The interaction between plant growth regulator (PGR) and nitrogen application in early-sown first wheat

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Key points

- In two first-wheat trials yielding 4.5–5.0 t/ha, the application of a plant growth regulator (PGR) (a single application of Chlormequat + Moddus at GS31–32) delivered no benefits in terms of yield or grain quality.
- The PGR application did not interact with additional nitrogen (N) applied in terms of yield or quality.
- The impact of PGR application on crop height was greater than the impact of nitrogen timing, however the differences in height were small (4.9cm at Redlands and 2.7cm at Yarrawonga).
- The grower-applied nitrogen at Redlands, at a rate of 75kg N/ha, and at Yarrawonga at a rate of 100kg N/ha, were shown to be optimum in terms of yield and quality, with no extra yield or protein resulting from the higher nitrogen application rates with Corack and Wedgetail.

Method

Trials were conducted in first wheat at Redlands, NSW (Trial 1) and Yarrawonga, Victoria (Trial 2), in order to examine the interaction between additional nitrogen (N) application above grower practice and the response to plant growth regulator (PGR). In both trials 0, 40 and 80kg N/ha were added on top of the nitrogen rate applied by the host farmer (Tables 1 and 2). Additional nitrogen was added at the tillering stage (GS23). The PGR, a mixture of Chlormequat (1L/ha) and Moddus (200mL/ha), was applied at Redlands on 29 July 2014, at 17°C and on 5 August 2014 at 13.7°C at the Yarrawonga site.

Trials were established as a split plot design where nitrogen rate was the main plot, and PGR application the sub plot — replicated four times. Data has been statistically analysed using analysis of variance (ANOVA), with means separated using the unrestricted least significant difference (LSD) procedure.

Trial 1: Redlands, NSW

Sowing date: 6 May 2014

Rotation: First wheat after canola

Variety: Corack

Stubble management: Canola unburnt

Rainfall:

GSR: 382.3mm (April – October)

Summer rainfall: 109.2mm

TABLE 1 Nitrogen application rates and timings – Redlands, NSW Trial 1

Nitrogen treatment	6 May 2014 (sowing) (kg N/ha)	19 June 2014 (kg N/ha)	24 June (GS23–26 tillering) (kg N/ha)	18 July 2014 (kg N/ha)	Total nitrogen applied (kg N/ha)
Standard nitrogen applied	6	36.8	Nil	32.2	**75**
Standard + 40kg N/ha	6	36.8	40	32.2	**115**
Standard + 80kg N/ha	6	36.8	80	32.2	**155**

TABLE 2 Nitrogen application rates and timings – Yarrawonga, Victoria Trial 2

Nitrogen treatment	21 April 2014 (sowing) (kg N/ha)	11 June 2014 (kg N/ha)	24 June 2014 (GS23–26 tillering) (kg N/ha)	12 July 2014 (kg N/ha)	Total nitrogen applied (kg N/ha)
Standard nitrogen applied	8	46	Nil	46	**100**
Standard N + 40kg N/ha	8	46	40	46	**140**
Standard N + 80kg N/ha	8	46	80	46	**180**

i) Crop dry matter production

There was no effect of additional nitrogen or PGR application on dry matter (DM) production (Table 3).

ii) Crop reflectance using normalised difference vegetation index (NDVI)

Crop canopy greenness was measured with a Greenseeker®. Differences in crop canopy greenness due to additional nitrogen were small and at most assessments were not significant. PGR application significantly decreased NDVI, an observation noted in the same trials during 2013 (Table 4, Figure 1).

iii) Influence on crop height and final head number

Nitrogen and PGR application had no effect on final head numbers recorded at harvest (Table 5), however there was a significant interaction (p=0.03) between nitrogen and PGR treatments on crop height (data not presented). PGR treatments significantly reduced the crop height by approximately 5cm (averaged across all nitrogen levels) but this effect was greatest at the lower rates of nitrogen applied.

TABLE 3 Dry matter 10 September 2014, start of ear emergence (GS51), 1 October 2014, mid-flowering (GS65) and 19 November 2014, harvest (GS99) at the Redlands trial site

Treatment	Dry matter (t/ha)		
Nitrogen treatment	**GS51**	**GS65**	**GS99**
Standard (75kg N/ha)	5.13[a]	11.11[a]	13.82[a]
Standard + 40kg N/ha	5.52[a]	11.30[a]	13.79[a]
Standard + 80kg N/ha	5.37[a]	11.14[a]	13.21[a]
Mean	**5.34**	**11.18**	**13.61**
LSD	0.85	1.53	1.65
PGR treatment			
Untreated control	5.41[a]	11.19[a]	13.63[a]
Moddus + Chlormequat	5.27[a]	11.18[a]	13.58[a]
LSD	0.42	0.48	1.01

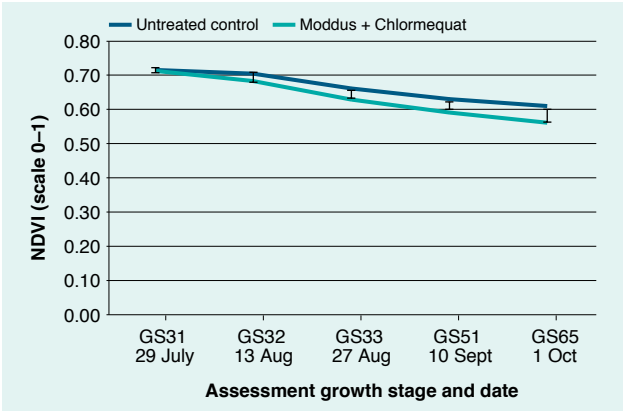

FIGURE 1 Influence of PGR on NDVI readings scale 0–1 at Redlands compared with the untreated control (UTC) (mean of 3 nitrogen rates)

* The error bars are a measure of LSD

TABLE 5 Crop height and heads/m² at harvest (GS99), 19 November 2014 at the Redlands trial site

Treatment	Height (cm)	Heads/m²
Nitrogen treatment		
Standard (75kg N/ha)	75.2[a]	284[a]
Standard + 40kg N/ha	76.1[a]	288[a]
Standard + 80kg N/ha	76.5[a]	288[a]
Mean	**75.9**	**287**
LSD	5.0	26
PGR treatment		
Untreated control	78.4[a]	285[a]
Moddus + Chlormequat	73.5[b]	289[a]
LSD	0.9	26

iv) Yield and quality

Extra nitrogen applied above the grower standard practice of 75kg N/ha did not increase final grain yield (Table 6). The additional 80kg N/ha significantly lifted grain protein by 0.75% and decreased screenings by approximately 1.5%. PGR application had no effect on yield or quality.

TABLE 4 NDVI scale 0–1 measured 29 July 2014, first node (GS31), 13 August 2014, second node (GS32), 27 August 2014, third node (GS33), 10 September 2014, start of ear emergence (GS51) and 1 October, mid-flowering (GS65) at the Redlands trial site

Treatment	NDVI				
Nitrogen treatment	**GS31**	**GS32**	**GS33**	**GS51**	**GS65**
Standard (75kg N/ha)	0.72[a]	0.70[a]	0.64[b]	0.60[b]	0.57[a]
Standard + 40kg N/ha	0.72[a]	0.70[a]	0.66[a]	0.61[ab]	0.59[a]
Standard + 80kg N/ha	0.71[a]	0.69[a]	0.64[b]	0.62[a]	0.60[a]
LSD	0.02	0.03	0.02	0.02	0.03
PGR treatment					
Untreated control	0.72[a]	0.71[a]	0.66[a]	0.63[a]	0.61[a]
Moddus + Chlormequat	0.71[a]	0.68[a]	0.63[b]	0.59[b]	0.56[b]
LSD	0.01	0.03	0.02	0.02	0.03

TABLE 6 Yield, test weight, protein and screenings at harvest (GS99), 28 November 2014 at the Redlands trial site

Treatment	Yield and quality			
Nitrogen treatment	**Yield (t/ha)**	**Test weight (kg/hL)**	**Protein (%)**	**Screening (%)**
Standard (75kg N/ha)	4.78[a]	81.8[a]	11.6[b]	6.4[a]
Standard + 40kg N/ha	4.94[a]	82.2[a]	12.0[ab]	5.4[ab]
Standard + 80kg N/ha	4.63[a]	81.6[a]	12.4[a]	5.0[b]
Mean	**4.78**	**81.9**	**12.0**	**5.6**
LSD	0.55	0.6	0.5	1.2
PGR treatment				
Untreated control	4.82[a]	81.6[a]	12.0[a]	5.6[a]
Moddus + Chlormequat	4.74[a]	82.1[a]	12.0[a]	5.6[a]
LSD	0.23	0.6	0.7	1.2

Trial 2: Yarrawonga, Victoria

Sowing date: 20 April 2014

Rotation: First wheat after canola

Variety: EGA Wedgetail

Stubble management: Canola unburnt but raked

Rainfall:

GSR: 372.8mm (April – October)

Summer rainfall: 113.6mm

i) Crop dry matter production

Although applying nitrogen above the standard practice of 100kg N/ha did not generate any additional DM when assessed at harvest, at the start of flowering there was a significant increase of approximately 0.5t/ha with additional nitrogen. PGR application significantly decreased DM production at the same flowering assessment, but again there was no effect at harvest (Table 7).

TABLE 7 Dry matter 10 September 2014, flag fully emerged (GS39), 1 October 2014, start of flowering (GS61), 26 November 2014, harvest (GS99) at Yarrawonga trial site

Treatment	Dry matter (t/ha)		
Nitrogen treatment	**GS39**	**GS61**	**GS99**
Standard (100kg N/ha)	6.16[a]	11.84[a]	15.76[a]
Standard + 40kg N/ha	6.28[a]	12.20[a]	16.03[a]
Standard + 80 kg N/ha	6.72[a]	12.57[a]	16.21[a]
Mean	**6.38**	**12.02**	**16.00**
LSD	0.72	0.81	2.41
PGR treatment			
Untreated control	6.56[a]	12.46[a]	16.09[a]
Moddus + Chlormequat	6.21[a]	11.94[b]	15.91[a]
LSD	0.45	0.46	0.67

ii) Crop reflectance using NDVI

The Yarrawonga site appeared to be more responsive to nitrogen than the Redlands site as the additional nitrogen applied at this site significantly increased crop canopy NDVI scores. This indicated greater crop canopy greenness where additional nitrogen was applied. Similar to the Redlands site, PGR application significantly decreased crop canopy NDVI scores (Table 8, Figure 2).

TABLE 8 NDVI scale 0–1, 5 August 2014 first node (GS31), 19 August 2014 second node (GS32), 5 September 2014 third node to flag leaf fully emerged (GS33–39), 10 September 2014 flag leaf fully emerged (GS39) and 1 October 2014 start of flowering (GS61) at the Yarrawonga trial site

Treatment	NDVI				
Nitrogen treatment	**GS31**	**GS32**	**GS33–39**	**GS39**	**GS61**
Standard (100kg N/ha)	0.70[b]	0.68[c]	0.69[c]	0.68[b]	0.58[b]
Standard + 40kg N/ha	0.71[b]	0.70[b]	0.72[b]	0.72[a]	0.60[ab]
Standard + 80kg N/ha	0.73[a]	0.72[a]	0.75[a]	0.74[a]	0.63[a]
Mean	**0.71**	**0.70**	**0.72**	**0.71**	**0.60**
LSD	0.02	0.01	0.03	0.03	0.04
PGR treatment					
Untreated control	0.72[a]	0.72[a]	0.75[a]	0.74[a]	0.65[a]
Moddus + Chlormequat	0.71[a]	0.69[b]	0.69[b]	0.68[b]	0.56[b]
LSD	0.02	0.02	0.02	0.03	0.04

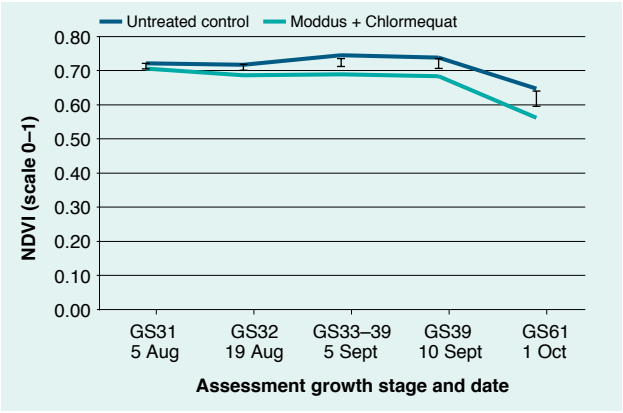

FIGURE 2 Influence of PGR on NDVI scale 0–1 at the Yarrawonga site, variety Wedgetail (mean of 3 nitrogen rates)
*The error bars are a measure of LSD

TABLE 9 Crop height and heads/m² at harvest (GS99), 26 November 2014 at the Yarrawonga trial site

Treatment	Height (cm)	Heads (m²)
Nitrogen treatment		
Standard (100kg N/ha)	83.6[a]	388[a]
Standard + 40kg N/ha	83.5[a]	409[a]
Standard + 80kg N/ha	83.4[a]	382[a]
Mean	**83.5**	**393**
LSD	2.4	82
PGR treatment		
Untreated control	84.8[a]	377[a]
Moddus + Chlormequat	82.1[b]	410[a]
LSD	0.8	40

TABLE 10 Yield, test weight, protein and screenings at harvest (GS99), 26 November 2014 at the Yarrawonga trial site

Treatment	Yield and quality			
Nitrogen treatment	**Yield (t/ha)**	**Test weight (kg/hL)**	**Protein (%)**	**Screening (%)**
Standard (100kg N/ha)	5.11[a]	76.8[a]	11.2[b]	1.2[b]
Standard + 40kg N/ha	5.12[a]	74.6[b]	12.9[a]	2.5[a]
Standard + 80kg N/ha	5.11[a]	73.9[b]	13.3[a]	3.1[a]
Mean	**5.11**	**75.1**	**12.5**	**2.3**
LSD	0.45	1.01	0.60	0.74
PGR treatment				
Untreated control	5.18[a]	75.2[a]	12.3[a]	2.1[a]
Moddus + Chlormequat	5.04[a]	75.1[a]	12.6[a]	2.4[a]
LSD	0.21	0.64	0.38	0.58

iii) Influence on crop height and final head number

Nitrogen and PGR application had no effect on final head numbers recorded at harvest (Table 9). However, there was a significant interaction between nitrogen and PGR application on crop height, as was the case at the Redlands site. In the Yarrawonga trial the PGR application significantly decreased the crop height, by approximately 3cm (averaged across all nitrogen levels), with the greatest effect measured at the higher rates of nitrogen application (data not shown).

iv) Yield and quality

Additional nitrogen had no effect on final yield, but increased grain protein by approximately 1.5–2.0% depending on the rate of nitrogen applied. The extra nitrogen significantly increased screenings by 1.25–2.0% and significantly decreased test weight below the APW minimum of 74kg/hL. Application of PGR had no effect on yield or quality (Table 10).

Conclusions

The application of a PGR (Moddus + Chlormequat) to first-wheat crops yielding 4.5–5.0t/ha produced no benefits in the 2014 trials irrespective of the soil nitrogen levels, despite small but significant effects on crop canopy height and crop canopy greenness (measured as crop canopy reflectance). Though additional applications of nitrogen lifted final grain protein above the 11.0–11.5% range, there was no benefit to yield indicating that the standard grower practice (75kg N/ha at Redlands and 100kg N/ha at Yarrawonga) was optimal for the season. In addition, at the Yarrawonga site the additional nitrogen significantly increased screenings and reduced test weight.

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