7.3 Maximising water use efficiency in the HRZ through canopy management - Inverleigh, Vic

Location:
This trial was undertaken at the Inverleigh research site

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Funding:
GRDC; Project Title – Optimising the profitability of HRZ cropping is South West Victoria through improved water use efficient farming systems.

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Background/aim:
The overall objective of this GRDC funded project is to increase crop water use efficiencies by 10% over the duration of the project through improved agronomic management strategies. This may include variety choice, time of sowing, nitrogen and other in crop management strategies.

This trial aims to evaluate the principles of full canopy management through integration of crop inputs (nitrogen, fungicide and growth regulators) across both wheat and barley to maximize crop strength, resilience and yield capacity in high yielding environments. Each input will be applied tactically to maximize both root penetration and crop stand-ability in a reliable cropping zone known for average water use efficiencies.

Take home messages:

- *Fungicide:* The barley crop displayed a significant biomass response to the fungicide application, irrespective of timing. The no fungicide treatment was severely damaged by scald pressure throughout the season. The biomass response did not however translate into a significant yield difference at the end of the season. The fungicide timing did not produce a significant yield or quality response in wheat.
- *Nitrogen:* No response to nitrogen timing was observed in grain yield or quality in the wheat trial. The no nitrogen treatment was the highest yielding treatment in the barley trial, significantly different to that of the late applied nitrogen. The interaction between nitrogen timing and application of growth regulators illustrated that they can be used tactically to reduce crop biomass and conserve water for grain filling.
- *Growth Regulators:* Growth regulators were identified as the key tool to manipulate the crop canopy and manage stored water. A significant response to late applied growth regulators was observed in relation to crop height in wheat. Biomass was reduced in both wheat and barley at the GS30 and GS39 growth stages where growth regulators were applied. This translated into a yield benefit in barley, however no significant response was observed in wheat.

Treatments:

Crop Type
Barley (cv. Gairdner)
Wheat (cv. 10.10.3)

Fungicide
Nil Fungicide
Prosaro 200ml @ GS30 & 39
Prosaro 400ml @ GS39

Nitrogen
Nil Nitrogen
50kg N @ GS00 (PSPE)
50kg N @ GS31

Growth Regulator
Nil Growth Regulators
Modus 200ml + Cycocel 1000ml @ GS25
Modus 200ml + Cycocel 1000ml @ GS31

Results and discussion:
Water use efficiency can be gained by managing the crop canopy. Crop canopy can be manipulated through the use of growth regulators and strategic nitrogen timing to reduce canopy biomass, increase plant root activity, and store and access soil moisture for increased yield potential.

The growth regulators Moddus and Cycocel were applied to the crop canopy at mid-tillering and early stem extension. Figures 1 and 2 illustrates that at GS30 the early applied growth regulator had a slight reduction in crop biomass. The later applied growth regulator was not yet applied at this stage. At full flag leaf emergence (GS39) both growth regulators showed reduced biomass production compared to the no growth regulator treatment. Stem extension is the key phase where growth regulators will be beneficial by reducing excess biomass production.
At dough development (GS80) and crop maturity (GS99) the growth regulator treatments had a greater biomass then the no growth regulator treatment. The greater biomass is a function of increased yield production compared to the no growth regulator treatment (Table 1).

Crop height in wheat (cv. 10.10.3) is also a strong indication of the effectiveness of growth regulators. Growth regulators applied at early stem extension significantly shortened the height of the crop compared to the no growth regulator treatment. On average the late applied growth regulator reduced the crop height by 8.4cm at GS39 and 7.5cm at GS99 compared to the other two growth regulator treatments. When the growth regulator is applied at the stem extension phase the internode length is reduced, thus reducing the overall crop height. Further details on the effect of growth regulator on internode length can be found in the Barley Growth Regulator Trial.

The relationship between nitrogen and growth regulator timing is important when considering canopy management. In wheat (cv. 10.10.3) where no nitrogen and seedbed nitrogen is applied a reduction in biomass is observed with the addition of growth regulator. When nitrogen is applied at GS00 the initial biomass of the crop is higher in response to the nitrogen application, however at the time of measurement (GS39) the effects of the growth regulator as seen. No response in biomass reduction is observed when comparing growth regulators when nitrogen is applied at GS30. This may be because the growth regulator has a reduced effect on a crop with sufficient nitrogen inputs.

Nitrogen and growth regulator applications must be considered jointly so that each can have their maximum benefit. It would be wasteful to apply nitrogen and growth regulators at the one timing (e.g: at GS30 as per Figure 4) as both would have reduced benefits. The water use efficiency of a crop is maximized by tactically managing inputs so that the growing season rainfall and stored moisture is best used to achieve a maximum yield potential.

The fungicide program is also a key management tool in protecting the crop canopy. In a year where scald pressure was high a fungicide program was required to retain green leaf area and protect from the onset of disease. Figure 5 illustrates that the no fungicide treatment had a significantly reduced biomass, particularly at the dough development (GS80) and crop maturity (GS99) phases. The onset of disease as a result of no fungicide severely reduced the yield potential of the crop. In this case protecting the crop biomass with a one or two foliar fungicide spray program is important to maximise yield potential.

Figure 1: Effect of Growth Regulators on Dry Matter Production – mean of 3 fungicide timings and 3 nitrogen timings (cv. Gairdner).

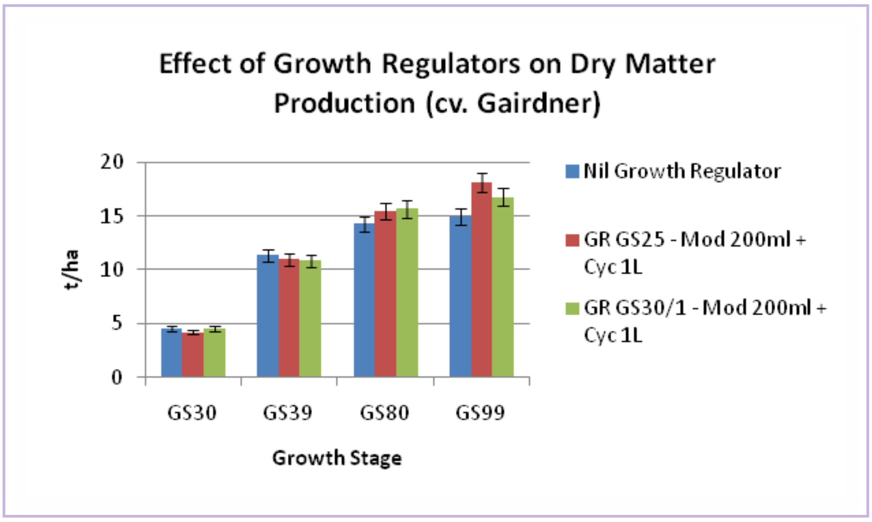


Figure 2: Effect of Growth Regulators on Dry Matter Production – mean of 3 fungicide timings and 3 nitrogen timings (cv. 10.10.3).

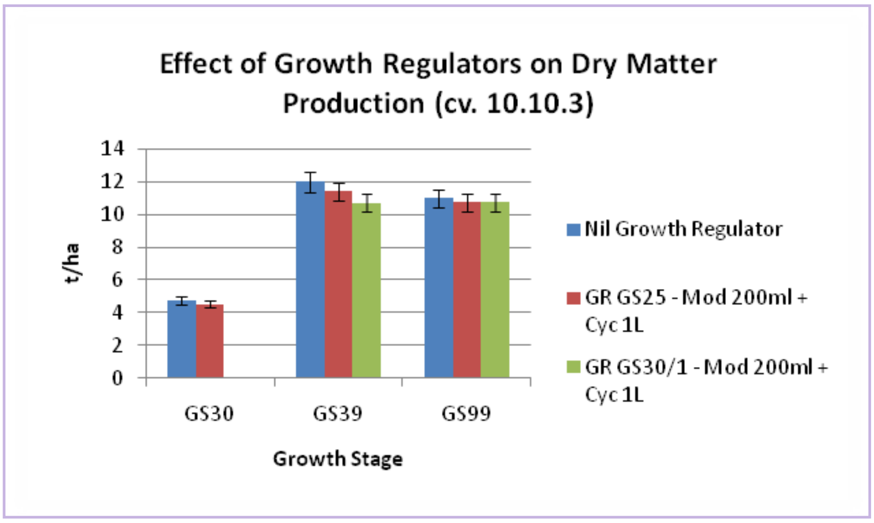
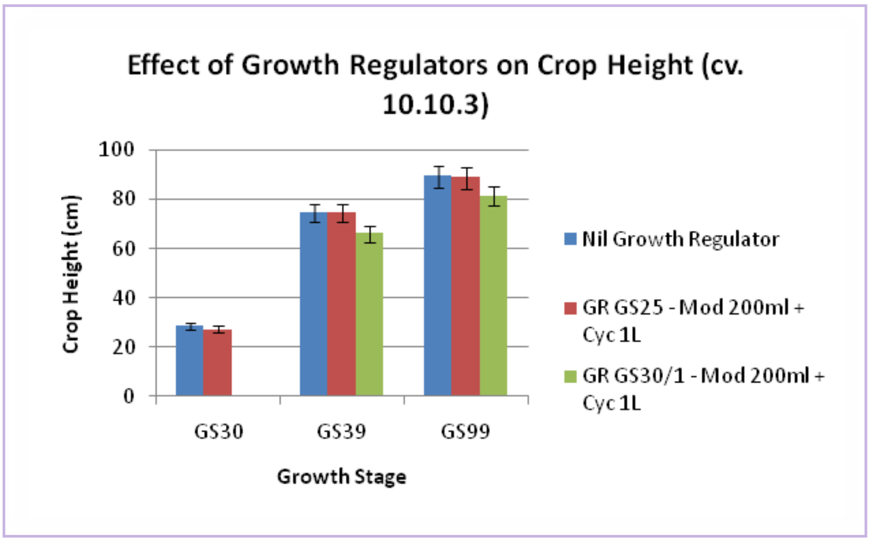


Figure 3: Effect of Growth Regulators on Crop Height – mean of 3 fungicide timings and 3 nitrogen timings (cv. 10.10.3).



Despite a clear biomass response to the fungicide timing this did not equate to a statistical yield advantage. The two spray program was the highest yielding fungicide strategy in both wheat and barley. This may be a response to the level of disease pressure, practically scald in barley for the 2009 season. Grain quality across all parameters was improved in barely where the two spray program was used. No significant difference in grain quality was observed in wheat where there was less disease pressure.

No statistical difference in grain yield or quality was observed in wheat for nitrogen timing. The average wheat yield was 5.04 t/ha, in comparison barley yielded an average 4.60 t/ha. The no nitrogen treatment yielded 4.80 t/ha, significantly higher than the late applied nitrogen treatment (4.40 t/ha). The no nitrogen treatment in barley had statistically higher retention, however no other quality parameters were statistically different.

The growth regulators applied at GS25 and GS31 both yielded significantly higher than the no growth regulator treatment in barley. No yield response was observed in wheat despite the biomass reduction (Figure 2). The yield result reflected that of the biomass in barley (Figure 1), where stored moisture from reducing canopy production may have assisted in producing a greater yield. No significant difference in grain quality for wheat or barley was observed as a result of growth regulator timing.

Figure 4: Interaction of Nitrogen and Growth Regulator Timing on Dry Matter Production at GS39 – mean of 3 fungicide timings (cv. 10.10.3).

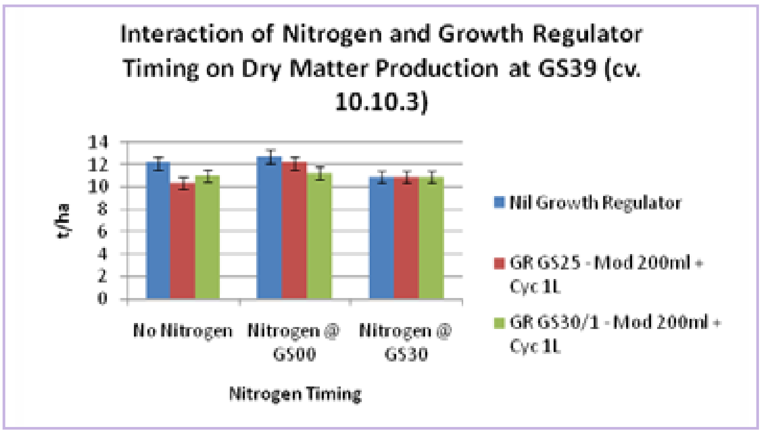


Figure 5: Effect of Fungicides on crop Dry Matter Production – mean of 3 nitrogen timings and 3 growth regulator timings (cv. Gairdner).

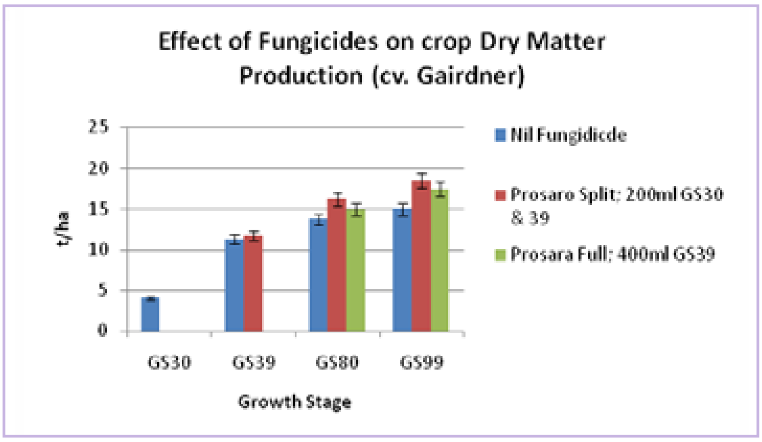


Table 1: Grain yield and quality analysis, including protein, test weight, retention & screenings, corrected to 12.5% moisture.

	[1]Yield (t/ha)	[2]Sig. Diff.	[3]Protein (%)	[3]Test Weight (kg/hl)	[3]Retention (%)	[3]Screenings (%)
Fungicides						
Nil Fungicide	4.20	a	12.3	67.6	58.4	9.2
Prosaro 200ml @ GS30 & 39	5.03	a	12.8	69.0	79.1	3.8
Prosaro 400ml @ GS39	4.55	a	13.3	68.9	73.6	4.9
Prob (F)	**0.246***		**0.362***	**0.003**	**0.022**	**0.024**
LSD (0.05)	**1.07**		**1.5**	**0.6**	**13.3**	**3.6**
Nitrogen						
Nil Nitrogen	4.80	a	12.1	68.5	73.1	5.4
50kg N @ GS00 (PSPE)	4.59	ab	12.8	68.6	69.4	6.0
50kg N @ GS31	4.40	b	13.4	68.5	68.5	6.4
Prob (F)	**0.013**		**0.0001**	**0.875***	**0.038**	**0.154***
LSD (0.05)	**0.25**		**0.3**	**0.5**	**3.7**	**1.0**
Growth Regulators						
Nil Growth Regulator	4.39	b	12.8	68.8	73.6	5.8
Mod. 200ml + Cyc. 1L @ GS25	4.67	a	12.6	68.7	73.1	5.5
Mod. 200ml + Cyc. 1L @ GS31	4.72	a	13.0	68.1	64.4	6.7
Prob (F)	**0.0002**		**0.030**	**0.0001**	**0.0001**	**0.012**
LSD (0.05)	**0.16**		**0.3**	**0.3**	**2.7**	**0.8**

[1] Consideration needs to be taken for yields, as plots represent 72.5% of arable area and thus should be calculated using this percentage for comparison to local and commercial results.
[2]Means followed by the same letter do not significantly differ (P=0.05, LSD).
[3]Quality parameterisation is based on 2009-2010 NACMA Barley Standards and should be used as a guide only. Testing was undertaken at Riordan Grains, Inverleigh Office. *These parameters are not statistically significant at the p=0.05 level.

There was limited yield response for nitrogen, growth regulator or fungicide timing in wheat. This may have been a function of the season where the hot finish did not allow the clear expression of each treatment to translate into yield. The limited yield response may also be compounded by the maturity length of the wheat variety 10.10.3. The long season nature of 10.10.3 may have allowed the in crop effects of nitrogen and growth regulator timing to dissipate, thus no clear response at harvest. Greater yield responses may be observed on a shorter season wheat variety.

Table 2: Grain yield and quality analysis, including protein, test weight, retention & screenings, corrected to 12.5% moisture.

	[1]Yield (t/ha)	[2]Sig. Diff.	[3]Protein (%)	[3]Test Weight (kg/hl)	[3]Screenings (%)
Fungicides					
Nil Fungicide	4.99	a	14.2	70.9	2.7
Prosaro 200ml @ GS30 & 39	5.19	a	14.3	70.9	3.1
Prosaro 400ml @ GS39	4.94	a	14.6	70.5	3.6
Prob (F)	**0.300***		**0.499***	**0.475***	**0.718***
LSD (0.05)	**0.38**		**0.77**	**0.86**	**2.60**
Nitrogen					
Nil Nitrogen	5.08	a	13.9	70.7	3.0
50kg N @ GS00 (PSPE)	5.05	a	14.5	70.9	2.9
50kg N @ GS31	5.00	a	14.8	70.7	3.3
Prob (F)	**0.848***		**0.0001**	**0.268***	**0.764***
LSD (0.05)	**0.27**		**0.32**	**0.31**	**1.10**
Growth Regulators					
Nil Growth Regulator	5.01	a	14.3	70.8	3.1
Mod. 200ml + Cyc. 1L @ GS25	5.04	a	14.3	70.8	2.6
Mod. 200ml + Cyc. 1L @ GS31	5.07	a	14.5	70.7	3.5
Prob (F)	**0.532***		**0.091***	**0.496***	**0.039**
LSD (0.05)	**0.11**		**0.26**	**0.26**	**0.70**

[1] Consideration needs to be taken for yields, as plots represent 72.5% of arable area and thus should be calculated using this percentage for comparison to local and commercial results.
[2]Means followed by the same letter do not significantly differ (P=0.05, LSD).
[3]Quality parameterisation is based on 2009-2010 NACMA Wheat Standards and should be used as a guide only. Testing was undertaken at Riordan Grains, Inverleigh Office.
*These parameters are not statistically significant at the p=0.05 level.

Conclusion:
The water use efficiency of a crop is maximized by tactically managing inputs so that the growing season rainfall and stored moisture is best used to achieve a maximum yield potential. Good biomass responses were observed in response to growth regulator and nitrogen timing. Growth regulators significantly reduced biomass during early stem extension and flag leaf emergence. The reduction in biomass may have contributed to enough stored moisture to increase yield potential, particularly in barley on the growth regulator treatments. The wheat demonstrated a significant crop height response to late applied growth regulators; however this did not translate into a yield advantage.
The average wheat and barley yields were 5.04 t/ha and 4.59 t/ha respectively. The wheat showed no significant yield or quality response to nitrogen, growth regulator or fungicide timings. Barley showed significant yield responses to the growth regulator treatments compared to that of the no growth regulator treatment. The water use efficiency of each crop can be maximised through the tactical management of inputs to maximum yield potential.