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Lodging management for Commander$^{\phi}$ – Moree, Gurley and Breeza 2012

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Key findings

In all trials PGR treatments were shown to reduce lodging to some degree, which was most likely a function of the reduced plant height obtained from PGR applications.

Yield responses to PGR application ranged from –13% to +16% for Commander$^{\phi}$ and Oxford$^{\phi}$ compared to the untreated control. Commander$^{\phi}$ was usually more responsive to the application of PGRs than Oxford$^{\phi}$.

Of the PGR treatments the combined Cycocel® + Moddus® treatment resulted in the most consistent reduction in plant height and greatest responses in grain yield, whether negative or positive.

These results highlight the variability in responses to PGR application, which makes it difficult to accurately predict the economic benefit of using PGRs within cropping systems.

Introduction

Plant growth regulators (PGRs) have been used routinely in high input, high yielding cereal systems in Europe and NZ for some time to shorten crop height and reduce the incidence of lodging. Lodging results in significant losses in crop production due to reduced movement of water, nutrients and translocation of plant stored carbohydrates through the stem into the head. Lodging also reduces grain quality, increases harvest losses and the actual cost of the harvesting process. Although gibberellin inhibitors and ethylene producers are the two main PGR groups, the research presented here only investigated gibberellin inhibitor products. These products act by blocking gibberellin biosynthesis which reduces internode length in stems thereby decreasing plant height. There are a number of phases in this pathway and different PGRs act at different points. For example chlormequat (Cycocel®) acts early in the pathway while more recently developed products such as trinexapac-ethyl (Moddus®) act on later stages.

PGRs have also been reported to have a yield enhancement effect by improving the proportion of crop dry matter that is partitioned into grain yield. This effect is related to a reduction in the plant resources required for stem elongation with these resources then available for grain-fill. Some PGRs have also been associated with increased root growth resulting in improved water extraction from soil. Yield responses to PGRs can be highly variable with responses ranging from –40% to +20% depending on product choice, application time, crop or variety and growing season conditions.

Site details

Breeza

Location:	**Liverpool Plains Research Station**
Previous Crop:	**Wheat**
Starting N:	**71 kg N/ha (0–120 cm)**
Sown:	**14th June 2012**

Moree

Location:	**“Bonniedoon”**
Co-operator:	**Paul and Charles Tattam**
Previous Crop:	**Chickpeas**
Starting N:	**51 kg N/ha (0–120 cm)**
Sown:	**20th May 2012**

Gurley

Location:	**“Murray Cumummualah”**
Co-operator:	**Scott Carrigan**
Soil:	**Grey Vertosol**
Starting N:	**91 kg N/ha (0–120 cm)**
Sown:	**31st May 2012**

Treatments

In 2012 a series of trials were conducted to investigate the capacity of PGRs to reduce lodging in Commander$^{\phi}$ (high yielding with poor straw strength) barley. Commander$^{\phi}$ and Oxford$^{\phi}$ (high yielding with good straw strength) were grown at a target plant population of 120 plants/m^2 with four treatments of: nil PGR, Cycocel® (0.2 L/ha), Moddus® (1.0 L/ha) and a combination of Cycocel® (0.2 L/ha) + Moddus® (1.0 L/ha). PGRs were applied in each season at stem elongation (GS31) at a 100 L/ha water rate. Sites were established at Gurley, Moree and Breeza. At the Breeza site there was no Moddus® only treatment. There was also a plus or minus defoliation implemented at the same growth stage to physically remove the canopy biomass. Defoliation was done to a height of approximately 5 cm with a lawn mower and all cut dry matter was removed from the plots with the catcher. The Breeza site was under irrigation to try and exacerbate the lodging risk. Due to a lack of significance in treatment effects on plant height, grain yield and a lack of lodging at Gurley, only the Breeza and Moree results are presented.

Results

Lodging severity was greater at the Breeza site compared to the Moree site, which was likely a result of the irrigated conditions implemented at Breeza (Table 1). At anthesis in Moree it appeared that lodging was going to be severe in Commander$^{\phi}$, however, a dry finish to the season ensured that lodging remained minimal. Oxford$^{\phi}$ at Moree had no evidence of lodging throughout the entire season while the severity of lodging in Oxford$^{\phi}$ at Breeza was 56% lower than that in Commander$^{\phi}$. Defoliation had minimal affect on lodging severity in Oxford$^{\phi}$, whereas for Commander$^{\phi}$ at Moree and Breeza lodging severity was reduced by 40% and 22% on average across all treatments with defoliation, respectively (Table 1). The use of Cycocel® reduced lodging severity in Commander$^{\phi}$ and Oxford$^{\phi}$ at Breeza by approximately 14% compared to the untreated control. In contrast the reduction in lodging severity was 40% and 48% from the Cycocel® + Moddus® treatment for Commander$^{\phi}$ and Oxford$^{\phi}$ at Breeza, respectively.

Table 1: *Lodging scores (Scale 0–9, where 0 is standing and 9 is flat on the ground) at harvest for the Moree and Breeza sites. Minus and plus relate to defoliation treatments.*

PGR Treatment	Moree				Breeza			
	Commander$^{\phi}$		Oxford$^{\phi}$		Commander$^{\phi}$		Oxford$^{\phi}$	
	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus
Nil	3.4	1.9	0.0	0.0	8.5	6.5	3.5	3.3
Cycocel®	2.2	1.5	0.0	0.0	7.5	5.3	3.0	3.0
Moddus®	0.0	1.0	0.0	0.0	–	–	–	–
Cycocel® + Moddus®	0.0	0.0	0.0	0.0	4.8	4.3	2.0	1.5

The ability of PGRs to reduce the severity of lodging appears related to their capacity to restrict plant height (Figure 1). At Breeza and Moree the Cycocel® + Moddus® treatment was the most effective at reducing plant height (Figure 1a and b). The Cycocel® + Moddus® treatment significantly reduced plant height by 40% and 12% for Commander$^{\phi}$ and Oxford$^{\phi}$, respectively, at Moree. There was a large difference between the extent of height reduction measured at the two sites with the maximum height reduction being 9 cm at Breeza compared to 34 cm at Moree. The maxiumum height reduction at Breeza was 9 cm and 4 cm for Commander$^{\phi}$ and Oxford$^{\phi}$, respectively, which were both with the Cycocel® + Moddus® treatment. The Cycocel® treatment significantly reduced plant height at Moree in both Oxford$^{\phi}$ and Commander$^{\phi}$, but had no significant effect on plant height at Breeza. The Moddus® only treatment was more effective at reducing plant height than the Cycocel® only treatment at Moree (Figure 1a).

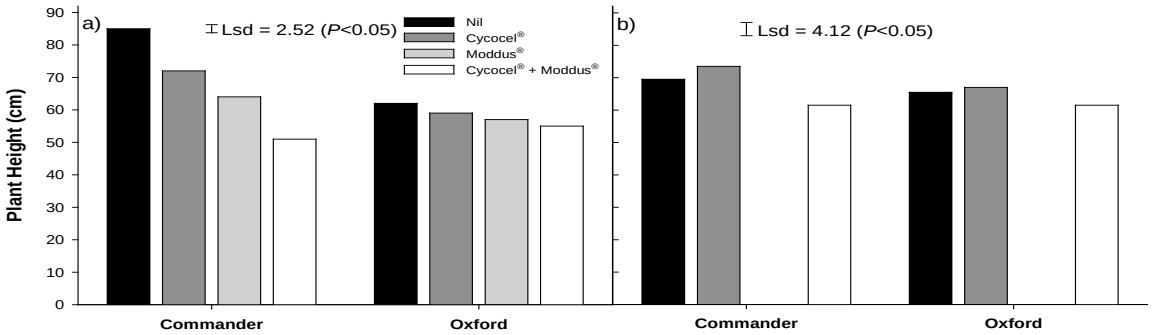

Figure 1: *Plant height at a) Moree and b) Breeza for Commander◊ and Oxford◊ barley treated with either no PGR, Cycocel®, Moddus® or a Cycocel® + Moddus® mixture at stem elongation.*

There was a contrasting effect of PGR treatments on grain yield at Moree and Breeza (Figure 2). At Moree the Cycocel® + Moddus® treatment significantly reduced grain yield by 0.9 and 0.25 t/ha for Commander◊ and Oxford◊, respectively. The Moddus® treatment at Moree also reduced grain yield by 0.4 t/ha compared to the untreated control. The Cycocel® treatment had no impact on grain yield at either site for Commander◊ or Oxford◊. At Breeza grain yield significantly increased for Oxford◊ and Commander◊ by 0.7 and 1.1 t/ha compared to the control treatment, respectively, where the Cycocel® + Moddus® treatment was applied. Regardless of treatment the yield of Oxford◊ was approximately 1.5 t/ha greater under the irrigated conditions at Breeza compared to Commander◊. The same difference in grain yield between varieties was not observed at Moree under dryland conditions.

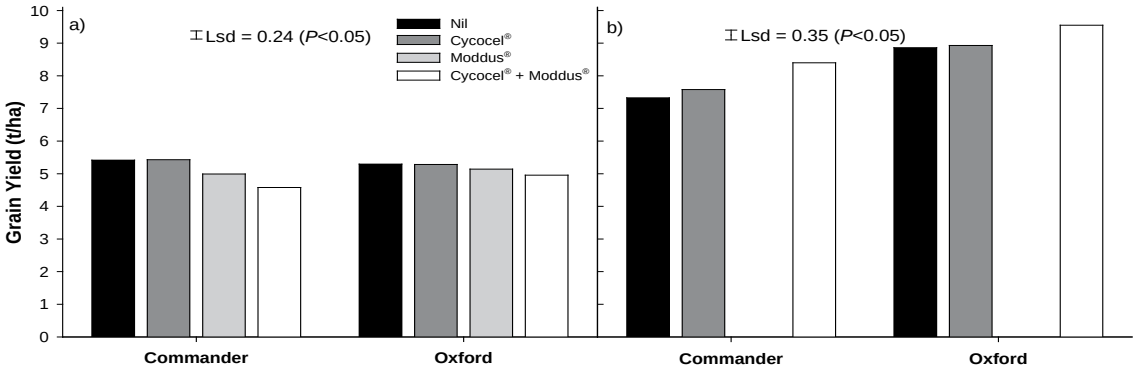

Figure 2: *Grain yield at a) Moree and b) Breeza for Commander◊ and Oxford◊ barley treated with either no PGR, Cycocel®, Moddus® or a Cycocel® + Moddus® mixture at stem elongation.*

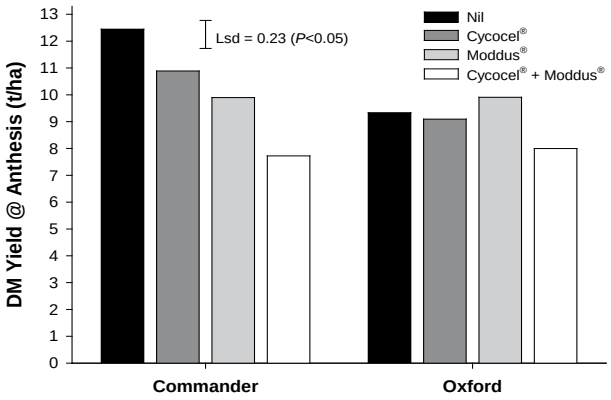

Figure 3: *Dry matter yield at anthesis at Moree for Commander◊ and Oxford◊ barley treated with no PGR, Cycocel®, Moddus® or a Cycocel® + Moddus® mixture at stem elongation.*

The reduction in grain yield for treatments including Moddus® at Moree may be related to the significant reduction in dry matter accumulation by anthesis. The Moddus® only and Cycocel® + Moddus® treatment reduced antheseis biomass in Commander◊ by approximately 2.5 and 4.5 t/ha (Figure 3). This large reduction in biomass at anthesis may have limited the yield potential of Commander◊ in particular. Oxford◊ generally had 1.5 t/ha less canopy biomass at anthesis compared to Commander◊ at the Moree site. The same reductions in biomass at anthesis were not observed at Breeza, however, reductions in plant height were not as large either.

Summary

In all trials PGR treatments were shown to reduce lodging to some degree, which was most likely a function of the reduced plant height obtained from PGR applications. Reductions in plant height associated with PGR application were generally moderate (3 to 15 cm) with the exception of the Moree site in 2012 where height reductions up to 34 cm were recorded. Yield responses to PGR application ranged from –13% to +16% in Commander$^{\Phi}$ and Oxford$^{\Phi}$. Whether it be negative or positive, Commander$^{\Phi}$ usually was more responsive to the application of PGRs than Oxford$^{\Phi}$. The grain yield and plant height results highlight the variability in responses to PGR application, which makes it difficult to accurately predict the economic benefit of using PGRs within a cropping system. Of the PGR treatments the combined Cycocel® + Moddus® treatment resulted in the most consistent reduction in plant height, which is likely due to the two products blocking giberellin production at different parts of the synthesis pathway. Further research is needed to understand the influence that PGRs are having on crop structure, tiller formation, root growth and soil water extraction in winter cereal crops in the northern grains region.

Acknowledgements

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