Moddus Evo: Controlling plant growth for reduced lodging and improved yields

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KEY MESSAGES

- Moddus Evo reduces lodging and can increase yields
- Application timing and concentration of Moddus Evo is critical
- Moddus Evo should not be applied to plants under stress
- Moddus Evo has improved formulation stability and plant uptake

INTRODUCTION

Lodging is considered one of the biggest barriers to reliably achieving high yields in intensive cereal production in Australia (Ref. 1 and 2). When favourable season conditions combine with traditional management practices in high input cereal production systems, lodging can result in significant reductions in yield and grain quality.

Between 16 and 18 million hectares of cereals are sown in Australia each year. The majority of these crops are grown under conditions not usually associated with yield reductions due to lodging. However, in high input production systems such as irrigated crops and cereals grown in high rainfall zones, the risk of yield reductions due to lodging is considerably higher when seasonal conditions favour such events. This area is estimated at between 5 and 10% of total cereal production in any given year.

In the presence of favourable climatic conditions plant lodging occurs in 2 forms: (1) stem lodging, a buckling of the lower internodes and (2) root lodging, a failure in the plants anchorage system in the soil (Ref. 3). While root lodging is considered more common, it is generally accepted that both can occur in the one field. The main factor considered responsible for weakened stems and decreased root anchorage is excessive green leaf area during the early stages of crop development up to early stem elongation (Ref. 1, 2 and 3). High biomass crops, resulting from high soil nutritional levels or high planting rates, in the presence of optimal moisture levels, generally tend to grow taller in a response to reduced solar energy capture in the lower canopy. This in turn can lead to the production of weaker stems and greater stress on root anchorage.

A great deal of research has been devoted to developing management strategies to reduce the incidence and severity of lodging in high input cereal production systems. These are all focussed on opening early canopies to reduce the plants response towards taller growth resulting in weakened stems and poor anchorage. Some of these strategies include:

Reduced seeding rates and wider row spacing
Delayed sowing dates with the use of shorter season varieties
Split or delayed Nitrogen (N) applications

All of these strategies alone or in combination have been shown to successfully reduce the incidence of lodging and maximise crop yields under the conditions experienced in the associated trials. However each of these strategies cannot be implemented without some risk of missing potential upsides in crop yield potential in the absence of lodging. In all cases growers need to implement these strategies before having an accurate idea of what the seasonal conditions will be like.

In a trial undertaken near Griffith NSW in 2004, the wheat variety Chara was evaluated at 3 planting densities and, in what turned out to be a season not conducive to lodging, the crop produced highest yields with the highest sowing rate (Ref. 2). In this instance, a grower would have foregone up to 0.5 t/ha in yield if a

reduced sowing density strategy was implemented. It should be noted that the same variety in a corresponding trial in 2003, a season conducive to lodging, produced greater yields with the lower plant densities.

Research (Ref. 1) has shown that in situations with high up front nitrogen levels, delaying the sowing date of irrigated wheat can result in reduced lodging risk, as later sown crops tend to be smaller and have fewer tillers. However this can reduce the yield potential due to the shorter growth period and increased exposure to heat stress during grain fill.

Similarly it has been clearly demonstrated (Ref. 1) that a delayed nitrogen (N) application strategy can reduce lodging risk significantly depending on variety grown. However, there is some risk attached to such programs if in-crop N is incorporated poorly or application timing is not optimal; the crop's maximum yield potential can be lost. He also notes that there is an increased risk in heavier soil environments, which is common in the northern cereal region, where prolonged wet conditions can leave growers unable to access paddocks for extended periods, potentially delaying N applications.

These results and comments are not referenced to reduce the importance of such strategies but to highlight the fact that they represent options that may suit some but not necessarily all growers or field situations.

By the same measure, the use of Plant Growth Regulators (PGR's), applied to reduce stem length and reduce the risk of lodging, will not be appropriate in all conditions. The one advantage they do have over these cultural strategies is that they allow the grower to assess the condition and potential of the crop before deciding to apply.

PGR's are used extensively overseas in high input, high yielding cereal production systems (Ref. 1 and 2). In countries such as New Zealand, the United Kingdom, Germany and France the use of PGR's to reduce the incidence and severity of lodging is common practice. In the UK alone it is estimated that around 84% of the winter wheat area sown is treated with PGR's (Ref. 3).

In Australia, the range of PGR's available to growers is limited to chlormequat chloride (wheat only) and ethephon (barley only) and the use of these products has generally been relatively low. The principle reason for this is simply that responses are viewed as variable and growers have not regularly seen the benefit of incorporating them into their management programs. The key factor contributing to this perception is a relatively low appreciation of the conditions and situations where the use of a PGR is appropriate. A great deal of resource has been devoted to optimising crop husbandry strategies to minimise lodging but relatively little time has been devoted to identifying the best situations to use PGR's for optimum results. If the field, variety or growing conditions are not conducive to lodging then the use of a PGR will have no benefit to the grower and many of the trials undertaken with PGR's have led to conclusions that ignore the fact that a PGR did not need to be applied in the first place.

Moddus® (250 g/L trinexapac-ethyl) is used by cereal growers in a range of overseas countries including New Zealand, UK and Germany to reduce the incidence and severity of lodging and optimise the yield and quality of high yielding wheat, barley and oat crops. Moddus® Evo is an enhanced dispersion concentrate (DC) formulation which has been developed to provide greater formulation stability and more effective uptake in the plant. With improved mixing characteristics and the potential to provide better consistency of performance Moddus® Evo is currently submitted to the APVMA for registration in Australian cereals.

The purpose of this research was to investigate the value of Moddus applications to Australian cereals to reduce lodging and improve yields.

METHODS

Field trials were run across Australia from 2004 to 2011. A range of varieties, climatic conditions and geographical locations were used. Application rates of Moddus Evo varied from 100-600mL/ha applied at different growth stages. Trials were established as small plots, typically 20-120m^2 using a randomised complete block design, incorporating 3 to 6 replicates.

Measurements were taken of the effect of Moddus application on plant growth, stem strength, stem wall thickness, lodging, lodging score, yield, as well as grain quality measurements.

Statistical analyses were undertaken on all results.

RESULTS

Optimising Moddus® Evo - application rates and timing in wheat

Moddus® Evo was assessed for reduction of lodging in wheat at a range of rates and at different timings (Figure 1). Moddus® Evo applied at rates of 300 or 400mL/ha consistently reduced lodging when conditions favoured its development. Similar performance was obtained when Moddus® Evo was combined with Chlormiquat chloride (CCC) (Figure 1a).

In trials examining the effect of Moddus® Evo and CCC combinations, the most effective rates for optimum yield enhancement and lodging protection (as demonstrated by crop height reduction), was 200 mL + 1000 to 1300 mL/ha respectively (Figures 1b and 1c)

Multiple trials were run examining the effect of application timing of Moddus® in wheat (Figure 1d). It was observed that the most consistent results came from applications of Moddus at the GS31/32 stage ie. When the second growth node was visible on the stem. Applications at earlier or later growth stages were typically more variable in efficacy and yield enhancement.

Optimising Moddus® Evo - application rates and timing in barley

A range of rates of Moddus® Evo were assessed for reduction of lodging and enhancement of yield in barley (Figures 2a and b). Moddus® Evo applied at rates of 300 or 400mL/ha consistently improved yields and reduced barley lodging. The optimal growth stage for Moddus application to have the most consistent and greatest impact on yield was GS30/32.

When growth conditions were favourable often a bounce back effect was observed, where compensation growth occurred. To reduce the impact of the bounce back, a second follow-up application of Moddus® Evo was evaluated (Figure 2c). It was seen when a second application of Moddus® was applied at GS37/39 the growth compensation was reduced. When conditions were favourable for bounce back the second application resulted in significant yield improvements (Figure 2d). The results displayed in Figure 2c is the average across a number of trials where a second application of Moddus® Evo was applied, not all of the trials favoured bounce back growth, which has reduced the overall impact.

Optimising Moddus® Evo - application rates and timing in oats

A range of rates of Moddus® Evo were assessed for a reduction of lodging and yield enhancement in oats. Moddus was applied in single or double applications. Moddus® applied at rates of 300-400 mL/ha consistently reduced lodging in oats (Figure 3). As previously seen with wheat and barley application timing at early stem elongation GS30/33 was optimal for height reduction, reduced lodging and improved yields. Double applications of Moddus® had little impact on oats (data not shown).

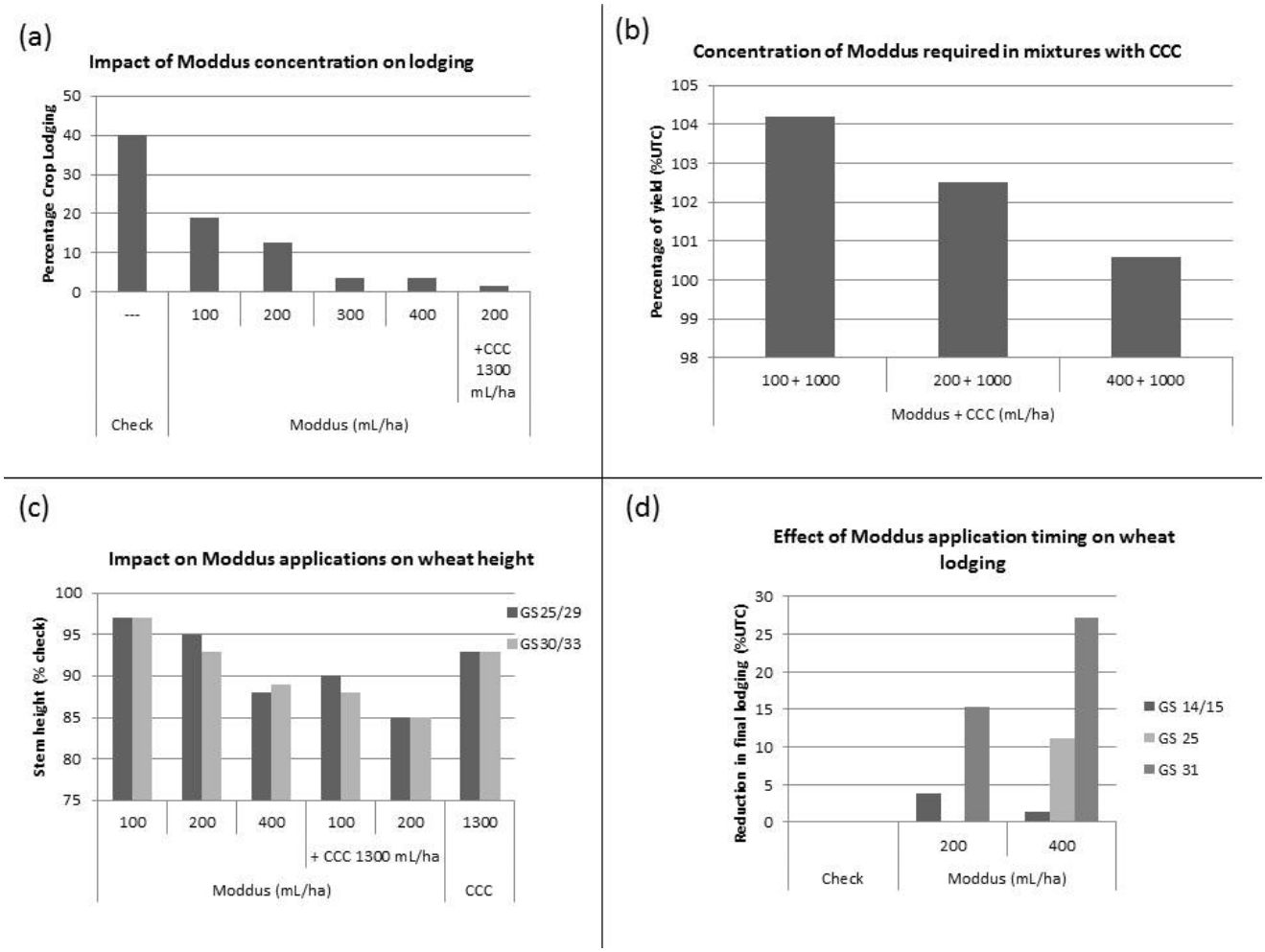

Figure 1(a) Effect of Moddus® concentration on lodging when applied at early stem elongation (GS31-32) wheat crops. Data presented is the summary of multiple trials. (b) Effect of Combinations of Moddus® Evo and chlormequat chloride on crop yield, data displayed is percentage improvement from untreated. Applications occurred on healthy growing plants at GS31-32. This is average data from five trials run in 2007, 80% of the trials did not have lodging. (c) Effect of Moddus® applications on stem height. (d) Effect of application timing of Moddus® on wheat at different growth stages.

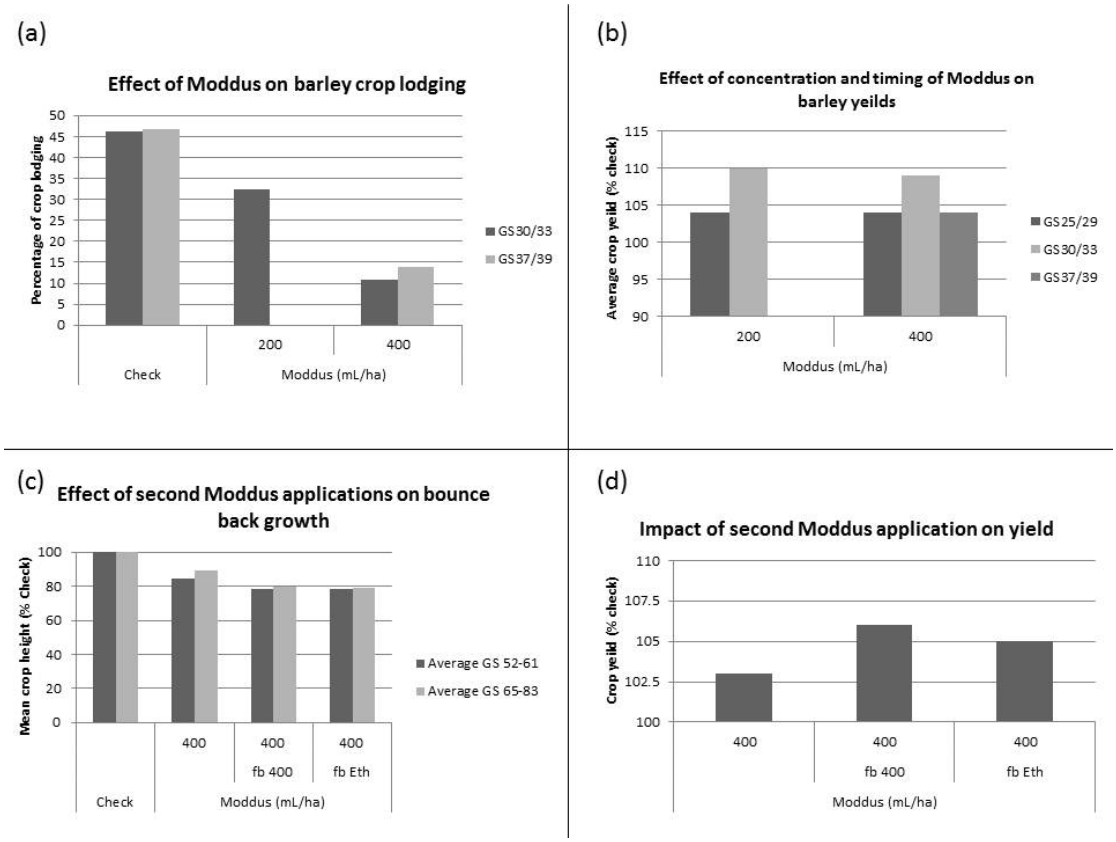

Figure 2.(a) Effect of Moddus® concentration on lodging when applied at early and late stem elongation in barley crops. Data presented is the summary of multiple trials. (b) Effect of concentration and timing of Moddus® applications on barley yields, data displayed is percentage improvement from untreated. Applications occurred on healthy growing plants, conditions were not favourable for bounce back growth. This is average data from five trials run in 2007, 80% of the trials did not have lodging. (c) Effect of second application of Moddus® on barley stem heights when conditions favour compensatory growth occurred following initial application. Eth – Ethephon applied at 500mL/ha. (d) Effect of second application of Moddus® on barley yields when conditions favour compensatory growth occurred following initial application. Eth – Ethephon applied at 500mL/ha.

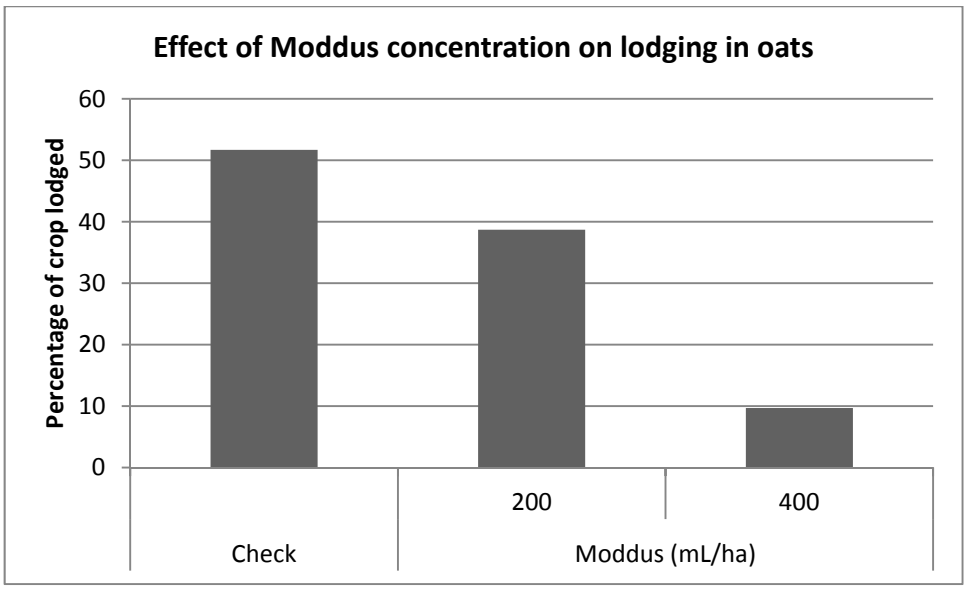

Figure 3. Effect of Moddus® concentration on lodging in oats, when application was at GS31/33. Results displayed are a summary of three trials.

DISCUSSION

Overall improvements in yield were often correlated with a reduction in stem height irrespective of whether lodging occurred or not. Yield improvements through the reduction of lodging are well documented. What is less understood is the often positive impact on yields with the use of Moddus® Evo in the absence of lodging.

Conversely during the course of the evaluation of Moddus® Evo on the yield enhancement and reduction in lodging there were a few trials with anomalous results, where Moddus® Evo application did not improve yield. When these trials were examined it was found that either environmental conditions during the lead up to the Moddus® Evo application were poor, with either extensive frosting, drought, poor subsoil moisture profile or nutrient deficiencies within the crop. As a result Moddus® Evo should only be applied to healthy growing crops with optimum yield potential.

Future research with Moddus® Evo

Continued research is focusing on developing a greater understanding of the factors that allow Moddus® Evo to improve cereals yields in the absence of lodging.

- Survival and development of secondary tillers in high biomass crops. Can the use of Moddus® Evo open canopies allowing the full development of secondary tillers in high biomass crops with good soil moisture reserves.

- Enhanced root development. Previous research has suggested that plants treated with Moddus® develop larger root systems. Larger root systems may allow plants to access greater soil moisture and nutritional reserves through the latter stages of crop development

- Redistribution of carbohydrates. The conversion of structural carbohydrates to water soluble forms to enhance crop yields under dry spring conditions. Preliminary results have indicated that Moddus has a significant effect on the concentration of water soluble carbohydrates in wheat and barley.

- Frost damage reduction. The use of Moddus® Evo has been shown to delay mid-season crop development by around 7-10 days. While treated crops “catch-up” and do not incur a harvest time penalty, on avergae this initial delay results in later flowering and grain filling occurring in less frost prone conditions.

- Barley head loss. Dramatic yield improvements were observed with certain barley varieties treated with Moddus® Evo due to head retention in conditions favourable to head loss. Further evaluation into the benefits of Moddus® Evo in reducing head loss in susceptible barley varieties is being assessed.

CONCLUSION

Moddus® Evo offers growers in environments conducive to lodging an in-season option to reduce the impact of lodging while allowing them to manage crops for maximal yields. The timing and concentration of Moddus® Evo applications is critical to produce the optimal yield improvements. Moddus® should only be applied to healthy growing crops. Moddus® Evo is a new generation plant growth regulator offering improved yield potential to Australian cereals.

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