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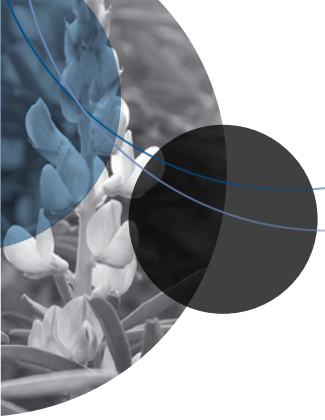

Agronomy – cereals

Influence of anti-lodging plant growth regulators on root activity in barley – Wagga Wagga 2017

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Key findings

- Plant growth regulator (PGR) application at the recommended time of early stem elongation (Z31) did not alter root or shoot growth in the barley cultivar (cv) Compass(ф).
- When PGRs were applied during early growth stages (Z12–13) root growth was inhibited or unchanged depending on the active ingredient applied and the application method.
- When PGRs were applied early and when applied as a soil drench they inhibited root growth, but when applied at the recommended time for controlling stem height, PGRs had no effect on root growth.

Introduction

Plant growth regulators (PGRs) are chemicals that regulate stem elongation and reduce plant height in cereals (Berry et al. 2000; Acuña et al. 2015). PGRs are used in farming systems that are susceptible to lodging, such as in high rainfall areas or under intensive management (e.g. irrigation, high nitrogen rates). There have been indications that PGRs might potentially modify plant characteristics, such as root growth, in addition to reducing the internode length of stems and shortening plant height (Cooke, Hoad & Child 1983; Berry et al. 2004). However, results have been inconsistent and are often dictated by the influence of PGR type, environment, growth stage of application, and cultivar.

The aim of this experiment was to investigate the effect of two commonly used PGRs on root growth. It was hypothesised that if root growth modification occurred due to PGR application it would be a result of either the PGR altering the allometric balance between roots and shoots; a modification of the allocation of photoassimilates between the root and shoot as a consequence of inhibiting shoot growth; or a translocation of PGR from the point of application to the roots to directly influence root growth.

Methodology

The experiment was conducted in glasshouse facilities at Charles Sturt University, Wagga Wagga NSW, to investigate the influence of two gibberellin-inhibiting PGRs: Moddus®Evo (250 g/L trinexapac ethyl) and Errex 750 (582 g/L chlormequat chloride) on root growth. One barley variety, cv. Compass(ф), was evaluated at two specific growth stages: early vegetative (Z12–13), and at early stem elongation (Z31), which is the recommended application time on the label.

PGRs were applied as either a soil drench or foliar spray to plants growing in PVC pots (100 mm diameter, 500 mm height) at two specific stages: the two- to three-leaf stage (Z12–13) or at the beginning of stem elongation (Z31) using a split-split randomised design, blocked by replication with four replicates. The rate of application of both PGRs was based on the highest label recommended rate to maximise the possibility of a response from the plants. Moddus®Evo was applied at 1 g active ingredient (ai)/L, which is equivalent to 400 mL/ha at 100 L water rate.

Errex 750 was applied at 7 g ai/L, which is equivalent to 1300 mL/ha at 100 L water rate. An untreated control, in which water was applied in place of chemical, was also included.

Multiple harvests were conducted from the date of application of the PGR treatments up to 20 days after treatments (DAT) to explore how soon plant growth was modified and to investigate more specifically the plant's response to the PGR over time. Shoots were removed at soil level and, depending on PGR timing, had either leaf extension (Z12–13) or stem height (Z31) measured. Tiller number, growth stage, and leaf area were also recorded. Soil was removed as an intact core and split into 10 cm increments for root washing. A selection of treatments was scanned for root length and diameter using WinRhizo. Shoots and roots were dried at 60 °C for dry weight determination. WinRhizo uses a computer program and image acquisition components to analyse root characteristics such as morphology (length, area, volume) and architecture.

Results

PGRs had varying effects on plant growth modification in cv. Compass(ɸ) barley. The effect of PGR application was only significant 20 DAT at the final harvest; as a result data is shown from the final harvest only.

PGR applied at the beginning of stem elongation (Z31); the label recommended time of application

Applying Moddus®Evo and Errex 750 at the recommended time of early stem elongation (Z31) had no significant effects on plant height, shoot dry matter (DM) production, root DM, or tiller appearance from either PGR in either treatment (data not shown).

PGR applied at the two- to three-leaf stages (Z12—13) of vegetative growth

When Moddus®Evo was applied during early growth stages (Z12–13) it significantly inhibited root and shoot DM in both treatments (52% and 61%, respectively of the untreated control) (Table 1). Foliar application of Moddus®Evo did not affect leaf extension rate, however, when applied as a soil drench, leaf extension rate was slower when compared with the untreated control (data not shown).

Table 1. The effect of applying PGRs during early (Z12–13) plant growth on mean tiller appearance (tiller number/day), shoot dry matter [DM] (grams), and root DM.

PGR	Application method	Tiller appearance (tiller/day)	Shoot DM (grams)	Root DM (grams)
Untreated control	Soil drench	0.38	6.31	1.71
	Foliar application	0.26	4.93	1.75
	Mean	0.32	5.62	1.73
Errex 750 (ai chlormequat chloride)	Soil drench	0.40	5.45	2.24
	Foliar application	0.35	5.87	2.32
	Mean	0.38	5.66	2.25
Moddus® Evo (ai trinexapac ethyl)	Soil drench	0.15	2.27	0.50
	Foliar application	0.32	4.59	1.39
	Mean	0.23	3.43	0.90
l.s.d. chemical		ns	1.53**	0.91*
l.s.d. application method		ns	ns	ns
l.s.d. interaction		0.16*	ns	ns

Note: ** $P<0.01$; * $P<0.05$; ns: not significantly different.
'Means' indicate the average of chemical regardless of application method (two application methods used; either soil drench or foliar application). Least significant differences (l.s.d.) shown for main effects and the interaction of [application method × chemical].

Tiller appearance was significantly affected by both PGR type and application method. A soil drench of Moddus®Evo reduced tiller appearance by 47%, however, a foliar application of Moddus®Evo did not reduce tiller appearance compared with the untreated control (Table 1).

Applying Errex 750 during early growth stages did not significantly influence root DM, shoot DM, or leaf area (Table 1).

Summary

Applying Moddus®Evo and Errex 750 at the recommended time of early stem elongation (Z31) were ineffective on root and shoot growth. When applied during early growth stages (Z12–13), Moddus®Evo significantly inhibited shoot DM, root DM, and the rate of tiller appearance. Results from applying Errex 750 during early growth stages was inconsistent, but overall did not significantly influence root and shoot growth.

In this study, only one barley cultivar (cv. Compass$^{(\dagger)}$) was evaluated. However, it is likely that the effect of PGRs on plant growth parameters would interact with cultivar with respect to growth stage, plant type, and environmental conditions. Therefore, further research is needed to determine which Australian barley cultivars respond to PGR application by reducing their shoot height before it will be possible to adequately quantify whether PGRs also affect root growth.

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