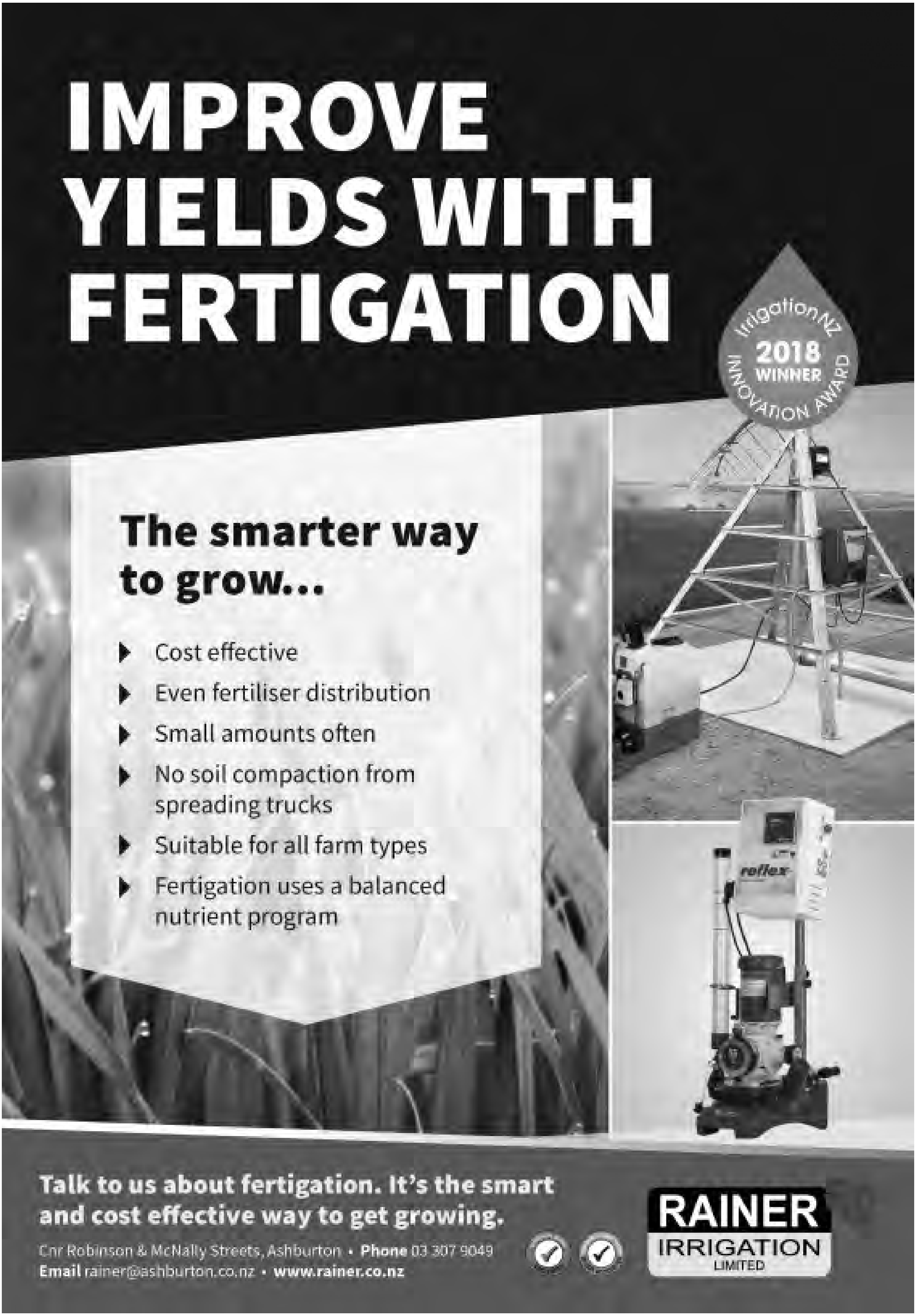
Generic herbicides

Over the past decade, the range of herbicide products offered has increased vastly, for example there are about 100 glyphosates available in New Zealand and over 500 in Australia. Testing of a few glyphosate products has shown vast differences in activity between and within species, with some effective on glyphosate resistant ryegrass if applied at young growth stages. Generally, herbicides from reputable companies that offer a quality guarantee are more effective over a wide range of environmental conditions. See www.plantscienceconsulting.com.au for more information.

7 Glyphosates @ 250g ai/ha vs susceptible ryegrass



1 2 3 4 5 6 7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Weed control and desiccation in white clover seed crops

Richard Chynoweth, Phil Rolston and Sonja Vreugdenhil, FAR and SIRC

Key points

- Weed control options in white clover are reducing with the loss of Jaguar® and the EPA's reassessment of various herbicides, e.g. Paraquat.
- Some hard to kill weeds e.g. sow thistle are going to require a more proactive approach to ensure control.
- Additives such as Sharpen® and Hammer® are providing potential 'spike' options for many herbicides on various weeds – more information is required about crop safety.
- Desiccation at harvest can be a problem in damp seasons when drying conditions are limited. In these situations, products which do not collapse the canopy may be useful.

Weed control

Weed control options in white clover are reducing. The loss of Jaguar (25 g/litre diflufenican and 250 g/litre bromoxynil) makes it difficult to control some weeds and other options e.g. Paraquat, are currently under review by the Environmental Protection Agency (EPA). For some hard to kill weeds e.g. sow thistle, a more proactive approach will be required to ensure adequate control.

This season we have investigated various options for sow thistle control, with treatments beginning in June. Sow thistle often regrows after the initial herbicide application, and requires follow-ups for complete control (Figure 1). The standard treatment of Jaguar plus 2,4 D Ester (e.g. Relay® Super S etc) applied in either late July or mid-August have provided high levels of control with the associated growth reductions (Figure 2). Many other treatment combinations, including MCPA, MCPB and Paraquat, provided similar levels of control when used in a sequence, while Gardoprim® (500 g/litre terbuthylazine) was useful for controlling spring emerging thistles. The addition of Sharpen (700 g/kg saflufenacil) has provided an interesting option for many herbicides and requires further investigation.

Mixing Quantum™ (500 g/litre diflufenican) and Bromotril® (400 g/litre bromoxynil) together provided similar control as Jaguar when applied in a mix with Relay Super S (680 g/litre 2,4-D as the ethylhexyl ester), while the addition of Sharpen added further knockdown (and damage to the clover).

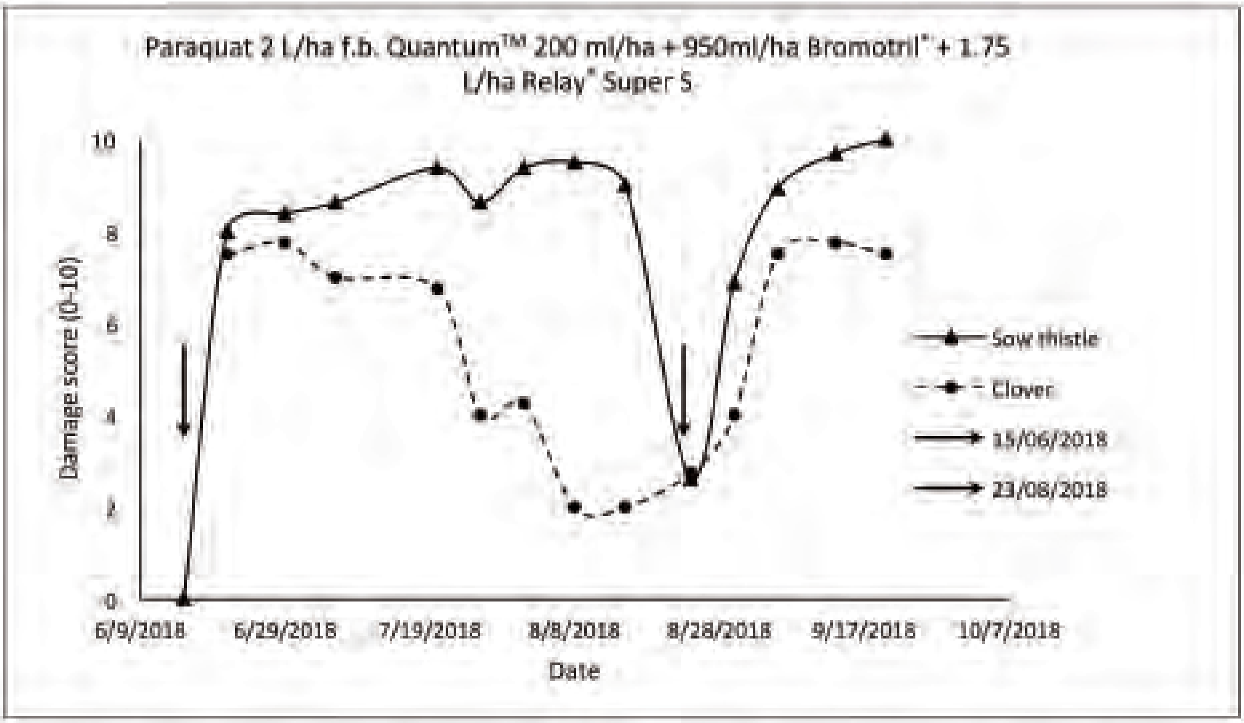


Figure 1. Sow thistle and white clover damage (0 – nil, 10 – complete biomass reduction) following the application of Paraquat on 15 June followed by Quantum™ (200 ml/ha) + Bromotril® (950ml/ha) + Relay® Super S (1.75 L/ha) applied 23 August, grown near Highbank, Mid Canterbury.

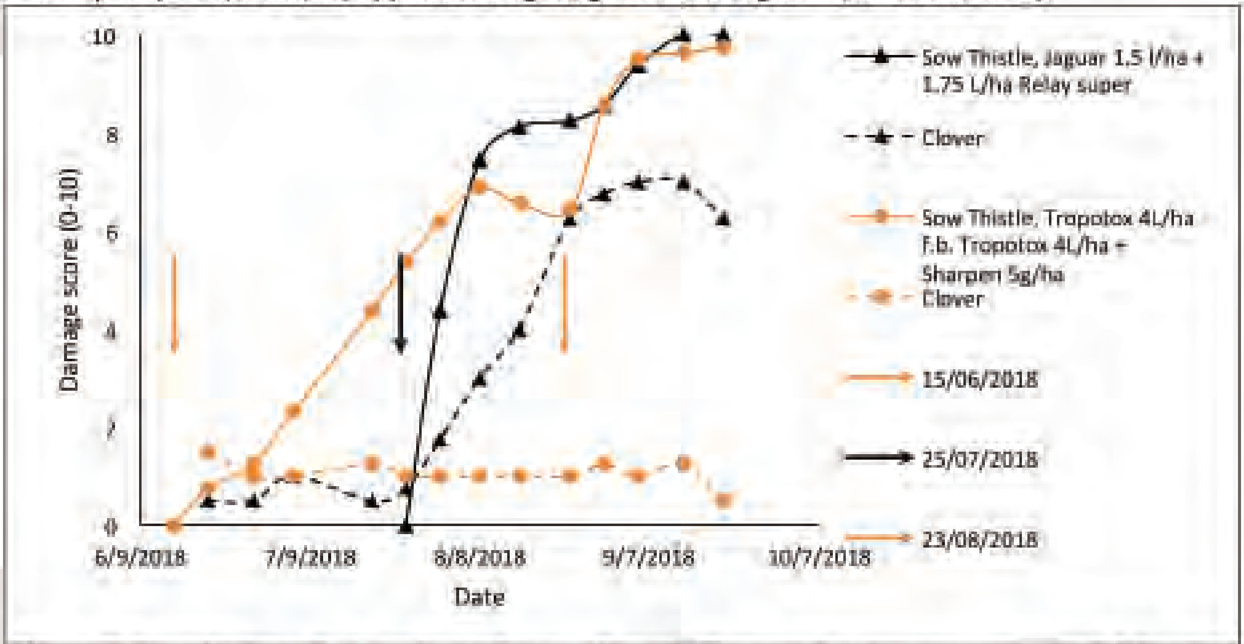


Figure 2. Sow thistle and white clover damage (0 – nil, 10 – complete biomass reduction) following herbicide applications at three timings during winter 2018, grown near Highbank, Mid Canterbury.

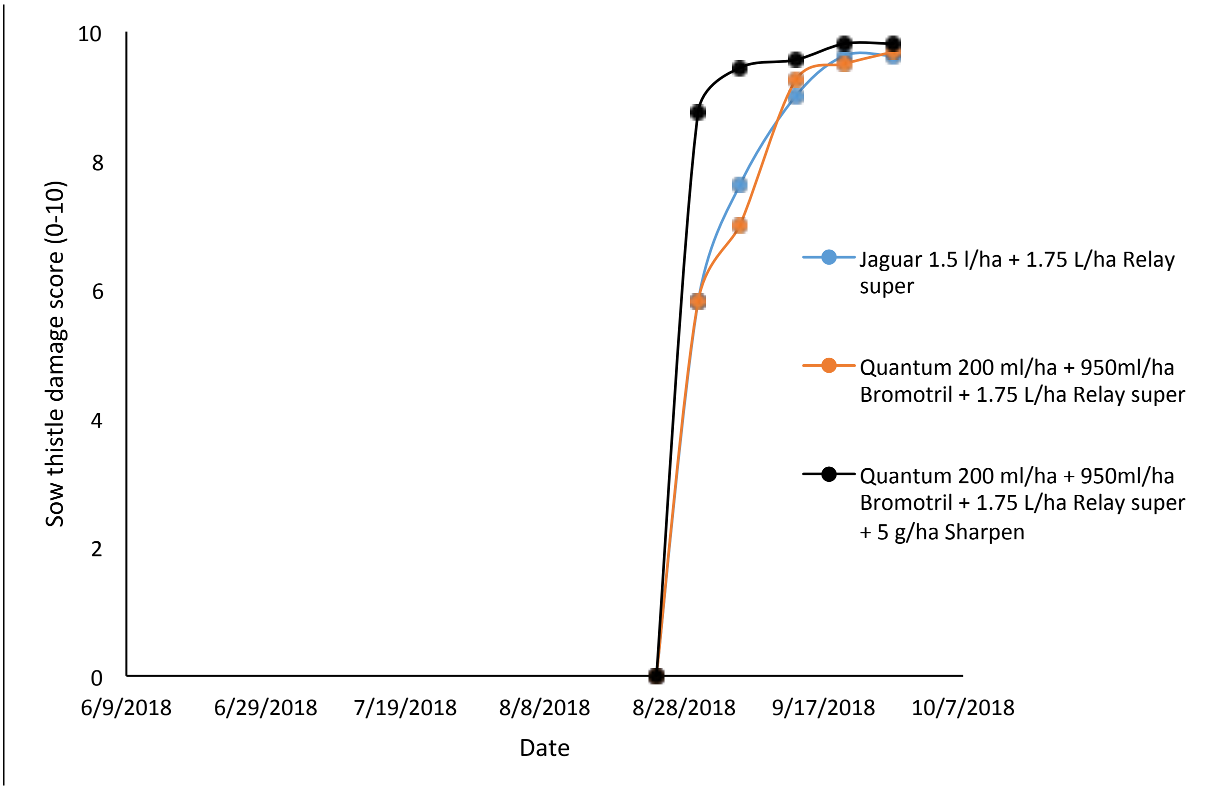


Figure 3. Sow thistle damage (0 – nil, 10 – complete biomass reduction) following application of three mixes of Diflufenican, Bromoxynil and 2,4 D ester applied 23 August 2018 grown near Highbank, Mid Canterbury.

Growth regulation by 2,4 D Ester can be useful in warm winters when early spring growth leads to row closure prior to the onset of flowering. However, dryland clover growers do not like to reduce growth in case of a dry spring where growth cannot be 'restarted'. In this situation a proactive approach, including early sowing and prewinter control using MCPA/MCPB applied twice, appears to provide good control with limited reduction in clover growth.

Desiccation

For two seasons trials have investigated different desiccation options with the aim of providing growers with options to stop growth in wet seasons. In wet seasons the use of MCPA as a pre-treatment to Reglone® (200 g/litre diquat) is common practice. MCPA distorts and slows grow, sometimes allowing Reglone to penetrate into the canopy. However the leaf canopy often collapses quickly, and in damp weather the material underneath does not dry. We have been interested in products which may slow or stop growth without collapsing the canopy, thus allowing drying to take place. In 2017/18 a trial was set up with five products used pre-Reglone application. All products were applied post-flowering when seed was golden. Seed yields were similar to the untreated for all treatments except when MCPA was used prior to Versatill™ (600 g/litre clopyralid) (Table 1).

Station 9: 10.00am and 2.00pm

Table 1. Seed yield of second year white clover cv. 'Kortare' following treatment with 10 herbicide/descant combinations, grown at the FAR Arable Research Site, Chertsey in the 2017/18 growing season.

Treatment	Pre-Treatment 1	Pre-Treatment 2	Desiccation 2	Seed Yield (kg/ha)
1	nil	nil	Reglone 4L/ha	**579**
2	MCPA 2L/ha		Reglone 4L/ha	**530**
3		Buster 5 L/ha		**577**
4		Buster 5 L/ha	Reglone 4L/ha	**551**
5	MCPA 2l/ha	Buster 5 L/ha	Reglone 4L/ha	**509**
6		Versatill 350 ml/ha	Reglone 4L/ha	**553**
7	MCPA 2l/ha	Versatill 350 ml/ha	Reglone 4L/ha	**578**
8		Roundup 3L/ha	Reglone 4L/ha	**552**
9	MCPA 2l/ha	Roundup 3L/ha	Reglone 4L/ha	**536**
10		Starane 0.9 L/ha	Reglone 4L/ha	**573**
			Mean	**531**
			CV%	**8.9**
			LSD	**68**

If post-harvest grazing is important, please adhere to all product with holding periods.

IPM for clover and brassicas

Abie Horrocks, FAR and Scott Hardwick, AgResearch

Key points

- Red clover casebearer moth has been present in New Zealand since at least 2015 and has been responsible for yield reductions in red clover crops.
- Long term reliance on synthetic pyrethroid and organophosphate insecticides to suppress this pest is unsustainable.
- Parasitoid wasps provide useful control of white clover casebearer moth in New Zealand.
- Research is underway to investigate IPM options for red clover casebearer.
- IPM strategies are already well established for seed and forage brassicas.

Red clover casebearer

Red clover casebearer moth (*Coleophora deauratella)*, was first reported in Auckland, New Zealand in December 2016, although the species was present from at least spring 2015. This species originates from Europe and the Middle East, and was accidently introduced to North America in the early 1960s. There it became the major pest in red clover crops, being responsible for seed yield losses of between 80–99.5%. In mid-Canterbury, red clover growers experienced similar yield reductions during the 2016/17 growing season.

Adult moths are expected to be seen in New Zealand from October-December. Eggs are laid by female moths at the base of florets, and the larvae feed on developing seeds in the florets over summer from inside their 'cases'. The first signs of low level damage are holes found in individual red clover florets. Moths overwinter as mature larvae, typically near the soil surface or in leaf litter. The larvae then pupate and emerge as adults the following spring/summer.

Currently there is a reliance on synthetic pyrethroid and organophosphate insecticides to suppress populations of red clover casebearer. However, the long-term use of these insecticides is unsustainable as it may result in resistant strains of this pest and, or, the flaring-up of other red clover pests e.g. diamond back moth, red clover thrips and aphids, through the suppression of natural enemies. These insecticides also interfere with the activities of red clover pollinators.

When white clover casebearer became established in New Zealand, insecticides were the only control method available, however, following the introduction of two parasitoids, *Bracon variegator* and *Neochrysocharis* sp. the need to apply insecticides to control white clover casebearer was substantially reduced. It is probable that red clover casebearer populations can be managed in the same way, and there is evidence that this is starting to occur.

Even though red clover casebearer has only been in New Zealand since 2015, at least one parasitoid is now attacking this pest. In 2018, *B. variegator,* a parasitoid that was released in 1961 to control white clover casebearer, was observed parasitising red clover casebearer larvae collected from red clover crops in Canterbury. While it hasn't been observed doing so yet, it is possible that *Neochrysocharis* sp. may also attack red clover casebearer.

Further research is needed to investigate the role of parasitic wasps (both the presence and efficacy), and generalist predators (such as lacewing larvae and pacific damsel bug) in contributing to the control of pest species which are present in red clover crops.

An on-farm demonstration trial comparing an Integrated Pest Management (IPM) approach to an insecticide only approach is about to get underway. As an IPM approach requires looking at the system as a whole (and not treating pest problems in isolation) the strategy developed will address

all insect pests (i.e. red clover casebearer, thrips, aphids). Decisions about insecticide applications will be based on trends in pest:beneficial ratios throughout the growing season; these will be determined by monitoring. Fortnightly monitoring will also provide useful information on both the presence and efficacy of parasitic wasps and predators, as well as determine if the insecticides are disruptive. Cultural controls such as varying closing dates will also be assessed this season.

Bracon variegator

- This parasite of casebearers was introduced into New Zealand for the control of white clover casebearer moth in the early 1960s.
- It was observed parasitising red clover casebearer moths in red clover crops in Canterbury in 2017, and will likely be doing the same in all red clover crops in New Zealand.
- Female parasites search among the florets of clover flowers for encased host larvae.
- After locating her target, the female stings and paralyses the host. Once the host is paralysed the female parasite inserts her ovipositor through the side or open end of the casebearer's case and lays an egg on the host larva. Several eggs can be laid on the larva but only one parasite will survive to complete its development.
- After completing its development the parasite larva pupates on the outside of the host's body in a white silken cocoon within the host case.
- *B. variegator* takes 16-20 days to complete its development from egg to adult. This indicates that this parasitoid can complete multiple generations per year.

Casebearer larvae feeding on red clover

Adult red clover casebearer moth

Adult damsel bug
Photo courtesy Plant & Food Research

IPM of brassicas

A three year Ministry for Primary Industries' Sustainable Farming Fund project (supported by FAR, Plant & Food Research, Forage Innovations and DuPont) compared an IPM strategy with farmers' conventional pest management practices on twelve spring- and autumn-sown seed and forage brassica crops. The IPM approach used monitoring to inform decision-making and was based on the following available tools:

- Biological – a range of naturally occurring biological control agents. Predators such as lacewings and ladybirds were active at all sites. Parasitic wasps were also present at all sites. The best way to monitor the presence of parasitic wasps was to look for parasitised aphids (aphid mummies), or the presence of parasitoid larvae inside diamondback moth larvae.
- Cultural controls – which will vary depending on the farm.

- Chemical – Chemical inputs were determined by monitoring (no routine use of insecticides) and if required selective, as opposed to broad-spectrum, chemicals were used where possible.
- Management decisions were based on trends in the ratios of pests:biological-control agents. Thresholds have limited value where beneficials are being taken into consideration. For example, if there are 10 diamondback caterpillars on a kale plant and high levels of predators and 70% of the caterpillars are parasitized, the recommendation for action would differ from if there were 10 diamondback caterpillars but no predators or parasitism. Determining if the problem is getting 'better' or 'worse' is key to determining if additional action is required.

As collaborating famers learnt more about the biological, cultural and selective chemical management options available, they became increasingly reluctant to use broad-spectrum insecticides. A comment from one grower involved in the project summed up his learnings with the comment "there's a war going on in my paddock and I wasn't aware. These things (predators and parasitoids) are out there in the paddock working 24 hours and you don't have to pay for them." This led to a 35% reduction in the number of insecticides applied under IPM, compared with conventional management. Where insecticides were used in the IPM systems, there was a shift towards the use of selective products and a 75% reduction in the use of broad-spectrum insecticides.

Despite these reductions, there were negligible differences in crop yields.

Dissected parasitised diamondback moth caterpillar showing innards of the caterpillar (middle and to the left), and the parasitic wasp larvae to the right (almost under finger nail).

Emissions trading and greenhouse gases – what do they mean for cropping?

Tim Brooker, FAR

Key points

- New Zealand accounts for 0.17% of global greenhouse gas (GHG) emissions, of which agriculture makes up 49%.
- Biological emissions from the dairy industry are 25% of New Zealand's gross emissions; the sheep and beef sector makes up 23%. Horticulture and cropping make up approximately 1%.
- The current government is committed to reaching net-zero emissions by 2050 – this will result in legislated and quantified long-term targets.
- It is not decided how agriculture will enter the Emissions Trading Scheme - methane is particularly difficult to weight.
- Agriculture is the sector most at risk from climate change – **we need to do our part.**
- Cropping has low biological emissions per ha when compared with livestock.
- It's not hard! We're actually on the right track – between 2006 and 2016, there has been a 50% reduction in cereal stubble burning, and a 23% increase in non-inversion crop establishment – this is an opportunity for cropping to promote our environmental sustainability.
- Emissions associated with N fertiliser manufacture and use account for 60% of total emissions for a wheat crop, however this drives yield and therefore efficiency per unit of output.
- You can model your farm emissions and potential reductions using Cool Farm Tool - https://coolfarmtool.org/

Why worry about greenhouse gas emissions?

As of October 2018, New Zealand and 180 other countries have ratified the Paris Agreement, which aims to keep the global average temperature within 2°C of pre-industrial levels. By signing this, New Zealand has committed to reducing GHG emissions to 30% below 2005 levels by 2030. Commitments come into force from 2021.

The Emissions Trading Scheme (ETS) is the government's main tool for reducing GHG emissions. The ETS penalises high emission activities and incentivises investment in technology and practices that reduce gross emissions. The ETS currently compares all GHGs as CO_2 equivalents based on a 100 year global warming potential. Having a common 'currency' for all GHGs in the ETS allows emissions in one industry sector to be traded against emission reductions of another gas in another sector.

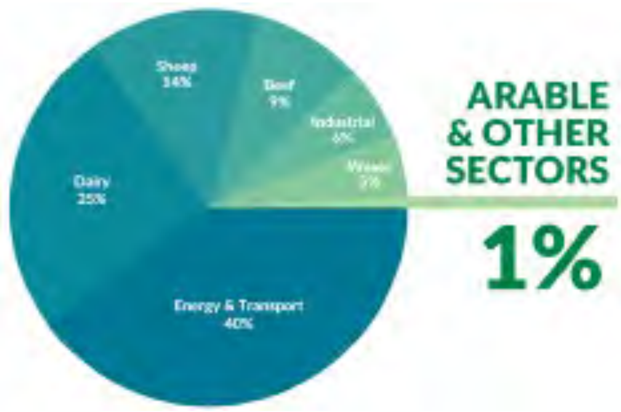
Biogenic emissions from agriculture account for 49% of NZ's gross emissions. They have been excluded from the ETS since its introduction in 2008, however it has been indicated by the current government that it will be required to enter in some form if we are to achieve our target by 2030. The debate has now moved from 'if' to 'how' agriculture should enter the ETS.

What is the emissions profile of agriculture in New Zealand?

Agriculture is the industry most at risk to the effects of climate change. Despite biological emissions from cropping contributing less than 1% of NZ's overall emissions, we still need to do our fair share to reduce emissions by 30% by 2030.

Where do emissions come from in cropping?

Biological emissions from cropping come from microbial conversion of N fertiliser (N_2O) and urea hydrolysis (CO_2), volatilisation and leaching (N_2O), residue management (methane and N_2O), liming (CO_2) and changes in soil carbon. These emissions are currently exempt from the ETS



Other emissions associated with the energy and industrial sectors include diesel for field operations, electricity, transport and the manufacture of fertiliser and agrichemicals.

Figure 1, over the page, shows the modelled output from Cool Farm Tool of a winter wheat crop grown with what is considered good management practice with regards to GHG emissions. This particular crop was direct-drilled and received 240 kg/ha of applied N, 205 mm of irrigation and yielded 11.5 t/ha. This scenario has been adjusted to compare with other management practices in Table 1.

- A steady-state (no change in tillage practice for 20 years) full cultivation regime emits an additional 40 kg CO_2-e/ha compared with direct drilling (scenario 2).
- Stubble burning increases emissions by 28.6% due to large amounts of methane released to the atmosphere, despite N_2O emissions decreasing (scenario 3).
- A combination of direct drilling, efficient use of N fertiliser, greater yield and no stubble burning has given a decrease of 37% in total emission compared with a typical management scenario 15 years ago (scenario 4).
- A decrease in N fertiliser from optimum and associated decrease in yield results in a reduction in emissions per hectare, but emissions per tonne of produce is greater (scenario 5).

Table 1: Effect of management strategies on GHG emissions from an autumn sown wheat crop

Scenario		Yield (t/ha)	Cultivation	Applied N (kg/ha)	CO2-e (kg/ha)	CO2-e (kg/tonne)	Increase/t from Scenario 1
1	Good practice	11.5	Direct drill	240	2980	259	0.0%
2	Full cultivation	11.5	Plough, maxitill, drill	240	3040	264	1.9%
3	Stubble burning	11.5	Direct drill	240	3840	334	28.6%
4	15 years ago	10	Plough, maxitill, drill	275	4100	410	58.3%
5	25% reduction in N	9.1	Direct drill	180	2420	266	2.7%

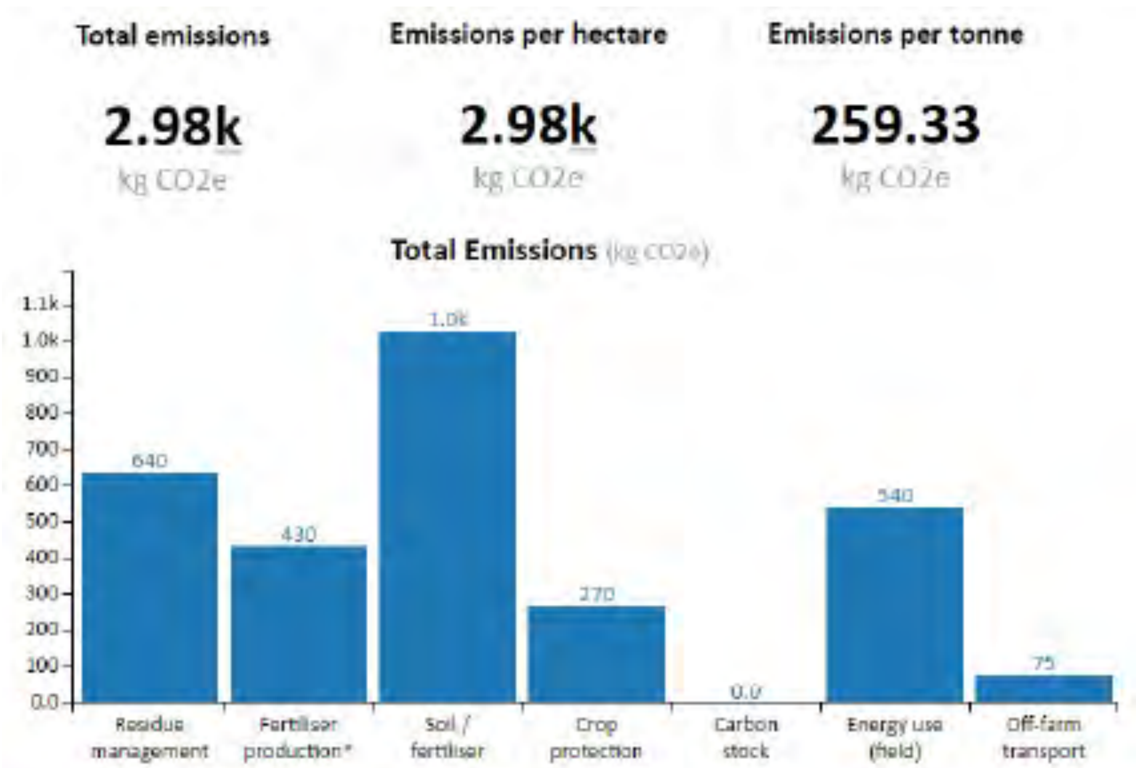


Figure 1: Output from Cool Farm Tool showing breakdown of GHG emissions from the wheat crop in Scenario 1.

Table 2: GHG emissions from New Zealand arable crops (Barber 2011)

	GHG emissions (kg CO2-e)		Average yield
	per hectare	per tonne	(t/ha)
Ryegrass seed	2190	1325	1.7
Maize silage	2190	125	17.9
Maize grain	2380	190	12.8

Table 3: Distribution of GHG emissions sources from arable farming (Barber 2011)

		Wheat	Ryegrass seed	Maize silage	Maize grain
Fuel		8%	10%	16%	19%
Electricity		6%	9%	1%	2%
Fertiliser production					
	Nitrogen	27%	30%	28%	23%
	Other	5%	4%	8%	9%
Agricultural chemicals		2%	2%	3%	4%
Field emissions					
	Nitrogen	33%	36%	32%	25%
	Lime	6%	8%	9%	5%
	Crop residue & compost	5%	0%	3%	13%
	Field burning	9%	0%	0%	0%

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Soil health in cropping systems

Abie Horrocks, FAR

Key point

Maximising your soil health will improve:

- Porosity and aeration
- Soil structure
- The number of beneficial soil organisms
- Nutrient availability
- Water storage and availability
- Yields

Not all soils are created equal, but maximising soil quality within the boundaries of the inherent properties laid down during the soil formation process (such as depth to gravels and proportion of sand, silt and clay) will increase the fitness of your soil for sustained crop production.

Over time, the production of arable crops can lead to changes (build-up or decline) in soil conditions (i.e. soil quality). Where best management practices are used, loss of soil quality under some forms of management can be balanced by other management practices that restore soil quality. Where management practices are intensive and non-restorative, the loss of soil quality increases the risk that soil conditions will limit crop productivity and cause adverse environmental impacts.

Carbon (C) is key to all aspects of soil health, as it provides an important food source for soil organisms and is the building block for all cell material. It is a key determinant of soil health because it regulates most soil biological, chemical and physical processes. The benefits of increasing organic matter (carbon) to soil function include preservation of soil structure, improved aeration, water infiltration and water storage, encouragement of earthworms and other soil fauna. There are many ways to build and maintain soil C such as with crop roots and residue, cover crops, mulch, livestock and compost. Minimising cultivation can reduce C loss as soil disturbance releases C to the atmosphere.

What is the current state of play of soil health in cropping soils of New Zealand?

This is a question that FAR is in the process of answering using existing data to capture soil health on cropping farms across NZ. A Plant & Food Research report with a focus on aggregate stability, C (% and t/ha) and penetration resistance, will use tables and diagrams to display ranges of previously measured soil quality values as well as recommended national targets (where available). An example of how this data can be used for benchmarking is given below in Figure 1 where aggregate stability has been averaged across 187 paddocks (79 intensive arable, 86 mixed arable and 22 long-term pasture). Aggregate stability is a useful measure of a soils resilience as it measures how stable individual aggregates are. This is an indication of how susceptible they are to breaking down under force from things like cultivation, heavy traffic, grazing and rainfall or irrigation impact. Good soil structure consists of stable aggregates which are bound together in a structure that has plenty of pores between and within the aggregates. These pores allow air and water movement through the soil. A stable structure resists degradation and seedlings can emerge easily and plant roots are able to grow unrestricted. Soils with poor soil structure have unstable aggregates which are fine and powdery. In a heavy textured soil the aggregates may form large dense clods with few pores. These soils compact easily, do not have a good balance of air and water movement and restrict plant root growth. Such soils are also more susceptible to erosion and reduced yields.

Preliminary results in Figure 1 show the percentage of Canterbury sites meeting the 'recommended target range' for aggregate stability by land use as:

- Intensive arable = 61%
- Mixed arable = 72%
- Long-term sheep pasture = 100

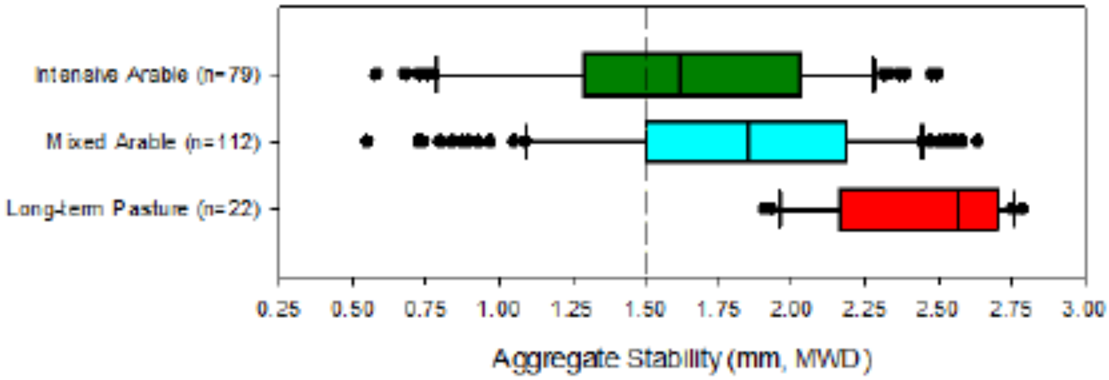

Figure 1: The box represents the middle 50% of stabilities, while whiskers represent the 10th and 90th quantiles. The line inside each box is the median value for this land use. Target value to be above is the vertical dashed line.

Data presented in Figure 1 must be treated with some caution as the representation of soil orders within the land uses is unbalanced, and we know soil properties can have a large influence on soil quality. Therefore, where there is enough data the report will separate out values by similar soil orders to help with benchmarking initiatives. For example, a farmer may want to know how their soils C % compares to other soils of the same or similar order in their region. Figure 2 is an example of how this will be presented using aggregate stability values across the different soil orders available.

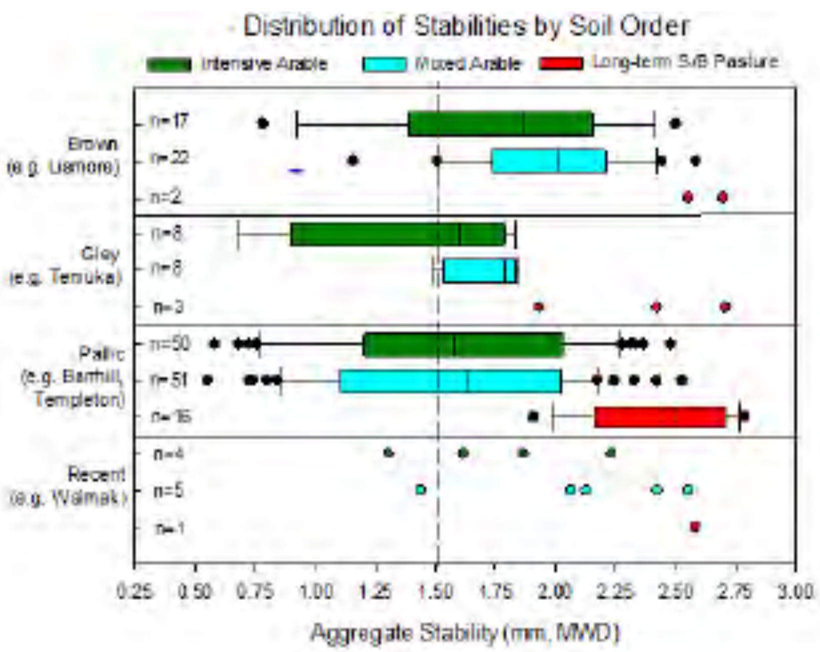

Figure 2: Distribution of aggregate stability scores by soil order.

Data source for Figures 1 and 2: State of Environment monitoring data set collected by Environment Canterbury and Plant and Food Research.

Environment Canterbury Regional Council

Plant & Food RESEARCH

Chertsey's Long-term establishment trial

Aggregate stability values at the Long-term establishment trial are shown in Figure 3. Since 2009 the inversion treatment's soil aggregate stability value has declined to below the recommended level of 1.5 MWD (the vertical dashed line in Figure 1). The non-inversion treatment fluctuates above and below this level and the no-tillage establishment treatment sits above this level. This can be explained by the soil C stocks being greater in the top 0-7.5cm (Figure 4) where there is no tillage (as aggregate stability is strongly associated with soil C).

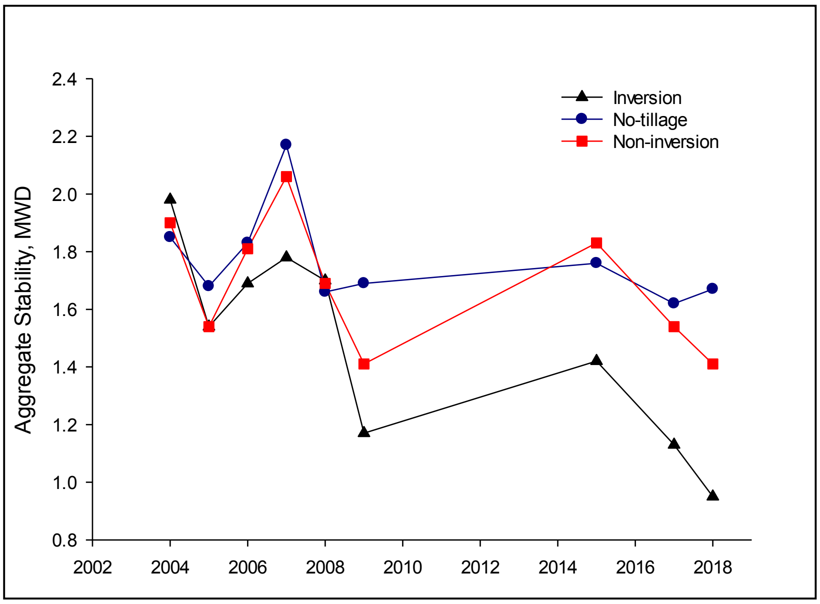

Figure 3: Aggregate stability 2004-2018 for inversion, non-inversion and no-tillage establishment treatments at Chertsey.

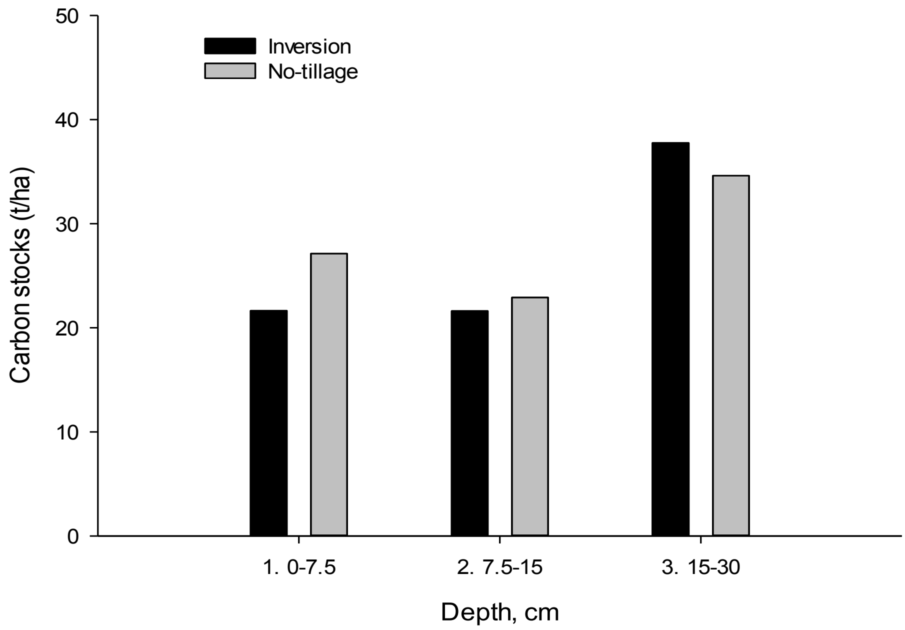

Figure 4: Carbon stocks at 07.5, 7.5-15 and 15-30 cm depth increments for inversion, non-inversion and no-tillage establishment treatments at Chertsey (measured in 2018).


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Visitor information sheet

We trust that you will enjoy your day with us at the FAR Arable Site; to assist us in ensuring your health and safety whilst on the property we ask that you read and heed the information below.

Health & safety

- Follow instructions from FAR staff at all times.
- Stay within the public areas and not to cross into any roped off area.
- Report any hazards noted directly to a member of FAR staff.

Specific hazards to be aware of:

Trips and falls: Watch out for guy ropes, irrigation pipes on the ground, uneven ground etc.
Weather: Sun block and hot and cold drinks are available at several locations on site. If the wind comes up and you feel any signs etc are unsafe, contact a FAR staff member.
Electric shock: Cables run into most tents, please take care and report any concerns to FAR staff.
Hot water urns: Watch out for cables and report any concerns to staff in the tent.
Drink driving: Alcohol will be served with dinner. Make sure you have a designated sober driver.

Emergency

In the case of an emergency, dial 111 and notify a FAR staff member.
The location is FAR Arable Site, 1904 Rakaia Highway, SH1, Chertsey.

First aid

We have a number of First Aiders and first aid kits on site. Should you require any assistance, please ask a member of FAR staff.

Rubbish

Rubbish bins are available for your use; we ask that you dispose of all rubbish considerately.

Vehicles

Vehicles will not be permitted outside of the designated car parking area, unless they are being displayed. Please ensure that your vehicle is parked in the designated area.

Smoking

No smoking permitted inside any marquee.

Thank you and enjoy your day.

Notes:

Notes:

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