



Crop canopy management through nitrogen & plant growth regulators

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in a nutshell

- Plant growth regulators (PGRs) are a useful tool for reducing plant height and in turn, lodging – especially when combined with management strategies that promote heavy canopies
- In this trial PGRs were not economically viable, as they reduced or only maintained yield potential – PGRs may have a role in other seasons and need to be tested across a range of seasons and situations
- PGRs will have a place in irrigated agriculture once appropriate registrations are developed; and they will be most useful used as part of a management package, adding another ‘tool’ to address yield limiting factors such as lodging

Under irrigation, wheat yields and grain quality can be significantly decreased if lodging occurs in the crop. A lodged crop is also much slower and more expensive to harvest than a standing crop. It is therefore very important to manage the crop canopy, so that there is enough foliage (tillers) to maximise yield potential, without creating a bulky canopy which is prone to lodging.

The easiest way to manage a crop canopy is by varying nitrogen inputs, and applying nitrogen inputs at different growth stages. Another way is to use plant growth regulators (PGRs) at critical growth stages to alter various hormone levels in the plant, shortening plant height and maximising standability at precise growth stages.

Note: Only Cycocel® is registered for controlling lodging in wheat in Australia. The purpose of this trial is to evaluate PGR strategies that are currently proven and registered overseas. Ethrel® 480 is registered in Australia in barley only.

A trial was conducted in 2006 at Benerembah, west of Griffith, to measure the influence of varying nitrogen rates and application times on grain yield and quality of durum wheat on flood irrigation. Under higher lodging risk nitrogen strategies, growth regulators were used with the aim of minimising lodging.

By evaluating a range of PGRs before registration, we were able to get some good data on how PGRs may fit into irrigated wheat systems, and this trial also allowed farmers to physically observe the effects of the PGRs in this region.

The trial follows work performed previously, which concluded that lodging in irrigated wheat was the most significant limitation to higher yields.

The paddock

The paddock chosen for the trial was a typical red/brown vertosol (a clay soil that shrinks and swells) on a border check irrigation layout. The paddock had faba beans in 2005, and was sown to wheat in 2004.

Soil tests (0–60 cm) were conducted before sowing, allowing a nitrogen budget to be calculated. We found we had 93 units of nitrogen in the top 60 cm. It was estimated that to



Figure 1: The trial at Benerembah showing treatment effects at maturity.



grow a 7 t/ha wheat crop at 13.5% protein we needed about 330 kg N/ha, therefore we had a deficit of about 270 kg N/ha. With the site being faba bean stubble, we believed that not all of the nitrogen was picked up in the soil test, so we decided to apply 375 kg urea/ha (172 kg N/ha) to the crop in addition to 11.3 kg N/ha in the starter fertiliser. This is a realistic nitrogen budget that was later proven in the field.

The crop was sown on 17 May, with 100 kg Granulock 12Z/ha (11.3 kg N/ha and 17 kg P/ha).

The paddock was pre-irrigated on 15 April, and watered three times in the spring (10 and 30 September and 22 October), using a total of 5 ML/ha. Each irrigation was scheduled using an Enviroscan® soil monitoring device, and no water stress was apparent. Only 138 mm fell in the growing season (April–October).

The paddock had 1.2 L/ha Roundup CT® + 1.2 L/ha Stomp® + 35 g/ha Logran® prior to sowing, and 200 g/ha Lontrel® 750WG on 12 July to control escape volunteer faba beans. No seed or foliar fungicides were used in this trial.

The trial

Two durum wheat varieties (EGA Bellaroi and Jandaroi) were planted using a small plot cone seeder at a sowing rate of 220 plants/m² (roughly 110 kg/ha).

Plots were 7.5 m long and 1.52 m wide. Each treatment was replicated three times in a randomised block design.

Plant measurements were taken at emergence, tillering and maturity.

The trial was harvested using a small plot harvester and grain yield and quality was assessed for each treatment.

Three PGRs were used in the trial at two growth stages.

- At DC31 (1st node) a mixture of 1 L/ha Cycocel 750A® (chlormequat) + 200 mL/ha of an experimental PGR (referred to as X in this trial) was applied as a foliar spray in a water rate of 85 L/ha. These PGRs inhibit the plant producing a hormone called gibberellin, which in turn results in shorter internodes, and therefore lower crop height.

Table 1: Treatments showing the various canopy management options explored in the trial. Each treatment was applied in the durum varieties EGA Bellaroi and Jandaroi.

Treatment	Application rate of nitrogen or PGR			
	At sowing	First node	Head emergence	Post flowering
1	Nil	Nil	Nil	Nil
2	375 kg urea/ha	Nil	Nil	Nil
3	Nil	375 kg urea/ha	Nil	Nil
4	125 kg urea/ha	250 kg urea/ha	Nil	Nil
5	125 kg urea/ha	250 kg urea/ha	Nil	10 kg N/ha Nitro humus® foliar
6	125 kg urea/ha	250 kg urea/ha + Cycocel® +X	Nil	10 kg N/ha Nitro humus® foliar
7	125 kg urea/ha	250 kg urea/ha + Cycocel® +X	Prep®	10 kg N/ha Nitro humus® foliar
8	Nil	Nil	Nil	10 kg N/ha Nitro humus® foliar



Figure 2: Height difference in Jandaroi prior to flowering, October, with (right) and without (left) PGR at DC31.

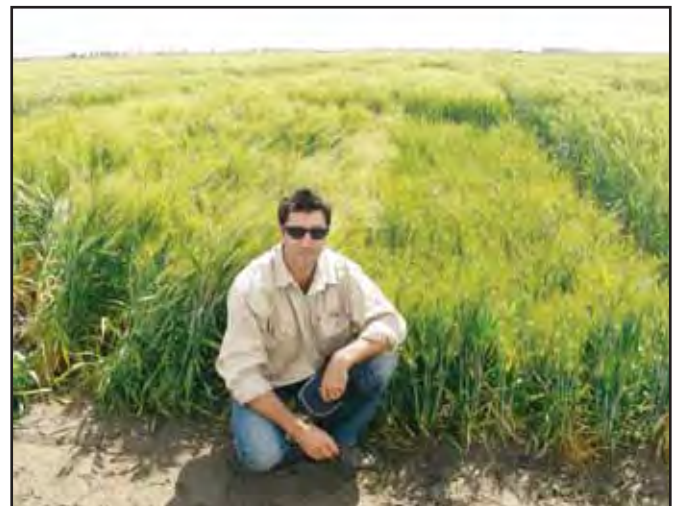


Figure 3: Barry Haskins next to plots of Jandaroi with and without PGR – note lodging in untreated plot on left.



- At DC 50 (head emergence) 500 mL/ha Prep® 720 (Ethephon) was used to minimise the 'bounce back' effect that usually follows the DC31 PGRs. Ethephon acts by increasing production of another hormone called ethylene, which has been seen to strengthen cell walls, and allow a more even height of plant heads (reducing apical dominance).

The results

Impact of nitrogen

Nitrogen treatments in this trial performed as expected, and mirrored previous research in southern NSW. There were similar reactions in both varieties, with the highest yields recorded when all of the nitrogen was applied at sowing or split between sowing and DC31, as shown in Figure 4.

In general, with the cooler start of the 2006 season limiting tillering, the highest yields were obtained when sufficient nitrogen requirements were applied at or close to sowing.

In relation to the effect of nitrogen application timing on grain protein, again results were as expected, as shown in Figure 5. If nitrogen was added early enough so that the plant was allowed sufficient time for uptake, then grain protein differences were minimal. Interestingly enough,

whilst not statistically significant, Nitro humus® at 10 kg N/ha produced a grain protein increase of between 0.5–0.7% above comparable treatments without the foliar application.

Impact of PGRs on plant height

The response from the PGRs was much more extreme than expected, showing a greater shortening effect than many other previous trials. As shown in Figure 6, the PGRs applied at DC31 reduced crop height in both varieties by between 16 and 28%. Most of this height reduction resulted from much shorter internodes between nodes 1 and 3. The plants did begin to 'bounce back' (ie internodes 4 and 5 significantly increased in length over the control), which was controlled by the DC50 application of Ethephon.

Impact of PGRs on lodging

Interestingly enough, a large variety difference was observed between Bellaroi and Jandaroi. Even with all of the nitrogen applied at sowing, Bellaroi did not lodge. Jandaroi however lodged severely, even when nitrogen applications were split. This lodging was most apparent following the last irrigation. By adding PGRs (both treatments) lodging was eliminated.

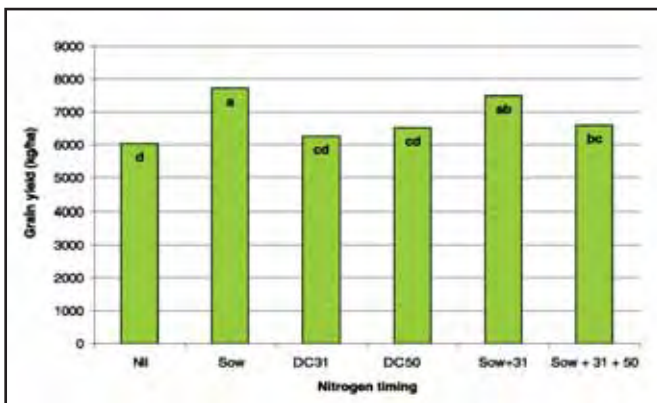


Figure 4: The effect of nitrogen application timing on grain yield across both varieties.

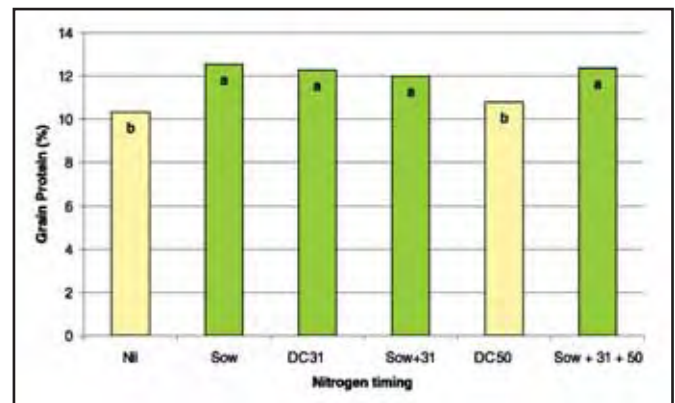


Figure 5: The effect of nitrogen application timing on grain protein across both wheat varieties.

Note: A significant difference between treatments is only apparent when the letters on the bars in the graph are different. In the case of two letters on a bar, results are only different to treatments without that letter, eg 'a' is significantly different to 'bc' but not to 'ab'.

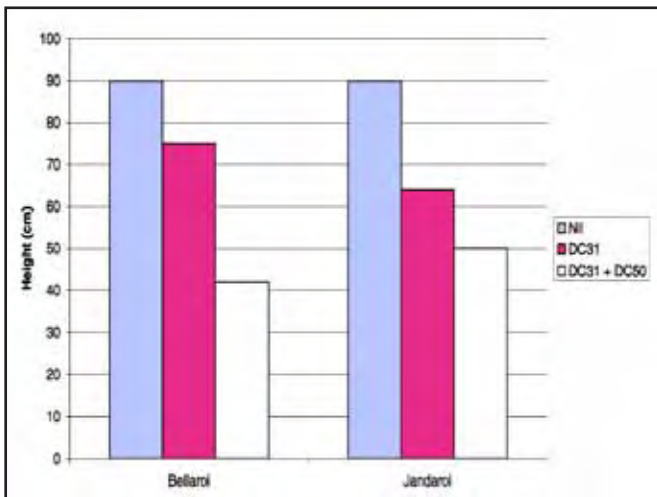


Figure 6: The effect of PGRs on plant height at maturity.

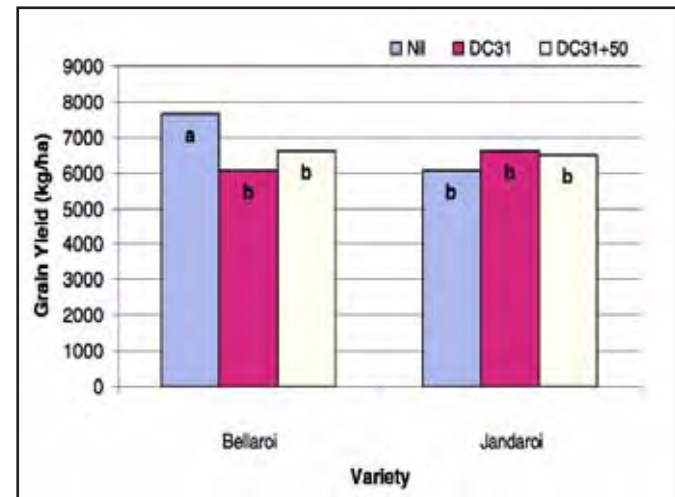


Figure 7: Impact of PGR treatments on grain yield in Bellaroi and Jandaroi.



Impact of PGRs on yield

In the absence of lodging as with Bellaroi, PGRs at DC31 actually reduced yield. This was probably a result of the excessive shortening effect observed in this trial. The outcome from excessive shortening may also have reduced grain numbers in secondary tillers, hence reducing yield (Figure 7).

When the crop lodged as it did in Jandaroi, yield was maintained by using PGRs. This suggests that the yield reduction associated with lodging was similar to that observed by the reduction in grain numbers on secondary tillers caused by the PGRs at DC31.

The addition of Ethephon at head emergence did not have any impact on grain yield in either variety compared to the application of the PGR at DC31.

Impact of PGRs on maturity


In both varieties, a significant delay in maturity occurred with the application of PGRs. Treatments that had a PGR at DC31 were 7–10 days slower to flowering than those without. This effect is well documented in other research, and in a practical sense could offer management options relating to frost risk.

Do we need to use PGRs to manage crop canopies in the future?

The results from this trial suggest that under the conditions experienced in the 2006 season, PGRs were not worth using. We must remember however that the season was very cool in June and July, which didn't promote excess tillering and therefore lodging. Secondly, the dwarfing response that we observed from the PGRs at DC31 was much greater than expected. This 'excess shortening' had a negative effect on grain numbers in secondary tillers, and in turn yield. We would not expect to see this response in every season. Additional work on the timing and rate of application also needs to be conducted.

PGRs would more likely fit into a 'recipe' for high yielding wheat, where they would be used only in situations where excessive lodging was expected, such as in overhead irrigation systems or high yielding flood paddocks. The decision to use these products could be made at DC31 when tiller counts for nitrogen management are made.

The conclusion

More work needs to be done to ensure a proper package is developed for effective use of PGRs in irrigated wheat. Once additional products are registered in Australia, they will no doubt have a place in irrigated wheat in the future, however refining the situations where they will be most useful will be the driving factor towards their success. 

GRDC Project DAN00098 - Variety specific agronomy packages

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Further information

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Figure 8: Plant height effect in September of PGR applied at DC31 on Jandaroi left and Bellaroi right. The smaller plants were sprayed with PGR and the larger plants were not.