WA CROP TECHNOLOGY CENTRE (ESPERANCE)

FAR AUSTRALIA

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

FIELD DAY

INCREASING PRODUCTIVITY IN THE ESPERANCE PORT ZONE

Wednesday 7th September 2022

SOWING THE SEED FOR A BRIGHTER FUTURE

Thanks to the following sponsor:

AFGRI EQUIPMENT

In collaboration with:

Department of Primary Industries and Regional Development

GOVERNMENT OF WESTERN AUSTRALIA

CSIRO

Esperance CTC trial site courtesy of: the Whiting family

VISITOR INFORMATION

We trust that you will enjoy your day with us at the WA Crop Technology Centre (Esperance) Field Day. Your health and safety is paramount, therefore whilst on the property we ask that you both read and follow this information notice.

HEALTH & SAFETY

- All visitors are requested to follow instructions from FAR Australia staff at all times.
- All visitors to the site are requested to stay within the public areas and not to cross into any roped off areas.
- All visitors are requested to report any hazards noted directly to a member of FAR Australia staff.

FARM BIOSECURITY

- Please be considerate of farm biosecurity. Please do not walk into farm crops without permission. Please consider whether footwear and/or clothing have previously been worn in crops suffering from soil borne or foliar diseases.

FIRST AID

- We have a number of First Aiders on site. Should you require any assistance, please ask a member of FAR Australia staff.

LITTER

- Litter bins are located around the site for your use; we ask that you dispose of all litter considerately.

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- Vehicles will not be permitted outside of the designated car parking areas. Please ensure that your vehicle is parked within the designated area(s).

SMOKING

- There is No Smoking permitted inside any marquee or gazebo.

Thank you for your cooperation, enjoy your day.

COVID-19

Help us keep COVID-19 away.

If you are visiting FAR Australia offices or trial sites, please observe the following good hygiene practices to reduce the risk of infection with COVID-19:

- Sanitise your hands when entering the office or trials' site and at regular intervals.
- Wash your hands regularly for 20 to 30 seconds. If soap and water is not available, use an alcohol-based hand sanitiser. Hand sanitiser does not replace washing your hands after using the bathroom.
- Avoid touching your eyes, nose and mouth.
- Cover your mouth and nose when coughing and sneezing with a tissue or cough into your elbow.
- Dispose used tissues into a bin immediately and wash your hands afterwards.
- Practice social distancing:
    - Keep a distance of 1.5 metres between you and other people.
    - Avoid crowds and large public gatherings.
    - Avoid shaking hands or any other physical contact.

Thank you for your cooperation.

INCREASING PRODUCTIVITY IN THE ESPERANCE PORT ZONE

FEATURING THE GRDC'S WA HIGH RAINFALL ZONE FARMING SYSTEMS PROJECT

On behalf of our investor, the **Grains Research & Development Corporation** along with the project team, I am delighted to welcome you to our 2022 Esperance Crop Technology Centre Field Day featuring High Rainfall Zone (HRZ) Farming Systems.

The HRZ Farming Systems project is led by the Department of Primary Industries and Regional Development (DPIRD) in collaboration with FAR Australia and Commonwealth Scientific and Industrial Research Organisation (CSIRO). This project has the objective of optimising cropping in the western HRZ regions.

To make the programme as diverse as possible I would to thank all our speakers who have helped to put today's programme together; in particular our keynote speaker Eric Watson who with his wife Maxine has made the trip from New Zealand to join us today. As the current world record holder for highest yield of wheat Eric will share some of his thoughts on those ingredients that help push our productivity forward wherever you farm.

Finally, I would like to thank the GRDC for investing in this research programme. Also, a big thanks to the Whiting family our host farmers for their tremendous practical support given to the team and to today's sponsor AFGRI for providing lunch and post event refreshments.

Should you require any assistance today, please don't hesitate to contact a FAR Australia staff member. We hope you find the day informative, and as a result, take away new ideas which can be implemented in your own farming business.

Nick Poole
Managing Director
FAR Australia

What is the project background and how did it originate?

HRZ Farming Systems

Over the past decade there has been a trend towards more cropping in the High Rainfall Zone (HRZ) but yields are typically 1-3 t/ha below water-limited yield potential for wheat and 0.5-1.5 t/ha for canola in an average season. This presents a significant opportunity to lift the profitability of cropping systems in the HRZ, defined in Western Australia as arable areas with annual rainfall above 450mm. This GRDC project was created to support growers to overcome major constraints, adopt superior long-season varieties and develop management packages to express superior yield potentials. In this project, DPIRD, CSIRO and FAR Australia have combined their expertise in farming systems, bio-economic modelling, disease management, and systems agronomy to work with growers to develop high production packages for the HRZ.

Over the three years of the project, the team has focussed on supporting growers to increase the value of the cropping phase in the HRZ farming system by 10%. This is being done by addressing both crop yield potential and the gap between potential and realised yield in wheat and canola crops grown in the HRZ of the Albany and Esperance port zones.

In 2019 the project team ran workshops at Dandaragan, Green Range and Esperance with farmers and advisers to help define the key elements of the HRZ and R&D needs to support increased productivity and profit. Issues, opportunities and priority questions identified guided the establishment of the experimental program in 2020. Key priorities coming from these workshops included how to best manage agronomy when potential is increased with soil amelioration, how to lift production through a combination of early sowing, improved genotypes and appropriate agronomy in cereals, how to manage nutrition to target high yields in HRZ environments, and how to improve the harvest index (achieved yield from established biomass) in large and bulky HRZ crops.

This project over the last two seasons has helped to deliver a better understanding of the yield potential of different combinations of germplasm (i.e. winter vs spring germplasm) and farming systems inputs. This gives us the opportunity on farm to identify options that can reduce the yield gap in the HRZ, and help quantify the economic risks associated with potentially higher input farming systems.

The project team is also working closely with SEPWA and Stirlings to Coast Farmers who are running paddock-scale demonstration projects (under PROC-9175784). This provides regular engagement with growers and consultants and ensures promising results from small-plot trials are validated at a paddock scale using commercial machinery.

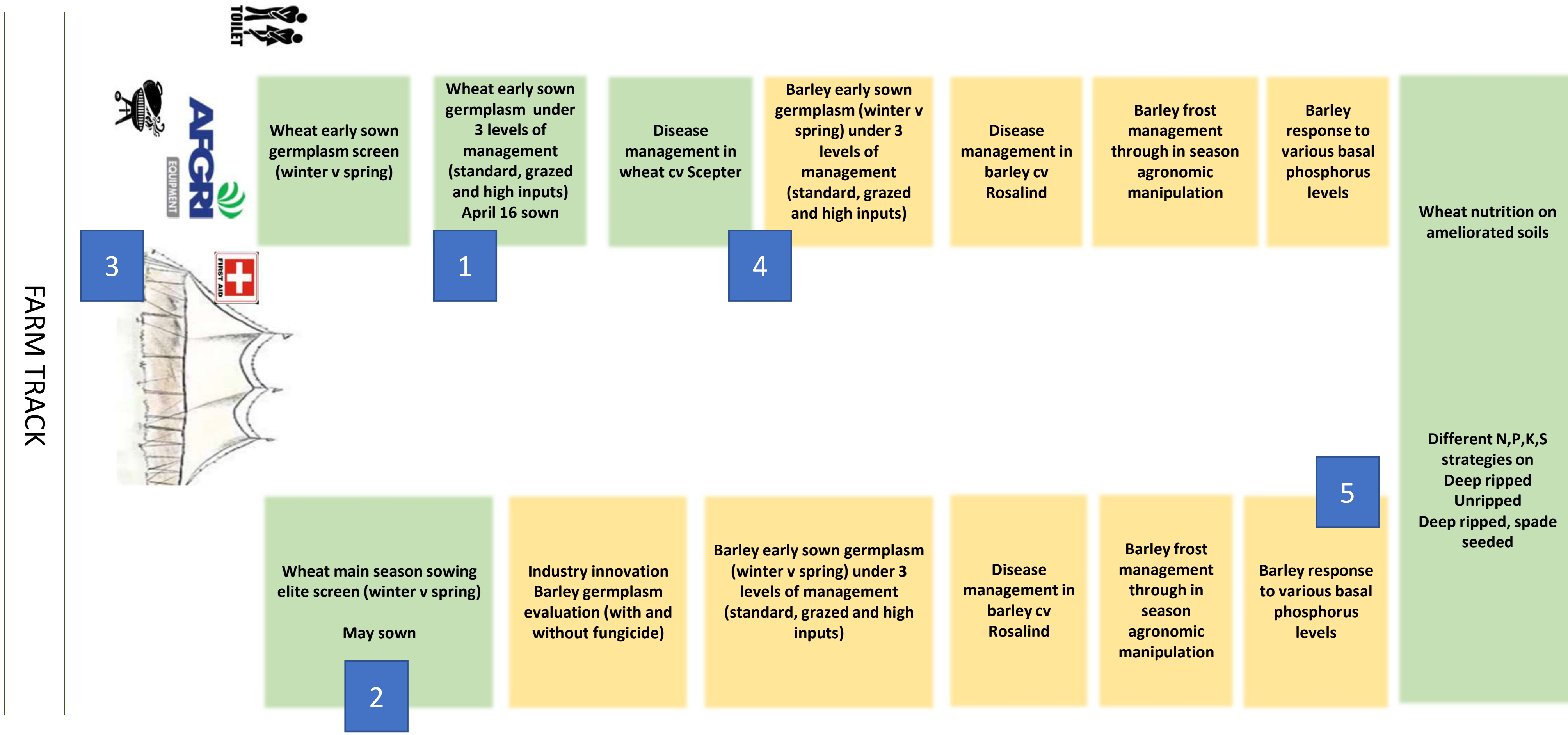
For more information on cereals contact Nick Poole (nick.poole@faraustralia.com.au) from FAR Australia.

For more information on canola contact Jens Berger from CSIRO (jens.berger@csiro.au) or Jeremy Curry from DPIRD (jeremy.curry@dpird.wa.gov.au).

WA CROP TECHNOLOGY CENTRE (ESPERANCE)

2022 SITE MAP: WA CROP TECHNOLOGY CENTRE (ESPERANCE)

Featuring the GRDC's High Rainfall Zone Farming Systems



WA CROP TECHNOLOGY CENTRE (ESPERANCE)

TIMETABLE

WA CROP TECHNOLOGY CENTRE FIELD DAY (ESPERANCE): WEDNESDAY 7 SEPTEMBER 2022

Featuring the GRDC's High Ranfall Zone Farming Systems Project

In-field presentations	Station No.	10:45-12:10	12:30	1:15	1:30	2:00	2:30	3:00	3:30	4:00
Jeremy Curry & Andrea Hills, DPIRD, Andrew Fletcher, CSIRO and Brad Westphal, Nutrien *Key research findings, successes in HRZ canola cropping across WA, and where future gains might come from.*	Canola research site	ALL	Lunch kindly sponsored by	Nick Poole, FAR Australia Managing Director - Welcome Darrin Lee, GRDC Western Panel Chair - Opening address						Closing address followed by refreshments kindly sponsored by
Eric Watson, NZ Grower and Guinness World Record Holder for highest wheat yield. *Are there learnings from the world record crop we can use here in the Esperance Port Zone?*	1				1				2	
Andrew Fletcher, CSIRO *What does modelling suggest about our yield potential in the Esperance Port Zone?*	2				2	1				
Geoff Fosbery, ConsultAg *Applicability of Hyper Yielding Crop Projects in the Medium and Low Rainfall Zone.*	3					2	1			
Nick Poole, FAR Australia *What have we learnt about maximising wheat and barley production at the Esperance Crop Technology Centre?*	4						2	1		
Jayme Burkett, FAR Australia and Nicky Tesoriero, Ceres Agronomy *P response in barley.*	5							2	1	
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For the afternoon's presentations, would be obliged if you could remain within your designated group number.

Thank you for your cooperation.

1	GROUP 1
2	GROUP 2


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2021 WA HRZ Project Canola Results – Esperance Nutrition

Jeremy Curry and Mark Seymour (DPIRD)

Aim

To determine whether macronutrient supply (phosphorus (P), potassium (K), sulfur (S)) becomes limiting as canola growers target high yields with high nitrogen rates in the high rainfall zone of WA.

Background

Improvements in farming system, yield potential of hybrid varieties and in agronomic management have increased realised canola yields in the HRZ. This raises a number of questions regarding fertiliser management of these high yielding crops including:

- How high do nitrogen applications need to be to target a 3-5t/ha canola crop?
- Is there a need to increase P/K/S supply to achieve these high yields?
- Do the critical soil or tissue test values hold true at these high yield potentials?

In the 2020 trial, despite yields of over 3.5t/ha when over 200 units of N was applied, there was little yield response to applying more than 15 units of phosphorus or to any applications of sulfur (S), potassium (K) or trace elements (copper, zinc and manganese).

The 2021 trial was located at Gibson and was sown to HyTTec Trifecta (3.8kg/ha to establish 40 plants/m^2) on 16 April. The paddock was deep ripped prior to the 2019 season.

Key Results:

Table 1: Soil test results taken at seeding at 10cm incremental depths.

Soil group: Grey deep sandy duplex

Depth	0-10cm	10-20cm	20-30cm	30-40cm	40-50cm	50-60cm
pH (CaCl2)	5.1	5.2	5.0	4.9	5.3	5.6
P (HCO3) (µg/g)	12	9	23	19	6	2
K (HCO3) (µg/g)	59	42	31	39	36	68
N (NH4) (µg/g)	8	4	2	2	2	2
N (NO3) (µg/g)	16	9	7	6	5	3
S (µg/g)	4.1	4.8	6.9	10.5	7.5	14.5
Organic carbon (%)	0.72	0.59	0.25	0.18	0.14	0.14
PBI	10.3	10.7	17.5	23.4	28.4	61.3
DGT-P	112	88	61	21	< 5	< 5

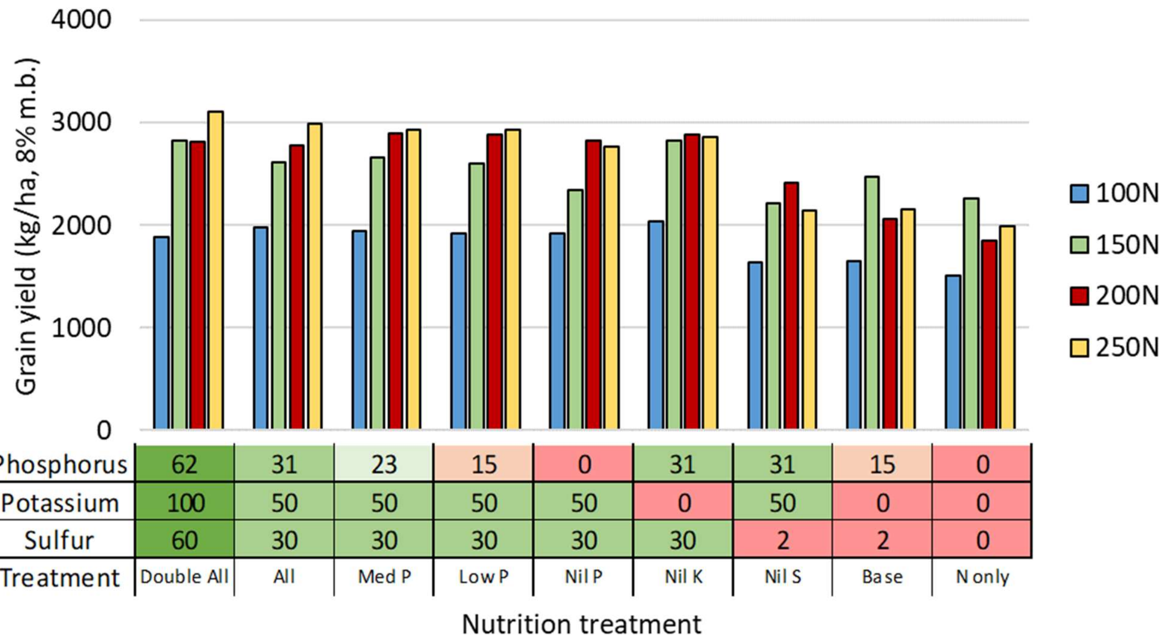


Figure 1: Canola grain yield (kg/ha, corrected to 8% moisture) of nine nutrition (variable phosphorus, potassium, sulfur) treatments across four nitrogen (N) rates at Gibson in 2021. LSD = 690kg/ha (345kg/ha within same N rate).

Summary

- Soil test results indicated that a response to sulfur was likely, while Colwell P (0-10cm) was just below critical levels (https://agric.wa.gov.au/n/6748).
- There was a large yield response to sulfur at this site, with applied sulfur increasing yield by over 800kg/ha with 250N applied. There was no response to phosphorus or potassium at this site.
- Although waterlogging (June to August) constrained yields at the site, increasing the nitrogen rate from 100N to 150N still increased grain yield from 1.9t/ha to 2.6t/ha (low sulfur plots excluded). Yield increases above 150N were modest, with 250N resulting in an average grain yield of 2.9t/ha.
- Given the large yield responses to nitrogen at this site, even with a theoretical 3:1 urea to canola price (e.g. urea $1500/t, canola $500/t), applying 150N resulted in the highest gross margin.

2020 Trial Report

2021 Trial Report

2021 WA HRZ Project Canola Results – Esperance Canopy Manipulation

Jeremy Curry and Mark Seymour (DPIRD)

Aim

To investigate whether chemical (plant growth regulators, PGRs) or mechanical (defoliation) manipulation of canola during growth can reduce height and improve harvest index while maintaining yield in the HRZ.

Trial details:

The 2021 site was located at Gibson and was sown to HyTTec Trophy on 16 April (at 3.6kg/ha to establish 40 plants/m^2). Eight canopy management treatments were applied across two nitrogen timing strategies. The canopy management strategies included Low and High (2 x Low) rates of two plant growth regulators (PGRs, not currently registered for canola) at early stem elongation (17 June), or two applications of the Low rate applied at early stem elongation and at early flowering (05 July). A defoliation treatment was applied at the seven-leaf stage (09 June) to simulate the effect of grazing. The nitrogen timing strategies involved a total of 200N applied with the bulk targeting either early (21 May) or late (24 June) vegetative stages.

Key Results:

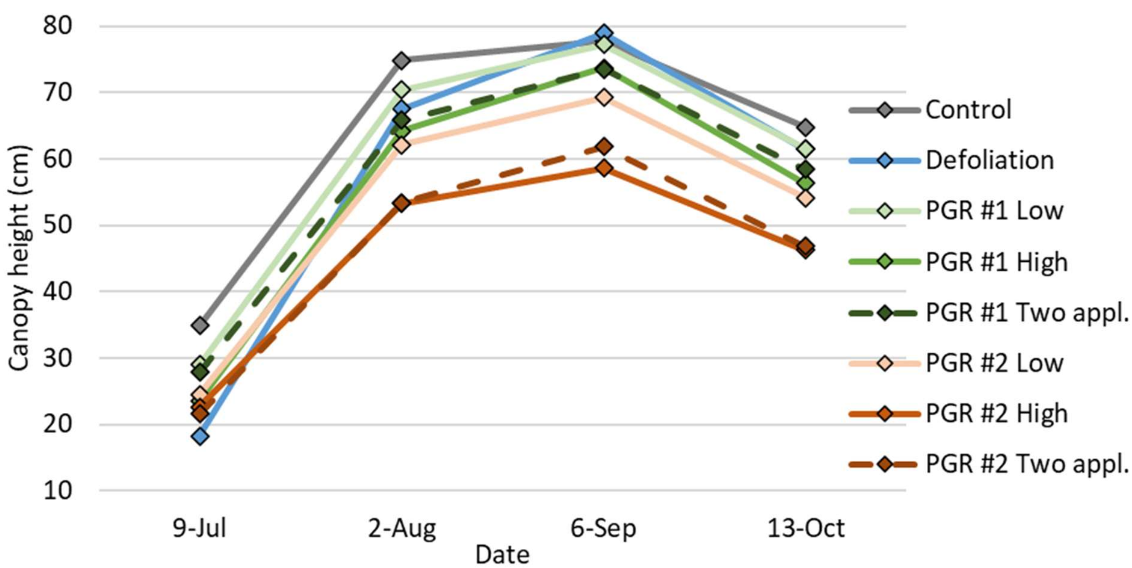


Figure 1. Canopy height (cm) of the eight canopy management treatments during growth and at maturity (average of six replicates at two nitrogen timings).

The PGRs showed significant impacts on plant height within two weeks of application and these effects persisted to maturity, with PGR #2 having a greater impact than PGR #1. Two applications did not impact final canopy height relative to applying the same total product in one application.

Defoliation (to 8-10cm height) in early June at the seven-leaf stage removed approximately two-thirds of the 1t/ha of dry matter produced to that date. Prolonged waterlogging (June to August) inhibited recovery of these plots, resulting in lower final biomass and yield regardless of whether the bulk of the nitrogen was applied before or after defoliation. Despite reducing height, the two plant growth regulators (regardless of timing or rate) generally did not impact biomass nor reduce yield relative to the control treatment.

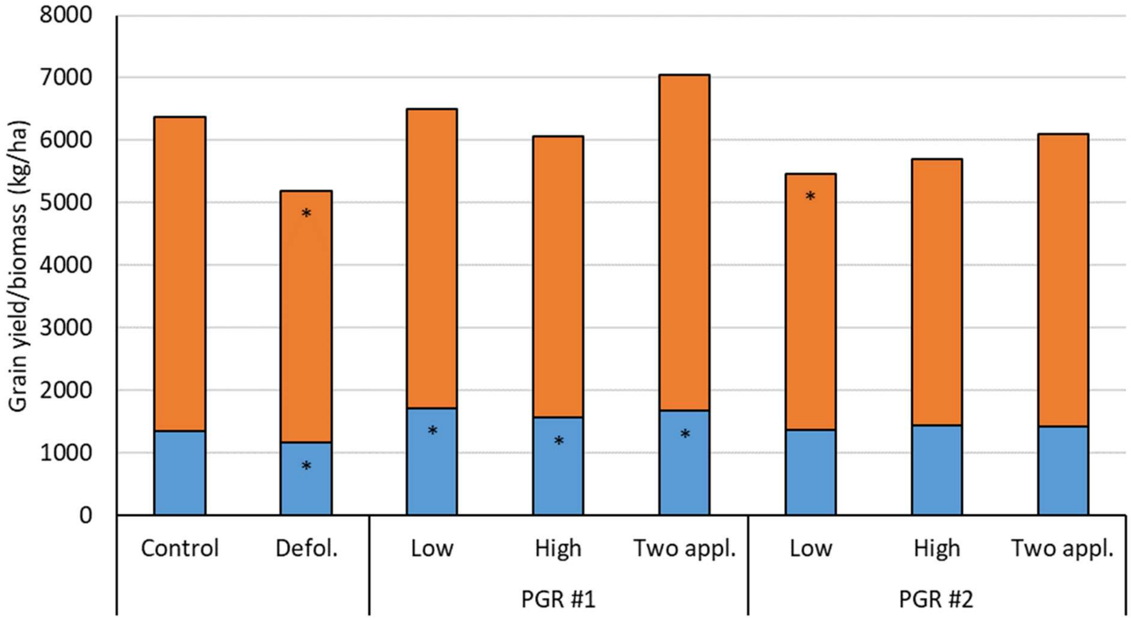


Figure 2. Grain yield (blue bars) and biomass at maturity (dry weight, orange bars) of the eight canopy management treatments (average of six replicates at two nitrogen timings). Asterisk denotes value is significantly (p<0.05) different to the control.

Summary:

- Prolonged waterlogged conditions limited plant height to below 80cm, total biomass production to below 7t/ha and yield to less than 2t/ha in this trial.
- PGR #1 had more modest impacts on plant height than PGR #2 yet resulted in a small increase in grain yield and oil.
- Defoliation (such as could be achieved with grazing) resulted in reduced yields due to inadequate biomass recovery following wet winter conditions.
- Nitrogen timing did not impact final biomass and yield, nor show an interaction with any canopy management treatments.
- Two years of trials of the plant growth regulators in highly contrasting seasons at Gibson have shown consistent reductions in height and biomass with minimal yield impacts; further testing is being conducted on both products in 2022.

Are there learnings from the world record crop we can use here in the Esperance port zone?

Eric and Maxine Watson farm a 490ha, fully irrigated arable property at Wakanui, near the coast on the Canterbury Plains, in the South Island of New Zealand. The soils are mostly silt to clay loams with an area of stony, shallow silt loams along the Ashburton River.

Wakanui has a temperate, island climate, with a long growing season (warm daytime temperatures and cooler nights). The average annual rainfall is about 600 mm but growing season rainfall is very variable. The property is fully irrigated, with 9 laterals, 7 with Variable Rate technology, drawing from 4 wells. There is an annual permitted volume of 1,432,792 m^3 (270 litre/sec, 4.4 mm/ha/day, approx. 311mm/ha)

Cropping programme - cultivation at a minimum where possible, while being mindful of the need for good seed-to-soil contact, with some direct drilling where applicable. Crop grown varies from year to year but roughly 1/3 cereals (mostly wheat), 1/3 grass for seed (perennial ryegrass, forage & amenity fescues, cocksfoot, and timothy) and 1/3 'other' - vegetable seeds (spinach, canola, radish; alternative pasture species (plantain, chicory, clover); and pulses (peas & faba beans).
Rotation depends on market, availability of seed and paddock history. Grasses are the most important component of the rotation, to build soil structure.

The main **driving forces** of the operation are timeliness and attention to detail. Grid-based intensive soil testing is carried out every second year. Deep soil N testing is undertaken in early August. Leaf tissue analysis is done throughout the growing period to diagnose trace element deficiencies. Neutron probes are used in most paddocks and read weekly to measure soil moisture and, with the VRI technology, provide great efficiencies with water usage.

What was learned from the 2017 record crop and applied in 2020?

- Stripping was very evident as seen from the combine - poor nitrogen application at 32m, also granular N inconsistent – bird damage evident there also. Hence the decision to go to liquid application of nitrogen.
- Quality of cultivation, drilling – good seed-to-soil contact
- Good seed very important, watch for new, improved varieties
- BYDV control critical
- Need to minimise plant stress

<u>**The 2020 Record Crop**</u>

The **variety** sown, on 17 April 2019 , at 73kg/ha, was Kerrin, an English feed wheat. It produced a crop with 136 plants/m^2 (1260 tillers/m^2)
Spray programme was rigorous and preventative. Three herbicides were used - necessary to maintain a clean crop – competition from weeds can affect yield considerably. Five fungicides applied on "prevention not cure" basis, to maintain green leaf area. Main diseases: some stem-based diseases (sharp eye-spot); septoria, brown

& yellow rusts; and head diseases especially in a damp season. Five insecticides were employed, mainly to prevent BYDV. PGRs were very important, to prevent lodging. Leaf tissue analysis was undertaken throughout the growing season so the plants wanted for nothing through trace element deficiencies.

Fertiliser: Superphosphate was applied at 500kg/ha prior to drilling. Nitrogen applied in liquid form, as were most trace elements. This greatly improved the accuracy of spread. A total of 5 applications of N applied (300kg/ha), with the total N uptake 20kg/T/grain removed, including soil nitrogen. Potassium was applied mid spring after herbage testing to match the crop requirements at the critical growth stage, as was sulphur.

	N	**P**	**K**	**S**	**Mg**
Total Kgs	301	45	100	88	0
Plus Soil N	46				
Total	**347**	45	100	88	
Kg/T/Grain removed	20	3.73	5.74	5.05	

Irrigation: a total of 140mm irrigation in 4 applications from early November to early January. The growing season rainfall 2019-20 (1 April- 31 January) was 548mm. The rainfall from 1 Nov to 31 Jan was 132mm - the crop was actually under moisture stress at one stage.

Weather played a big part in the success of the record attempt. It was an ideal sowing season, followed by a warm, dry winter and spring. During grain-fill the nights were cool and dewy, with sunny, warm daytime temperatures and no excessive heat (only 3 days over 30*C)

Thoughts for the future:

- Climate change - warmer winters – disease pressure? uncertain rainfall, more extremes?
- Crispa, gene technology - as yet banned in New Zealand
- Carbon sequestration/tax /reporting/ land use
- Regenerative Ag – politicians on the bandwagon and a disturbing amount of extremism
- Water – limited resource, more competition
- Fertiliser - availability, cost, soil testing, regulation limiting nitrogen use
- Regulation – National Policy Statements in New Zealand - some good (protecting productive land) but others unrealistic, like Freshwater
- Potential loss of Agrichemicals that we need
- Resistance to herbicides
- Biosecurity

What does simulation modelling tell us about yield potential in the Esperance Port Zone?

Andrew Fletcher, Chao Chen, Jens Berger

Our objective was to investigate yield potential and the factors leading to improved yield potential in the HRZ with a particular focus on exploiting early sowing opportunities. A central hypothesis being tested was that we could improve wheat yield potential by utilising early sowing opportunities with long-season wheat cultivars that required vernalisation compared to the more commonly used mid and late-spring types.

We used APSIM-Wheat to simulate potential yields of wheat. Initially, the model showed a poor agreement of observed and simulated yields which improved markedly after calibrating flowering time. Thereafter, long-term simulation studies were undertaken for Esperance using the tested APSIM-Wheat model with relatively recent climate data (1990-2021).

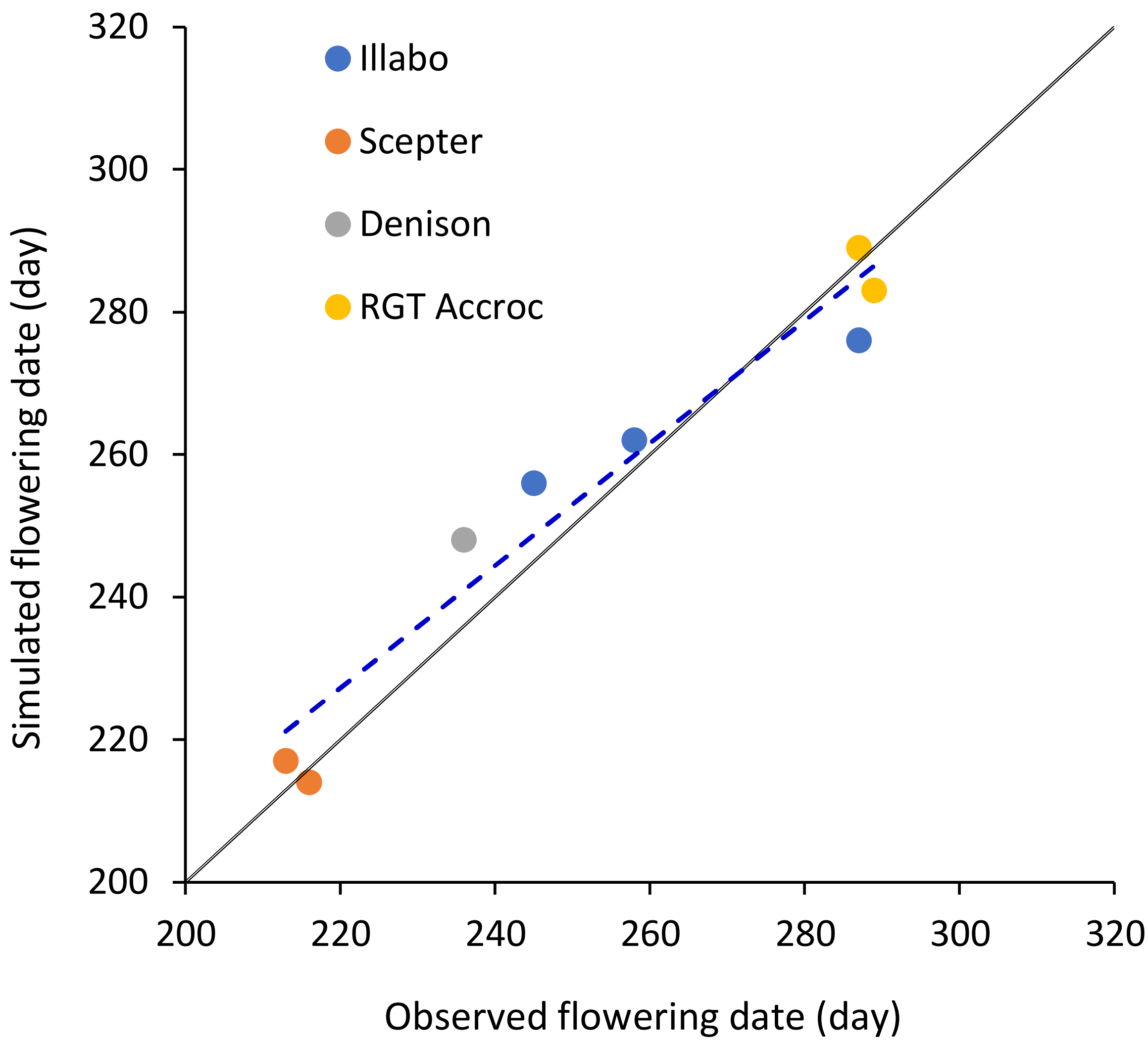
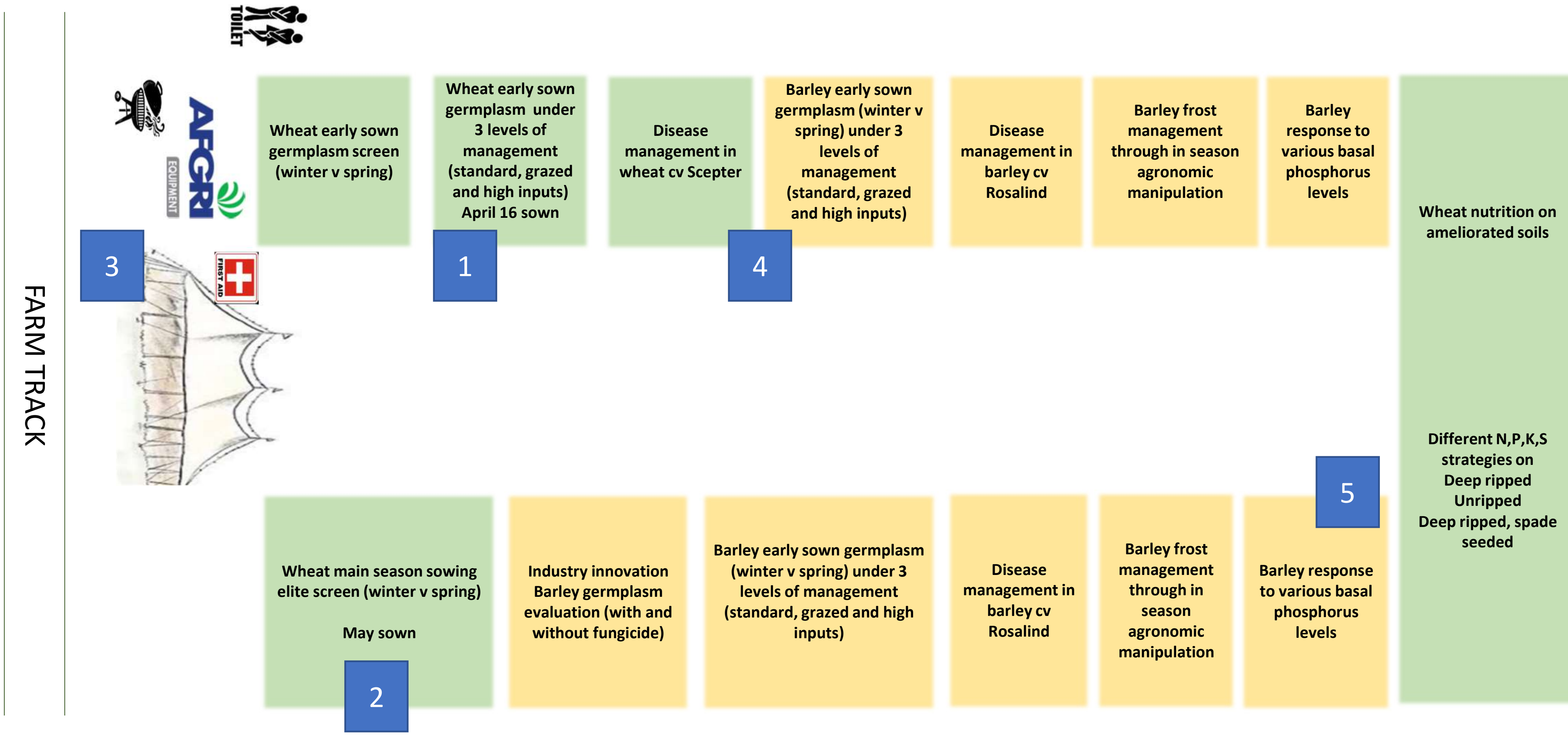


Figure 1. Observed and simulated flowering date at Esperance

WA CROP TECHNOLOGY CENTRE (ESPERANCE)

2022 SITE MAP: WA CROP TECHNOLOGY CENTRE (ESPERANCE)

Featuring the GRDC's High Rainfall Zone Farming Systems



WA CROP TECHNOLOGY CENTRE (ESPERANCE)

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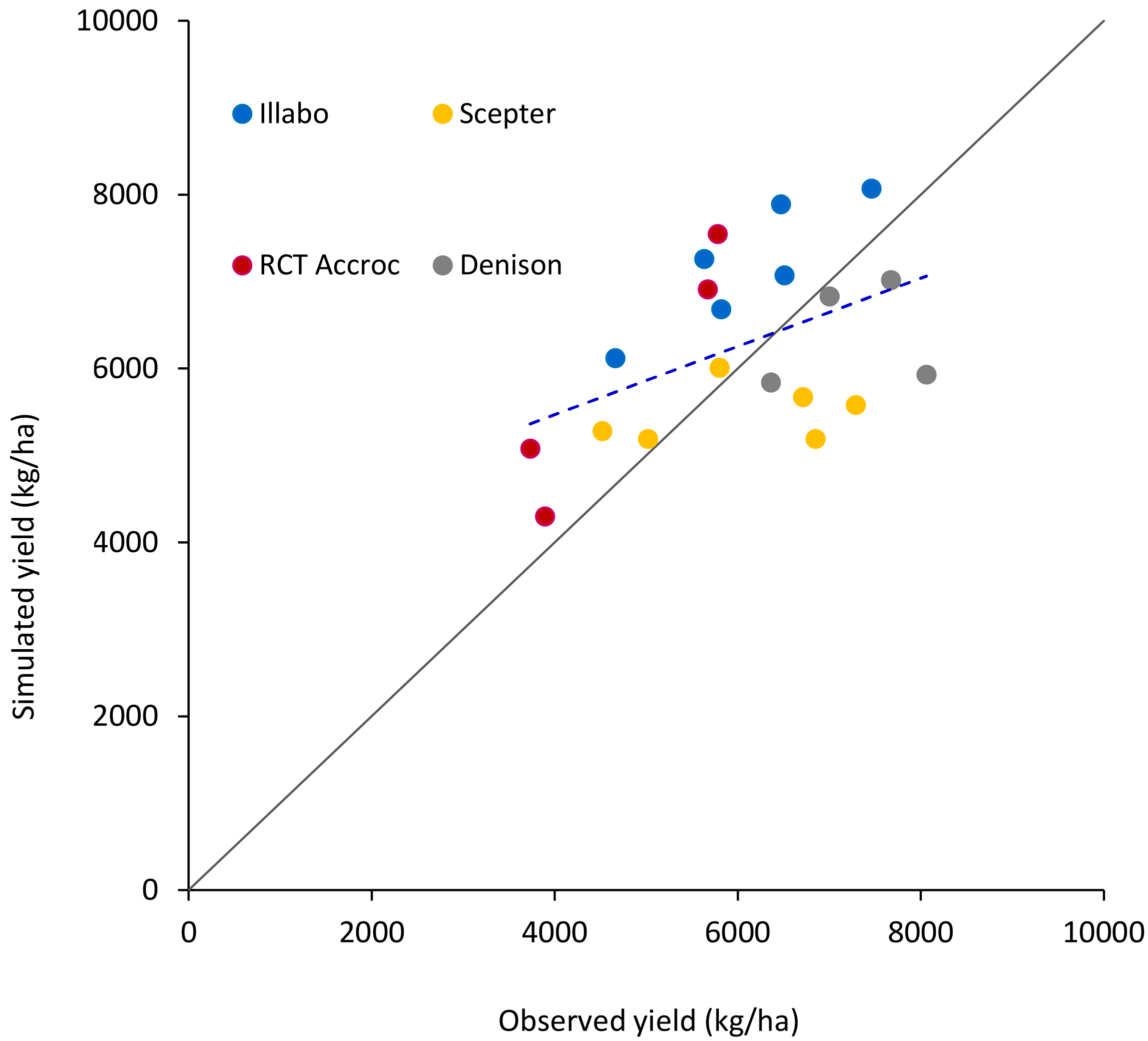

Figure 2. Observed and simulated yield at Esperance.

We identified optimal combinations of sowing date and cultivar from six times of sowing (10 Apr, 20 April, 30 Apr, 10 May, 20 May and 30 May) under unlimited N supply. The four cultivars covered a wide range of flowering time, from RGT Accroc (most vernalisation sensitive mid-winter type), Illabo (early winter type), Denison (late spring type) and Scepter (least vernalisation sensitive mid spring type). Regardless of genotype the greatest yield was achieved when sown around the 10 April. Among the four cultivars, the strong winter genotype (RGC Acrocc) achieved the lowest yield. When an early sowing opportunity was available (before 20 April), early winter and spring cultivars would achieve similar yields, but if a cultivar had to be sown later than late April, spring cultivars would consistently outperform winter cultivars.

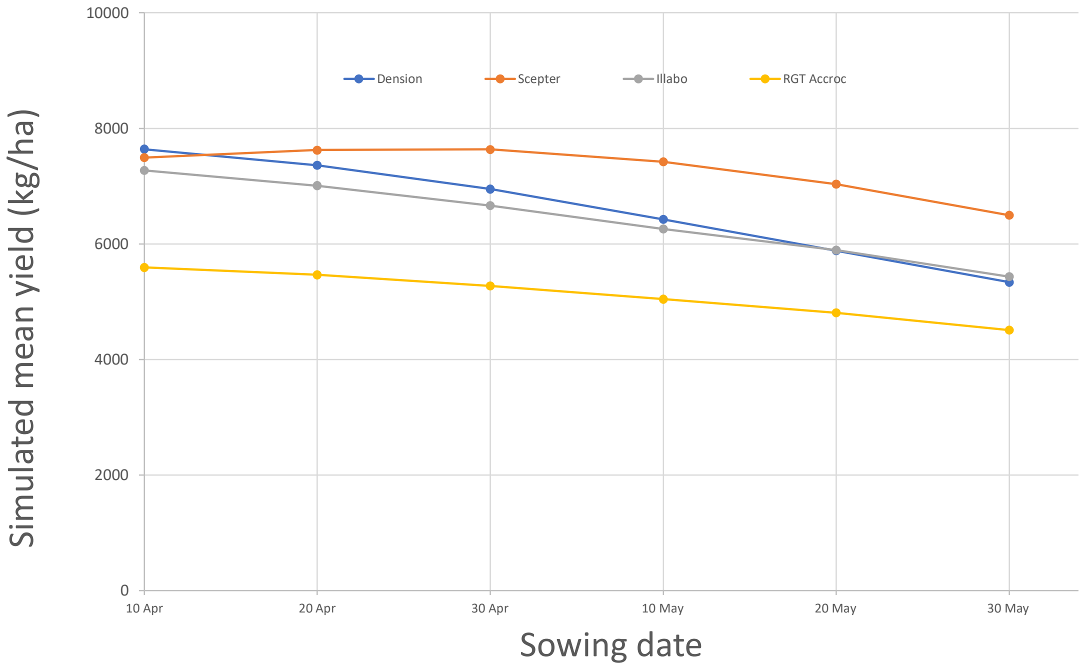

Figure 3. Simulated mean yield at Esperance for a range of sowing dates and cultivars.

While the calibrated APSIM model has a reasonable agreement between observed and simulated yields, there were still a number of situations where observed yield exceeded the simulated yields. This highlights that farmers in the Esperance HRZ are doing a great job and producing yields close to the potential.

APSIM underestimation of yield may have been due to:

- Imperfect knowledge of initial starting conditions of the model. (i.e. soil water and N)
- Poor soil characterisation. We made our best estimates of the appropriate soil type but may not have fully captured the impacts of soil amelioration.
- Imperfect knowledge of plant growth processes/seasonal responses.

HRZ cropping is a dynamic exercise with growers changing soil characteristics through amelioration and trying out new cultivars that are increasingly sown relatively early compared to traditional practices. To apply models like APSIM in a meaningful way requires lots of data that describes soil conditions and plant growth throughout the season so that the model can be thoroughly validated, and unexpected mismatches between observed and expected used to drive hypotheses that will improve our understanding of the system. We suggest that the yield benefit from long season cultivars sown early is far from settled and needs further investigation.

Experiences with long season wheats in medium to low rainfall areas

Geoff Fosbery (Principal Technical Consultant), Farm Focus Consultants, Dongara.

Background

It is not new to grow long season wheats from early April and even March. In 1927 the Western Australian Department of Agriculture earliest sowing recommendation for wheat was from April 1st! As climate change and variability has been developing over the last few decades relative to the previous century the number of crop germination opportunities in May and June in eastern wheat belt low to medium rainfall areas has significantly decreased. This is in contrast to March and April where the number of crop germination opportunities has significantly increased in the eastern wheatbelt. The sowing of unsuitable wheat varieties too early on these opportunities has also increased the risk of frost risk. Therefore, there has been interest in trialling longer season wheats on these early germination opportunities.

Pro's

- Where early rain has occurred on paddocks that can become waterlogged an early established wheat crop can develop significant biomass above and below ground prior to winter rains utilising more water and is able to with stand anaerobic soil conditions longer than an establishing wheat crop.
- The efficiency of utilisation of nutrients in the soil bank and applied is significantly better than later sown crops. Wheat roots in Clay soils grow at about 1cm/day while sandy soils with few constraints can grow at around 2cm/day. Longer season varieties are therefore possibly growing 30 to 70cm greater root growth which are able to explore significantly greater soil volume for water and nutrients.
- Early sown wheat can be a source of Autumn Feed gap for the stock enterprise. Grazing can commence from the 4 to 5 leaf stage but at least 3 to 4 cm of green material needs to be left for the crop to recover.
- Extending the window of opportunity to germinate crops increases the area a farm business seeding capital (airseeder, tractor, seed and fertiliser trucks, etc.) can sow. This can decrease the machinery costs per cropped hectare and perhaps allow farm expansion without further capital investment in seeding equipment.
- Thousands of hectares of light land are being ameliorated during Summer and Autumn and on some occasions the ameliorated paddock is left barer than would be liked and susceptible to wind erosion. A longer season wheat variety (usually a winter wheat) can be sown into this situation, possibly straight after amelioration or after follow up rain, to provide cover and prevent a wind erosion risk and provide an excellent crop.
- If the early sown wheat is not suitably successful in establishing, then there is often still time to sow a wheat crop in the paddock utilising a more conventional variety and germination time. There is a cost but not a disaster!

Con's

- When sowing into soil temperatures at 30 degrees plus there is often a shortening of the coleoptile therefore, chasing soil moisture can be difficult. Use a variety with a longer coleoptile and a large seed size to help compensate.
- The weed control packages for these early germinating wheat crops are difficult as many weeds to germinate need colder soils. This doesn't happen till the wheat crop is well established, competitive and look relatively clean in June, then the pre-emergent grass weed controlling herbicides have broken down to a level where they may stunt the new germinating grass cohort but they can set seed. Therefore farmers should select relatively clean paddocks to trial this wheat establishment system.

The primary role of Field Applied Research (FAR) Australia is to apply science innovations to profitable outcomes for Australian grain growers. Located across three hubs nationally, FAR Australia staff have the skills and expertise to provide 'concept to delivery' applied science innovations through excellence in applied field research, and interpretation of this research for adoption on farm.

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SOWING THE SEED FOR A BRIGHTER FUTURE

Lessons from the cereals research in the High Rainfall Zone (HRZ) Farming Systems project in Western Australia

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Key messages

- Ameliorated sandplain soils deep ripped to 800mm increased wheat yield by approximately 0.5t/ha at a cost benefit ratio of just less than $2 return for every $1 spent when crops were grown under standard nutrition.
- 2021 results for the first time in the project illustrated that higher nutrition offset the benefits of soil amelioration indicating that unripped ground had greater need for higher fertiliser input in seasons of higher potential.
- Winter wheat cultivars extend the ability to sow early (early – mid April) on large acreages, however, with yields of 6-8t/ha (2020 & 2021) the HRZ project has to date shown no difference in yield between the best winter and spring cultivars on ameliorated soil in a frost-free environment.
- Increased inputs, particularly nutrition have been the key to cost effective yield increases in wheat trials over the last two seasons, while in barley both disease management and nutrition hold the key to higher output in seasons of higher yield potential.
- The principles of canopy management are more applicable to the increased yield potentials of ameliorated soils and to maximise crop yields in the better seasons of the WA HRZ.
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WA HRZ Farming Systems project at Esperance – what were the objectives of this project?

The WA HRZ farming systems project is a GRDC multi-agency (DPIRD, FAR Australia, CSIRO) investment that aims to reduce the gap between current and potential yield in wheat and canola in WA's HRZ. The concept of the cereal research programme for the HRZ project has been to explore the productivity and profitability of cereal crops (primarily wheat) sown in mid-April (16 April sowing date for all three years) as part of a soil ameliorated farming system. This research has been primarily conducted on sandplain here at the Whitings Farm (Shepwok) in the Esperance region (a frost-free environment).

Soil amelioration and crop establishment

Results from the HRZ project in 2020 and 2021 illustrated that there was a significant yield advantage of 0.45 & 0.47 t/ha respectively to deep ripping to a depth of 800mm on a sandplain soil prior to establishing wheat. With ripping costed at $80/ha and grain at $310/t soil amelioration produced an approximate return of just under $2 for each $ spent (assuming benefits were only apparent for one year). Spade seeding superimposed on deep ripping (costing approximately $140/ha) generated higher yields (0.69t/ha) than deep ripping alone but was less responsive to higher levels of nutrition input (both extra N and extra NPKS), indicating that spade seeded crops had access to greater nutrient availability without the need for the increased fertiliser input (Table 1).

Table 1. Influence of deep ripping and establishment method on 2021 season grain yields (t/ha) under nutrition strategies regimes – FAR Esperance Crop Technology Centre 2021 sown 14 May Catapult

		Nutrition superimposed establishment method					
		Standard		Standard + N		Standard + NPKS	
Amelioration & Establishment							
2019 Ripped, Tine DBS		3.30	d	3.66	cd	4.72	a
2019 + 2021 Ripped (800mm), Tine DBS		3.77	c	4.31	b	4.59	a
2019 + 2021 Ripped (800mm),Spade Seeder		4.46	a	4.62	ab	4.46	a
Rip x Nutrient interaction	P value - 0.003	LSD 0.39					

Standard N based on 164kg N/ha with 40N extra in standard + N and

N: 204kg N/ha P: 5.6kg, K: 23.7kg, S: 42kg/ha in standard + NPKS

Using management to build and protect high yielding crops in wet environments (seasons)

Canopy management is a broad term but fundamentally relies upon adopting techniques that allow crops to intercept more radiation (sunlight) and transpire more water into biomass at the time in the season that contributes most to yield. This is first achieved by ensuring flowering is matched to environment (optimally for WA HRZ mid-September) and second by ensuring that a high proportion of the upper crop canopy leaves remain intercepting light (retain green leaf area, disease control) during the 'critical period' for grain number formation (month before flowering in cereals). Unlike low rainfall environments, excessive growth before stem elongation can be unproductive and lead to lodging, shading and poor light interception in the critical period. Equally nitrogen (N) limitation, poor P nutrition and/or poor disease control during this period will lower grain number potential and yield either by limiting biomass production in the critical period or its conversion into yield (harvest index). Harvest indices of 50% or slightly higher should be possible with good management, so to achieve 10t/ha cereal grain yields the final biomass needs to be greater than 20t/ha. In 2021, where crops stayed free of frost and waterlogging, the project team could explore higher yields in WA. So, what are we achieving in our cereal projects in WA in terms of wheat grain yields and final harvest dry matters (Figure 1)?

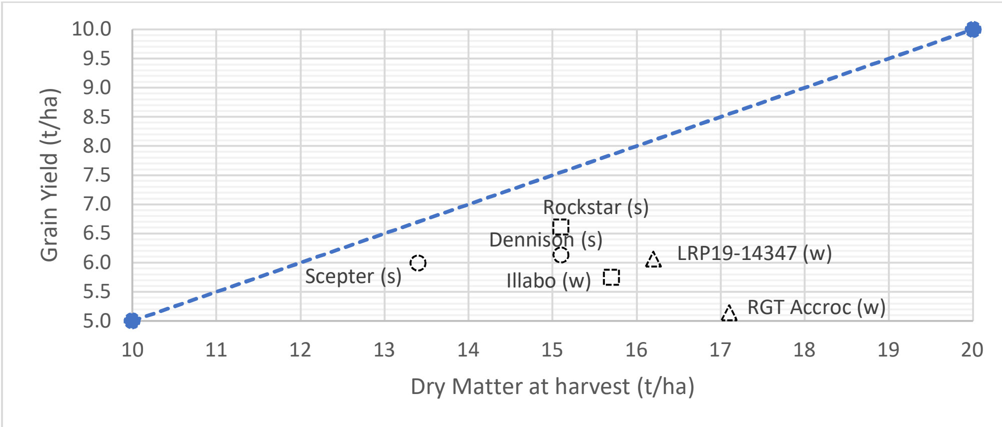

Figure 1. Relationship between dry matter and grain yield (t/ha) at 0% moisture across spring and winter wheat types at Esperance (s – spring wheat) and (w – winter wheat) grown under higher nutrition input, FAR WA Esperance Crop Technology Centre 2021. The dotted line represents aspirational yields that are possible with a harvest index of 50%.

Figure 1 illustrates that spring wheat cultivars such as Scepter sown in mid-April do not produce the final harvest dry matter of later flowering spring types such as Dennison or the winter wheats such as LRP19-14347. This is related to flowering too early limiting growth in the critical period. In contrast increases in dry matter at harvest associated with late developing wheats that spend too long in the vegetative period and have flowering windows past the optimum for the region do not maximise grain yield. For example, RGT Accroc (a red grained feed wheat) flowered in mid-October and had a harvest index of just 30% (Figure 1 & Table 2). Removing biomass through simulated grazing (mechanical defoliation) in project trials has been largely neutral (harvest index and yield) provided defoliation was conducted no later than GS30. In contrast, at Frankland River where grain yields were higher, RGT Accroc was able to translate a greater proportion of its harvest dry matter into higher grain yield with an HI of 39%.

Table 2. Influence of cultivar on grain yield (t/ha) under different canopy management regimes – FAR Esperance Crop Technology Centre 2021 sown 16 April.

	Canopy Management (Grain Yield t/ha)						
	Standard Input		**“Grazed” Standard**		**High Input**		**Mean**
Cultivar (Type)	t/ha		t/ha		t/ha		t/ha
Illabo (Winter)	5.63	fgh	5.95	efg	6.47	b-e	**6.02**
Rockstar (Spring)	6.24	c-g	6.04	efg	7.44	a	**6.57**
LRP19-14347 (Winter)	6.22	c-g	6.09	efg	6.93	abc	**6.41**
Cutlass (Spring)	5.91	efg	4.98	hi	6.49	b-e	**5.79**
Denison (Spring)	6.36	b-f	6.14	d-g	7.00	ab	**6.50**
RGT Accroc (Winter)	5.67	fgh	5.58	gh	5.78	efg	**5.67**
Scepter (Spring)	5.02	hi	4.56	i	6.85	a-d	**5.47**
Mean	**5.86**	**b**	**5.62**	**b**	**6.70**	**a**	
LSD Cultivar p = 0.05 b			0.43		P Value	0.026	
LSD Management p=0.05 a			0.28		P Value	<0.001	
LSD Cultivar x Management P=0.05			0.74		P Value	<0.001	

Standard Input – 182kg N/ha and two fungicides, Grazed + Standard Input – standard input with mechanical defoliation, High input – 223kg N/ha, three fungicides (including a strobilurin & a SDHI) and a PGR.

Although APSIM modelling of the Esperance research site clearly shows a yield advantage to sowing winter wheat over spring wheat in mid-April, trial results to date have indicated no difference in yield in this relatively frost-free environment. This is despite spring wheats flowering in August prior to the recognised optimal flowering window of mid-September. Despite achieving similar yields to spring wheats, low harvest indices have been a consistent theme with winter genetics that are not as well adapted to the environment. Breeding efforts for WA have historically focussed on spring wheats that have been selected for a higher harvest index and faster development that suit WA's shorter grain filling period (relative to the HRZs in other states). This year's research site is trialling a number of new winter wheats to explore whether harvest index can be improved in winter genetics which have been selected based on higher harvest index. ***Side by side trials planted at Esperance CTC in mid-April have shown no yield advantage over the same cultivars planted in mid-May.***

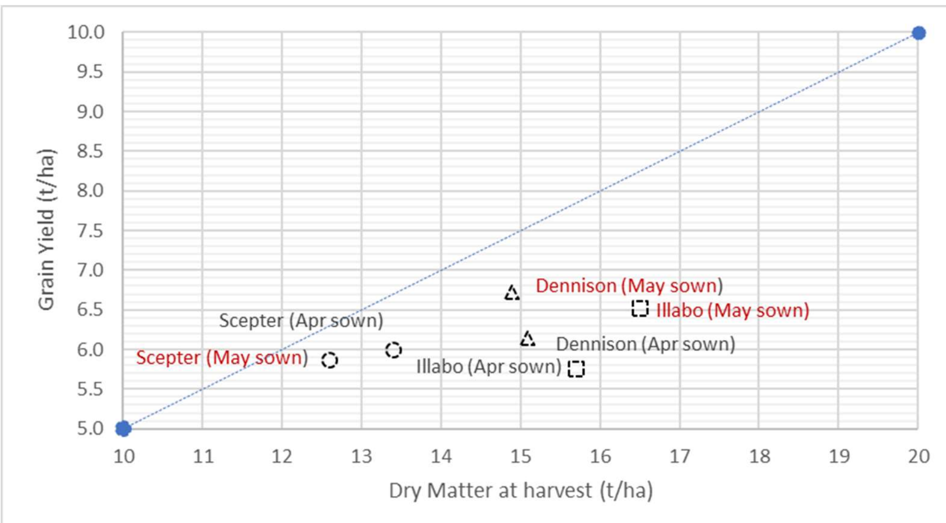

Figure 2. Relationship between dry matter and grain yield (t/ha) at 0% moisture in spring wheat at Esperance (spring wheat – April and May sown) FAR WA Esperance Crop Technology Centre 2021. The dotted line represents aspirational yields that are possible with a harvest index of 50%.

Hyper Yielding barley crops – importance of disease management to maximise yield potential in barley

The importance of disease management in keeping the upper canopy leaves free of infection in both the critical period four weeks before flowering and during grain fill was observed in barley research at both the Frankland and Esperance sites. RGT Planet⦶ and Rosalind⦶ have been consistently high yielding cultivars in most high rainfall zones of Australia, particularly those like WA where the season is slightly shorter and subject to higher temperatures during grain fill. While new germplasm introductions such as winter cultivars show promise in the cooler climate HRZ's they still are not stable in yield and are more vulnerable to lodging and head loss. Under high disease pressure and with lower fungicide input other spring cultivars (such as Laperouse⦶) can yield similar or higher than RGT Planet⦶ but do not always have the same yield potential when disease is managed. Improving yield in RGT Planet⦶ relies upon effective disease control with robust fungicide regimes and highlights the need for growers to consider carefully when better chemistries such as the SDHI's are applied to maximise yield response and to manage fungicide resistance. The need for higher fungicide input in Planet⦶ was observed at both Esperance and Frankland in 2021. In Esperance in the WA

HRZ farming systems project, barley yields matched and exceeded those of wheat sown at the same time. Laperouseᶲ was significantly higher yielding than Planetᶲ under a standard fungicide input, but under a high input fungicide strategy, including SDHI and strobilurin chemistry, yields of both were higher at 8t/ha with no difference between the two cultivars (Table 3).

Table 3. Influence of barley cultivar on grain yield (t/ha) under different canopy management regimes – Esperance, WA 2021 sown 16 April (the site was not affected by frost).

	Canopy Management (Grain Yield t/ha)					
Cultivar (Type)	**Standard Input**		**"Grazed" Standard**		**High Input**	
Laperouseᶲ (Spring)	**7.16**	**c**	6.31	de	**8.00**	**a**
Urambieᶲ (Winter)	6.31	de	6.48	d	6.60	d
RGT Planetᶲ (Spring)	**6.59**	**d**	5.59	f	**8.00**	**a**
HV8 Nitroᶲ (Spring)	5.80	ef	5.56	f	7.45	bc
Rosalindᶲ (Spring)	5.74	f	5.32	f	7.70	abc
Mean	**6.32**		**5.87**		**7.55**	
LSD Cultivar p = 0.05		0.32			**P Value**	<0.001
LSD Management p=0.05		0.60			**P Value**	<0.01
LSD Cultivar x Management P=0.05		0.55			**P Value**	<0.01

Standard Input – 182kg N/ha and two fungicides, Grazed + Standard Input – standard input with mechanical defoliation, High input – 223kg N/ha, three fungicides (including a strobilurin & a SDHI) and a PGR

Plot yields: To compensate for edge effect a full row width (22.5cm) has been added to either side of the plot area (equal to plot centre to plot centre measurement in this case). All results have been analysed through ARM software.

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Phosphorus Response in Barley (cv RGT Planet)

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Research has shown that good soil fertility is required to produce hyper yielding crops, but that nitrogen (N) applied at rates higher than 150 to 180 kilograms per hectare does not produce an economical yield response. Crop yields often exceed what is theoretically possible from soil and applied N. Western Australia South Coast sandplain soils are generally considered relatively infertile and phosphorus (P) rates may also need to increase in order to further improve yields in a hyper-yielding crop production system on ameliorated soils. This trial aims to determine the optimum rate of P for yield and cost-effectiveness, which is particularly relevant given current high fertiliser prices.

Planet barley was sown on the 17th April and Monoammonium Phosphate (MAP) was banded to supply 0, 11, 22, 33 and 44 units of P in comparison to a farm standard of 16.5. Colwell P was 32mg/kg in the topsoil and 10-20 centimetre increment, with very low levels at depth. Nitrogen was balanced across these treatments and all other nutrients applications have been equal. Early observations were that 44P may have inhibited root growth and this treatment did have slightly lower establishment as measured by plant density (Figure 1). This effect was not significant and established

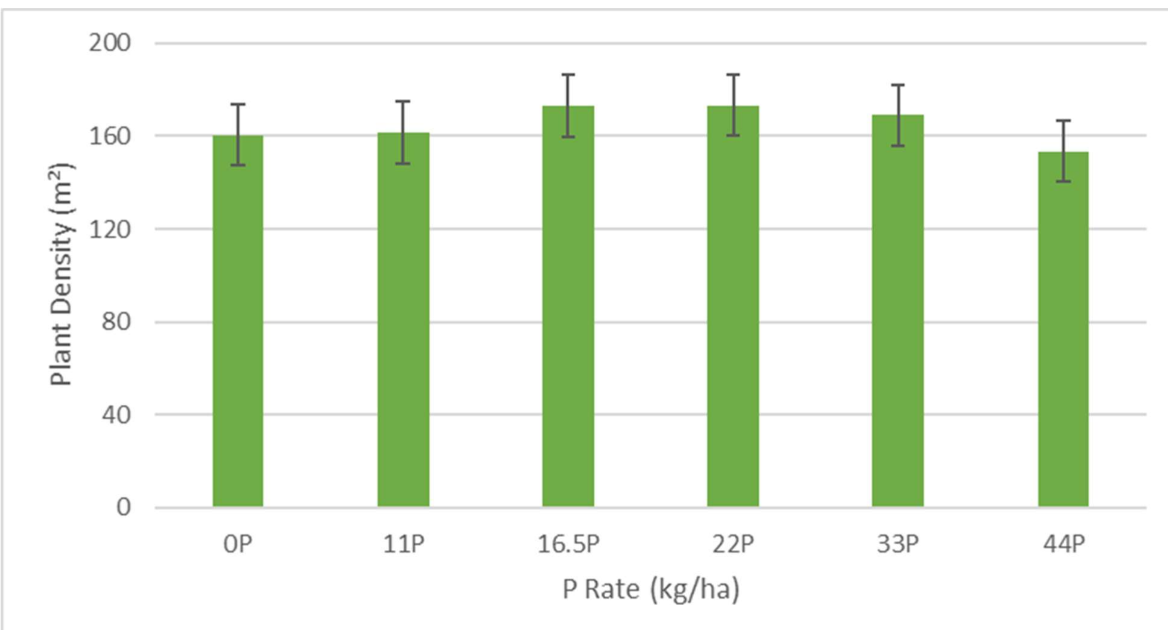

Figure 1. Effect of phosphorus rate on barley plant density (plants per square metre) measured on the 4th May 2022, 17 days after sowing.

plant density was adequate for all treatments. Tiller count was measured at GS37 and tillering was significantly reduced in the 0P treatment compared to all treatments with applied P (Figure 2). The greatest amount of tillers was produced by 33P (561/m^2), which was significantly higher than 11P and 16.5P, but not 22P and 44P (Figure 2).

During this assessment it was noted that a higher proportion of tillers in the low P treatments were weaker and less likely to produce grain.

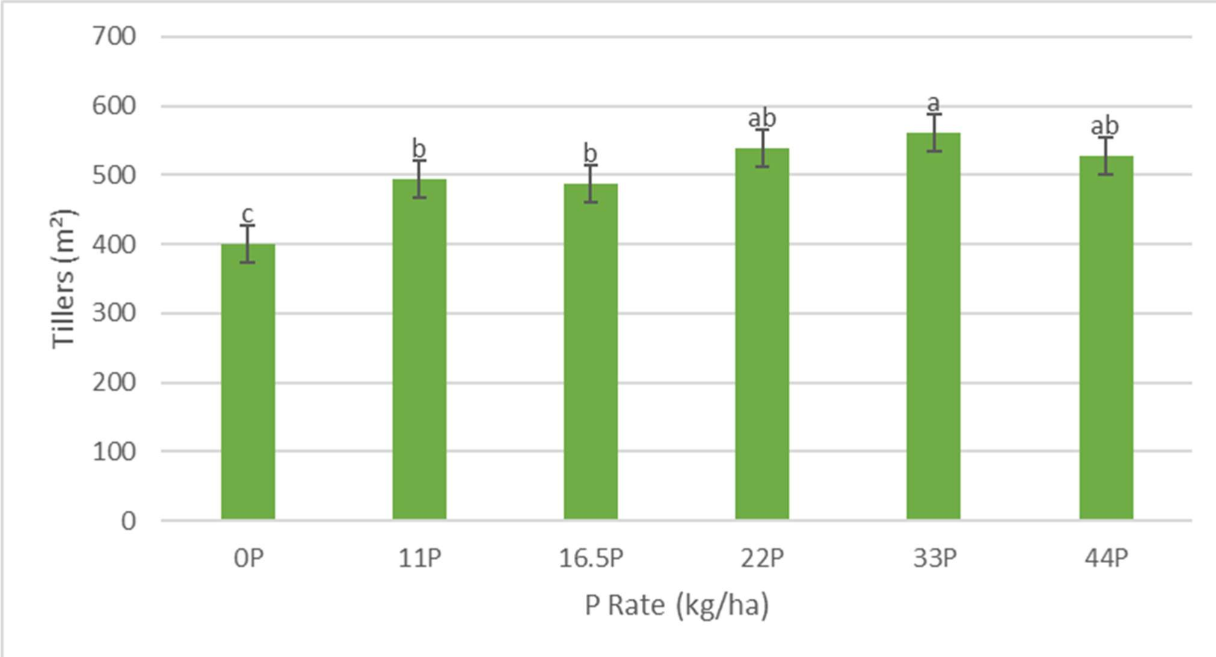

Figure 2. Effect of phosphorus rate on barley tiller production (tillers per square metre) on 5th July 2022, 79 days after sowing, when crop was at GS37. Bars with the same letter do not significantly differ (P=.05, LSD).

Development of the 0P treatment slowed after tiller counts were taken, which is a known effect of P deficiency, so that it was at GS43 (early booting) at the time of dry matter assessments 108 days after sowing. All other treatments were assessed at GS65. Treatments with 16.5P or greater had produced approximately 12t/ha of dry matter by this stage, whereas 11P had produced significantly less (~10t/ha), and 0P only 7.6t/ha (Figure 3). Dry matter production is an important determinant of yield and is also important for crop competitiveness with weeds. As noted during the tiller count assessment, 0P resulted in significantly weaker tillers than treatments with P, with an average tiller weight of only 0.87grams. Differences in tiller size between other treatments were less significant, ranging from 1.17g to 1.3g, although 33P did produce significantly larger tillers than 11P and 44P Figure 4). These larger tillers are likely to produce more grain, while small tillers are more likely to abort.

Normalised Difference Vegetation Index (NDVI) measurements have been taken throughout the season and are displayed in Figure 5. in relation to days after sowing. This is another measure of biomass production (up to full crop cover) and shows that treatments with P produced biomass at a significantly higher rate than 0P. NDVI of the 11P treatment was also significantly lower than the other P treatments until the last measurement on the 24th August, whereas 0P has never compensated sufficiently to match the other treatments. This is despite a decline in NDVI for all P treatments since the measurement 65 days after sowing (~GS32).

Some of the reduction in NDVI at later stages can be explained by head emergence, but loss of green leaf area due to disease is also a contributing factor. Initially it was observed that low P treatments had higher levels of Net Blotch, particularly Net Form,

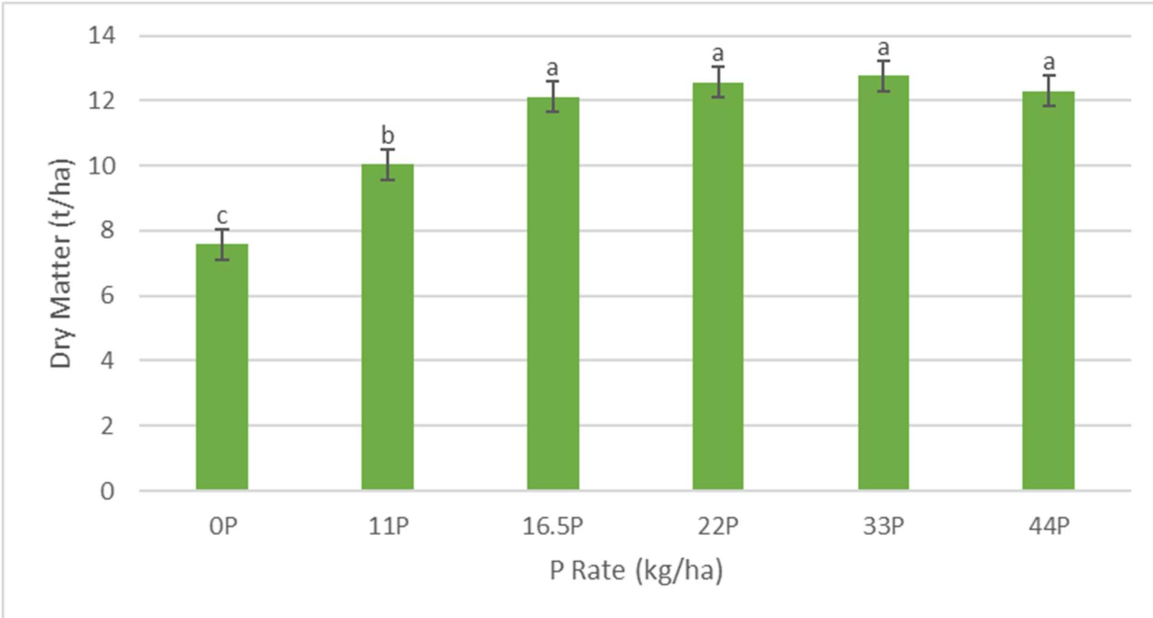

Figure 3. Effect of phosphorus rate on dry matter production 108 days after sowing. All treatments were at GS65, except 0P which was at GS43. Bars with the same letter do not significantly differ

due to poor nutrition compromising resilience against infection. However, a disease assessment at the beginning of anthesis measured an increase in the percentage of infected leaf area for both Spot Form, but particularly Net Form Net Blotch on Flag-2 with increasing rates of P (Figure 6). There was a corresponding decline in green leaf retention on Flag-3 (Figure 6). This is likely due to higher biomass creating a thicker canopy with greater humidity and reduced air flow, which promotes disease.

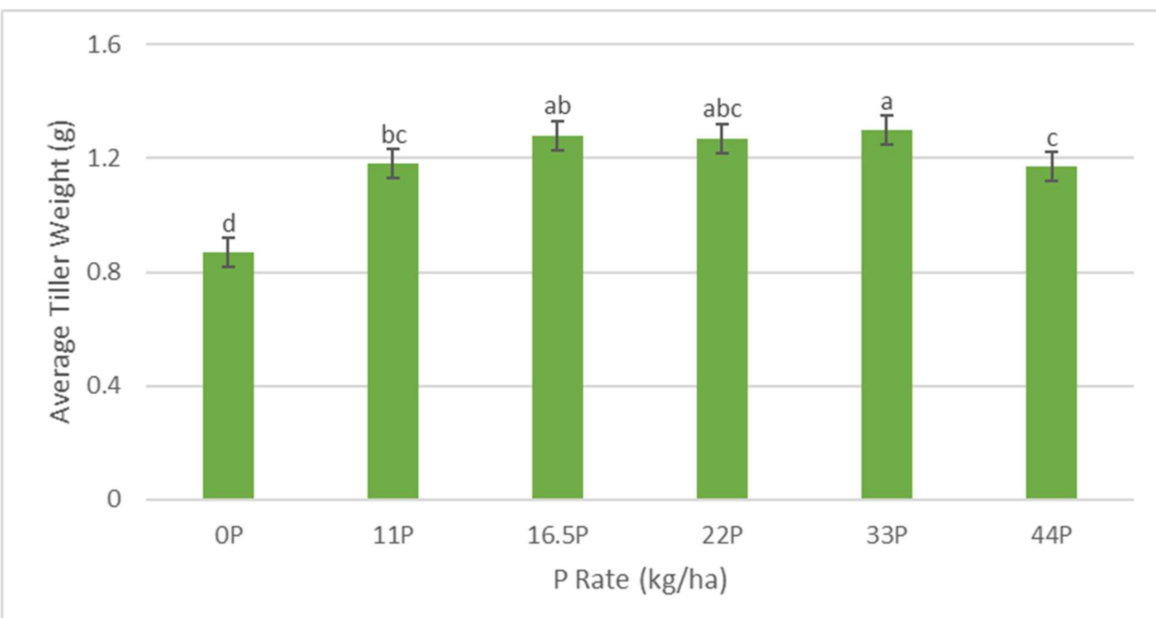

Figure 4. Effect of phosphorus rate on barley tiller weight (grams) calculated by subsampling 50 tillers at time of dry mater sampling 108 days after sowing. Bars with the same letter to not significantly differ (P=05, LSD).

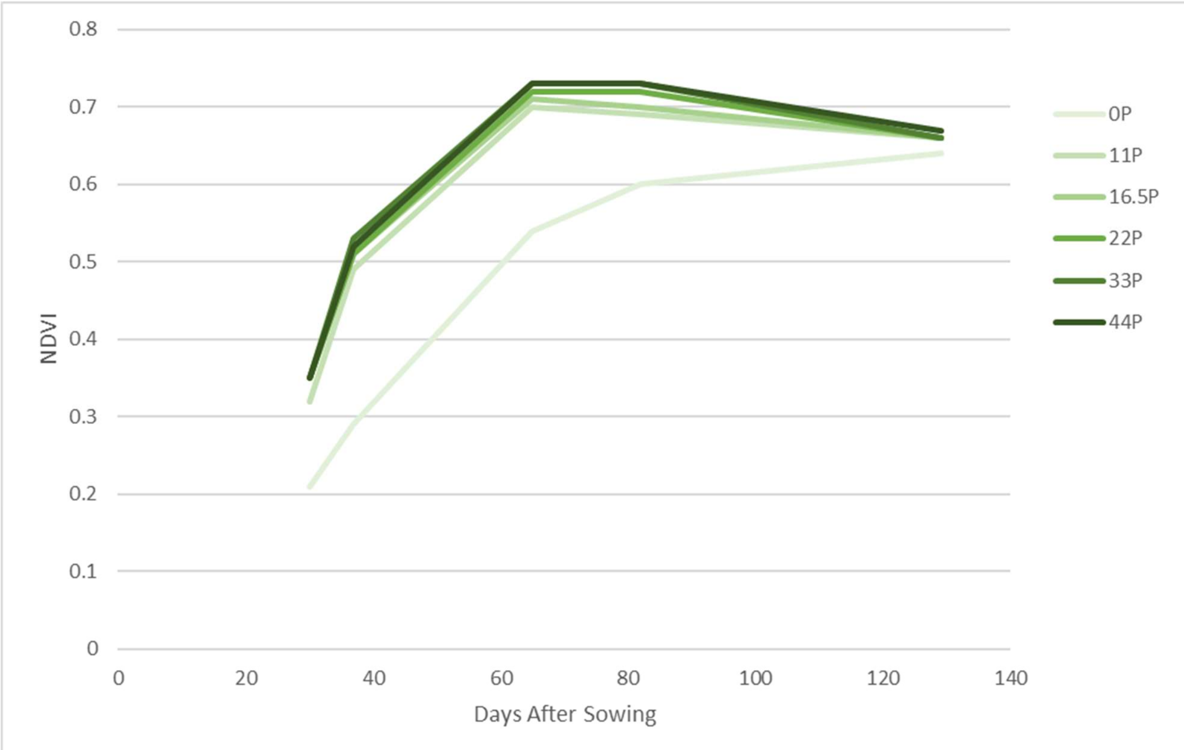

Figure 5. Effect of phosphorus rate on NDVI of barley measured 30, 37, 65, 82 and 129 days after sowing.

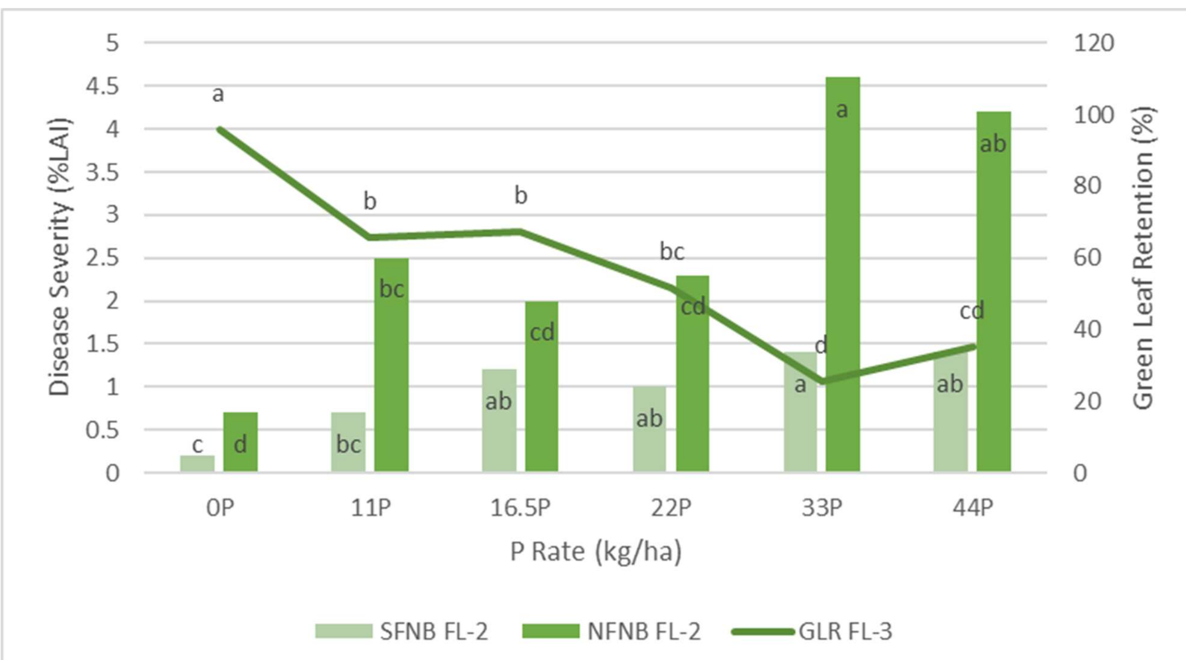

Figure 6. Effect of phosphorus rate on severity of Spot Form Net Blotch (SFNB) and Net Form Net Blotch (NFNB) on Flag-2 (F-2) and Green Leaf Retention (GLR) of Flag-3 (F-3) in barley. Assessment was completed on 18th August, 123 days after sowing when crop was at GS69-71, except for the 0P treatment which was at GS49-54. Bars with the same letter do not significantly differ (P=.05, LSD).

Tissue test analysis has been conducted with all treatments showing adequate P levels, which is surprising given the visual negative impacts of applying 0 or 11 units of P. The trial will be taken through to harvest with final grain yield being used to determine the benefit and cost-effectiveness of applying more P than current farmer practice. Despite the 33P treatment producing the greatest number of tillers, size of tillers and dry matter, it is unlikely that the response will be strong enough to justify the additional fertiliser spend compared to standard farm practice (16.5P).

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