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

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Key points

- In a low-yielding situation at Coreen, Victoria (less than 2.5t/ha) following a dry spring, plant growth regulator (PGR) application lead to a significant yield reduction (0.14t/ha) in early-sown first wheat.
- PGR application significantly reduced crop height in both trials (by up to 10% in the Coreen trial), but did not reduce crop canopy biomass (dry matter), suggesting that crop biomass was redistributed, not reduced.
- The addition of extra nitrogen (N), over and above the farm standard (75kgN/ha Coreen), significantly increased grain protein but not yield.
- PGR application significantly reduced Normalised Difference Vegetative Index (NDVI) readings taken with a Greenseeker®, particularly where application was superimposed on lower amounts of applied nitrogen.

Location: Yarrawonga, Victoria
Rainfall:
  Annual: 377.8mm
  GSR: 222mm (April — October)
Soil:
  Type: Red loam over clay
Sowing information:
  Variety: EGA Wedgetail
  Sowing date: 4 April 2013
  Sowing equipment: 12m DBS with narrow tines, 15mm individual press wheels
Row spacing: 37.5cm
Paddock history:
  2012 — canola
  2011 — wheat
  2010 — wheat
Plot size: 18m x 3m
Replicates: 4

Location: Coreen, NSW
Rainfall:
  Annual: 349mm (Balldale PO 74004)
  GSR: 282.5mm (April – October)
Soil:
  Type: Clay loam
Sowing information:
  Variety: Whistler
  Sowing date: 29 April 2013
  Sowing equipment: Auseeder DBS (15.3m)
Row spacing: 30cm
Paddock history:
  2012 — canola
  2011 — wheat
  2010 — wheat
Plot size: 15m x 3m
Replicates: 4

Aim

The aim of the trial was to evaluate the effect of plant growth regulator (PGR) application (lodging control, yield effect and net margin) in early-sown first wheat grown under different levels of nitrogen application.

Background

Plant growth regulators are routine inputs for high-yielding cereal crops grown elsewhere in the world and are used primarily to shorten the crop in order to prevent lodging. Recent research carried out by a major agrochemical manufacturer has increased the interest in the role of these products in broadacre cereal production in Australia; however the influence of PGR application can vary depending on the lodging risk (cultivar's resistance to lodging, fertility etc) and moisture status of the crop. Where crop lodging occurs, PGR application is frequently associated with improved crop standing power and significant yield increases as a result of better light interception.

This trial aimed to establish whether the larger crop canopies associated with earlier sowing, higher rates of nitrogen or both are reliable candidates for PGR application in the Riverine Plains region. In addition, the study looked to quantify the crop canopy parameters and environmental conditions that accompany positive and or negative yield effects produced by these agrochemicals.



Method

Two early-sown first wheat trials were established to study the influence of PGR application in first wheat.

The first trial was established at Coreen, New South Wales with the cultivar Whistler, sown 29 April 2013 on a 30cm row spacing following canola. The trial site was subject to 282mm growing season rainfall (GSR: April – October).

The second trial was established at Yarrawonga, Victoria, with the cultivar EGA Wedgetail, sown 4 April 2013 on a 37.5cm row spacing after canola and was subject to 222mm GSR (April – October).

A replicated split plot experiment was established at each site to test the effect of three different nitrogen levels (main plot) and the application of the PGR (sub plot).

i) Nitrogen treatment

Nitrogen rate was based on the paddock standard nitrogen (applied by the host farmer), paddock standard plus 40kg N/ha and paddock standard plus 80kg N/ha with the additional nitrogen applied at the start of stem elongation–first node (GS30–31). Paddock nitrogen application rates for both sites are set out in Tables 1 and 2.

ii) PGR treatment

The PGR, which was a mixture of two active ingredients: trinexapac ethyl and chlormequat (Moddus 200ml/ha + Chlormequat 1L/ha), was applied at second node (GS32) on 1 August 2013 at Yarrawonga and 26 August 2013 at Coreen in 101L/ha water with no adjuvant.

Results

Coreen, NSW

i) Influence of nitrogen rate and PGR on dry matter production

Dry matter (DM) assessments (0.5m row x two per plot) were made at the PGR application timing (26 August) to determine the effect of the additional nitrogen on crop growth and again at early grain fill (GS71) (7 October), 39 days after PGR application to determine the influence of PGR and its interaction with nitrogen. There was no significant effect of the additional 40 and 80kg N/ha on DM at GS32, but there was a significant difference when assessed at GS71 — 80kg N/ha produced significantly more DM than the standard nitrogen input (see Figure 1).

At GS71 there was no recorded difference in DM as a result of PGR application and no interaction with the level of applied nitrogen (see Figure 2).

ii) Influence of nitrogen rate and PGR on crop height and NDVI

There was a significant reduction in crop height of 7–8cm as a result of PGR application recorded at the start and end of grain fill (see Figure 3). Crop reflectance measurements taken with a Greenseeker® at GS71 showed significantly higher NDVI (canopy greenness readings) scores where more nitrogen was applied and significantly lower NDVI scores where PGR was applied (untreated 0.61, PGR 0.58). These scores indicate the greenness of the crop canopy (see Figure 4).

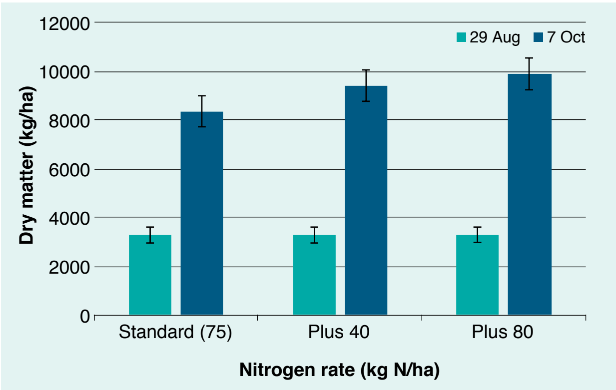

FIGURE 1 Influence of nitrogen rate on dry matter production at second node (GS32), 29 August (38 days after nitrogen application) and early grain fill (GS71), 7 October*

* 7 October assessment is the mean of the nitrogen rates with and without PGR
Error bars presented as LSD value

TABLE 1 Nitrogen application rates and timings — Coreen, NSW

	29 April (sowing) (kg N/ha)	11 June (kg N/ha)	12 July (kg N/ha)	22 July (GS30–31) (kg N/ha)	Total N applied (kg N/ha)
Standard N applied	6	36.8	32.2	Nil	**75**
Standard + 40kg N/ha	6	36.8	32.2	40	**115**
Standard + 80kg N/ha	6	36.8	32.2	80	**155**

TABLE 2 Nitrogen application rates and timings — Yarrawonga, Victoria

	4 April (sowing) (kg N/ha)	10 July (kg N/ha)	28 July (kg N/ha)	23 July (GS31) (kg N/ha)	Total N applied (kg N/ha)
Standard N applied	8	46	46	Nil	**100**
Standard N + 40kg N/ha	8	46	46	40	**140**
Standard N + 80kg N/ha	8	46	46	80	**180**

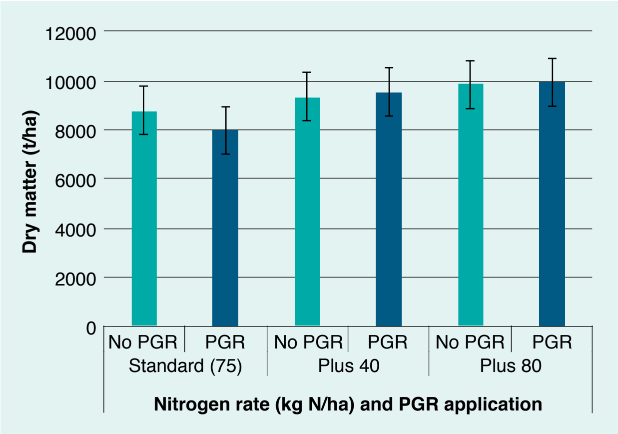

FIGURE 2 Influence of nitrogen rate and PGR application on dry matter production at early grain fill (GS71)*

* Error bars presented as LSD value

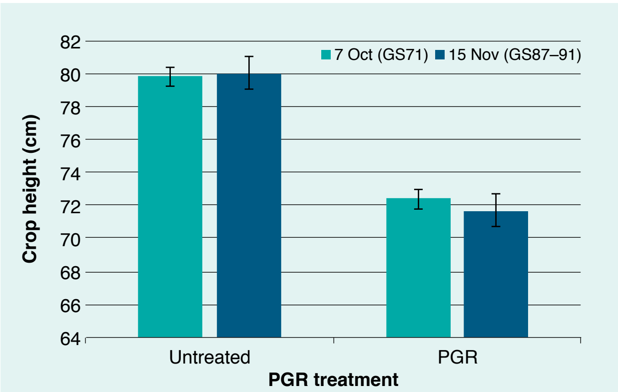

FIGURE 3 Influence of PGR on crop height when assessed at early grain fill (GS71) 7 October and hard dough-ripening (GS87–91) 15 November*

* Mean of three nitrogen rates

Error bars presented as LSD value

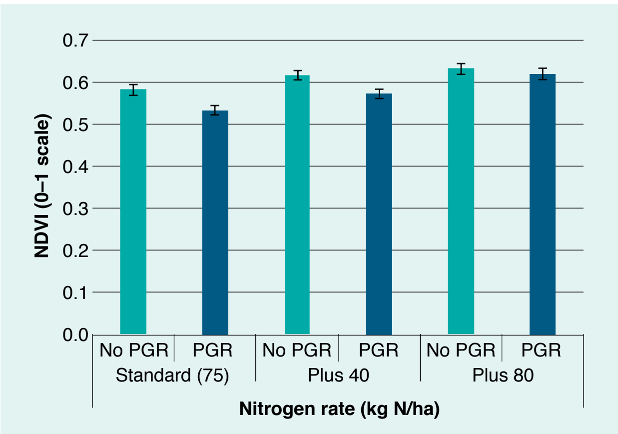

FIGURE 4 Influence of nitrogen rate and PGR application on NDVI, (GS71) 7 October*

* Error bars presented as LSD value

Yield and quality

i) Influence of PGR on grain yield and quality

Yields were less than 2.5t/ha due to the dry spring, which developed after PGR application. Under these conditions there was a significant yield penalty of 0.14t/ha where the crop was treated with PGR at second node (GS32). In terms of grain quality, PGR application significantly increased test weight, however screenings and protein content were unaffected when averaged across the three nitrogen rates (see Table 3).

ii) Influence of nitrogen rate on grain yield and quality

Additional nitrogen application (above the farm standard of 75kg N/ha) significantly increased grain protein, however no significant differences in yield were recorded. The addition of 40kg N/ha increased the protein content by 1% above the standard nitrogen rate and an additional 2.3% when an extra 80kg N/ha was applied giving a protein content of 16.2% (see Table 4).

There was no significant interaction between nitrogen rate and PGR application on yield and quality. PGR application reduced yield irrespective of nitrogen rate applied (see Figure 5).

The highest crop yield was produced by the 75kg N/ha (standard) with no PGR applied, which was significantly higher yielding than 155kg N/ha (standard plus 80kg N/ha) plus PGR. The PGR application and extra nitrogen above the farm standard nitrogen rate was uneconomical.

TABLE 3 Grain yield and quality, comparing untreated and PGR-treated crops*

	Yield (t/ha)	Protein (%)	Test weight (kg/hl)	Screenings (%)
Untreated	2.35[a]	15.0[a]	64.3[b]	8.7[a]
PGR GS32	2.21[b]	15.0[a]	66.6[a]	8.2[a]
P value	0.04	0.64	0.04	0.21
LSD (5%)	0.14	0.31	2.2	0.83

* Mean of three nitrogen rates

[a, b] Values followed by the same letter are not statistically different

TABLE 4 Grain yield and quality, comparing three nitrogen rates*

	Yield (t/ha)	Protein (%)	Test weight (kg/hl)	Screenings (%)
Standard N applied (75kg N/ha)	2.33[a]	13.9[c]	66.4[a]	7.8[a]
Standard + 40kg N/ha	2.33[a]	14.9[b]	66.2[a]	8.1[a]
Standard + 80kg N/ha	2.19[a]	16.2[a]	63.7[a]	9.4[a]
P value	0.32	0.001	0.16	0.27
LSD (5%)	0.23	0.7	3.3	2.3

* Mean of two PGR treatments

[a, b, c] Values followed by the same letter are not statistically different

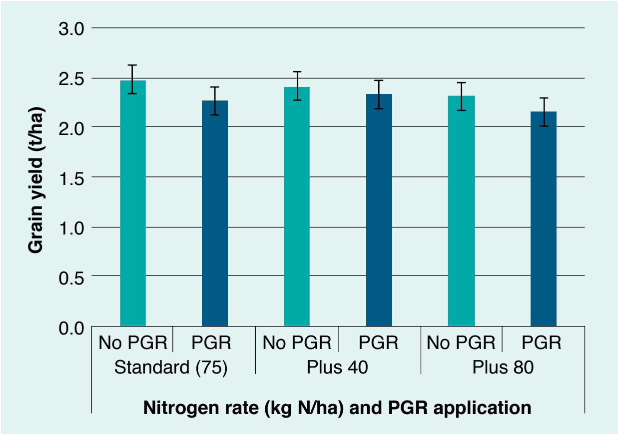

FIGURE 5 Influence of nitrogen rate and PGR application on grain yield (t/ha)*

* Error bars presented as LSD value

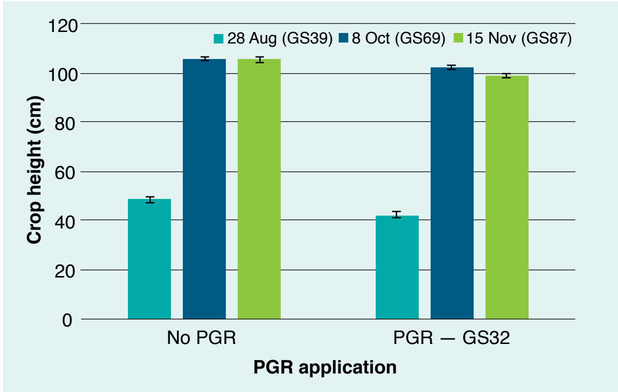

FIGURE 7 Influence of PGR on crop height when assessed on 28 August, 8 October and 15 November (27, 65 and 103 days after PGR application)*

* Mean of two nitrogen rates for 28 August assessment, mean of three nitrogen rates for 8 October and 15 November assessments
Error bars presented as LSD value

Yarrawonga, Victoria

i) Influence of nitrogen rate and PGR on dry matter production

Dry matter production was unaffected by an additional 80kg N/ha (above the farm standard of 100kg N/ha) or the application of PGR at GS32 when assessed at GS37–39, 27 days after PGR application (see Figure 6).

ii) Influence of nitrogen rate and PGR on crop height and NDVI

PGR application significantly reduced crop height at all three assessment timings: flag leaf emergence (GS39), end of flowering (GS69) and hard dough (GS87).

At the GS69 assessment it was also noted that additional nitrogen applied at GS30–31 increased crop height by 2cm (see Figure 7).

NDVI readings showed few significant differences as a result of either additional nitrogen or PGR application (see Figure 8). The only difference generated in NDVI was the lowest NDVI reading was recorded where PGR was applied to the standard nitrogen treatment, a result also recorded at the Coreen site. There was no difference between the other treatments.

iii) Influence of nitrogen rate and PGR on internode length and length of newest emerged leaf

A total of 160 single stem samples (40 samples per treatment) were analysed at GS37–39 to examine the influence of PGR application and extra nitrogen on internal internode length and the length of the newest emerged leaf. The measurements revealed small reductions (0.5–2.0cm) in the internode lengths between first and second nodes and between second

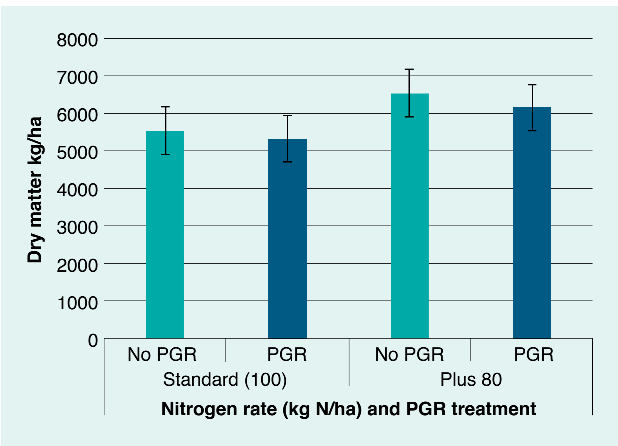

FIGURE 6 Influence of nitrogen rate and PGR on dry matter production at flag leaf emergence (GS37–39), 27 days after PGR application on 28 August*

* Error bars presented as LSD value

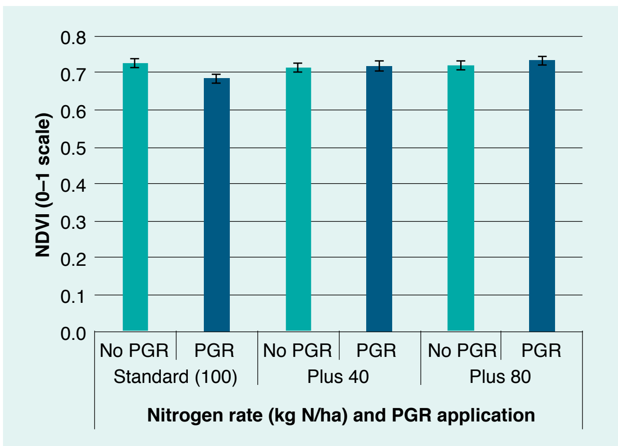

FIGURE 8 Influence of nitrogen rate and PGR application on crop reflectance measurements (NDVI) assessed GS69, 8 October*

* Error bars presented as LSD value

TABLE 5 Influence of PGR and nitrogen rate on internode length and newest emerged leaf length

Treatment	Internode length (cm)			Flag leaf
	Basal to first node	First to second node	Second to third node	Length (cm)
100kg N/ha	3.90[a]	9.60[a]	11.68[a]	33.2
100kg N/ha + PGR	3.98[a]	9.28[ab]	10.05[b]	29.4
180kg N/ha	4.06[a]	10.25[a]	11.61[a]	34.3
180kg N/ha + PGR	3.35[a]	8.41[b]	10.05[b]	30.0
LSD — same level of N	0.99	0.93	1.23	
LSD — different level of N	1.41	1.01	1.19	

[a, b] Values followed by the same letter are not statistically different

and third nodes and 4cm reductions in the length of the newest emerged leaf (principally the flag leaf) when PGR was added (see Table 5). Differences in internode between the first and second node and the second and third node were significant as a result of PGR application, but nitrogen had no statistical effect.

Yield

Unfortunately this trial was not taken through to yield due to being harvested accidently by the farm header.

Acknowledgments

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