What are the effects of chlormequat and trinexapac-ethyl alone or in combination on lodging, height and yield of winter wheat in Tasmania?

Angela M. Merry[1], Geoff Dean[1], Tina Botwright Acuña[2]

[1] Tasmanian Institute of Agriculture, School of Land and Food, University of Tasmania, Private Bag 46, Kings Meadows, TAS, 7249, Angela.Merry@utas.edu.au

[2] Tasmanian Institute of Agriculture, School of Land and Food, University of Tasmania, Private Bag 54, Hobart, TAS, 7001

Abstract

In the High Rainfall Zone (HRZ) irrigation and high rates of applied nitrogen fertiliser may increase the risk of lodging in winter wheat. Crop lodging can limit crop productivity through interfering with water and assimilate supply to the developing grain. Lodging can also interfere with harvest ranging from slowing harvest operation through to total crop loss when lodging is severe. Plant growth regulators (PGRs) mimic or alter production of plant hormones and thus regulate plant growth and development and are used as an insurance measure against lodging. In some instances, PGRs have been reported to increase yield irrespective of whether lodging has occurred. Experiments were conducted on winter wheat cvs. Brennan and Revenue over four seasons (2009-2012) in northern Tasmania. Crops were treated with varying rates, combinations and timings of chlormequat (CCC) and trinexapac-ethyl (TE). Experiments evaluated the individual and combined effects of these two PGRs on height and grain yield. PGRs treatments reduced height in most years, for example in 2012 the combined treatment of CCC and TE applied at early stem elongation had the greatest height reduction, decreasing plant height by 17% compared with the control. No lodging occurred in any year. PGRs increased yield in some years, for instance in 2012, CCC applied at mid tillering and early stem elongation increased yield by 7.5 and 4.1% respectively compared with the control. The results indicate that both TE and CCC alone and in combination can decrease lodging risk and in some seasons PGRs may increase yield.

Key words

Plant growth regulators, cereals, yield components

Introduction

Lodging of winter wheat can increase cost of production by directly affecting yield and increasing costs by reducing harvest-ability of the crop. The plant growth regulators (PGRs), chlormequat (CCC) and trinexapac-ethyl (TE) have been found to decrease height, increase stem diameter (Tolbert 1960) and strength (Zagonel and Fernandes 2007), thereby reducing lodging risk. In High Rainfall Zone (HRZ) production systems, where there are often high inputs of applied fertiliser and water, PGRs may be used to decrease the incidence of lodging. Though the role of PGRs to reduce lodging risk in winter wheat is well accepted, there have been inconsistent effects on yield. For example Shekoofa and Emam (2008) showed CCC increased grain yield when applied at mid tillering while Espindula *et al*. (2009) showed that CCC had no effect on yield, and TE applied at high rates reduced yield.

The aim of this research was to evaluate the individual and combined effects of two PGRs, CCC and TE, on lodging, height and yield of winter wheat over several seasons in a high input system in northern Tasmania.

Materials and Methods

Trials were located in commercial paddocks of wheat in the Hagley area in Tasmania (41°31'S, 146°54'E) over four growing seasons (2009-2012). The trials were established on commercially sown paddocks of wheat cultivars Brennan (sown 11th May 2009, 16th June 2011, 1st May 2012 at 100 kg ha $^{-1}$) and Revenue (sown 3rd June 2010 at 105 kg ha^{-1}). Weeds and pests were controlled as per commercial practice. Each trial was a randomised complete block, with four replicates. Plots were aligned perpendicular to the sowing direction and the borders sprayed out with glyphosate. Plot sizes were 1.85 m wide and 8 or 12 m in length depending on the year of the experiment. PGR treatments were applied according to Zadoks growth stage at mid tillering (GS 24) and stem elongation (GS 30). Treatments were CCC 24, CCC 30 (CCC applied at 730 g a.i. ha^{-1} at GS 24 and 30), TE 24, TE x2 24, TE 30 (TE applied at 50 and 100 g a.i. ha^{-1} at GS 24 and 30), CCC + TE 24, CCC + TE 24 & 30, CCC + TE 30 (combination of CCC and TE at 730 and 50 g a.i.

ha^{-1} at GS 24 and 30). Extra controls were added to induce lodging, GA + N (gibberellic acid at 8 g ai.i ha^{-1} and nitrogen at 15 kg a.i. ha^{1} at GS 24), early N (15 kg a.i. ha^{-1} at GS 24) and late extra N (15 kg a.i. ha^{-1} at GS 45). Plants were sampled from 0.6 m^{-2} quadrats at physiological maturity and plot harvester was used to measure yield.

Results

No lodging occurred in any treatment in any year. In 2010 no significant effects on height or yield were realised. The lack of treatment effects in 2010 may be attributed to the exceptionally wet winter with the paddock being waterlogged shortly before treatments were applied. The additional controls added to induce lodging did not differ from the nil control and hence have been omitted from results presented in Figures 1 and 2.

The effects of chlormequat and trinexapac-ethyl on plant height

PGR treatments applied at GS 30 showed height reductions in most years (Figure 1). The greatest reduction in height was achieved with CCC and TE applied at early stem elongation (GS 30). Neither the single or double TE applications applied alone at mid tillering (GS 24) reduced height.

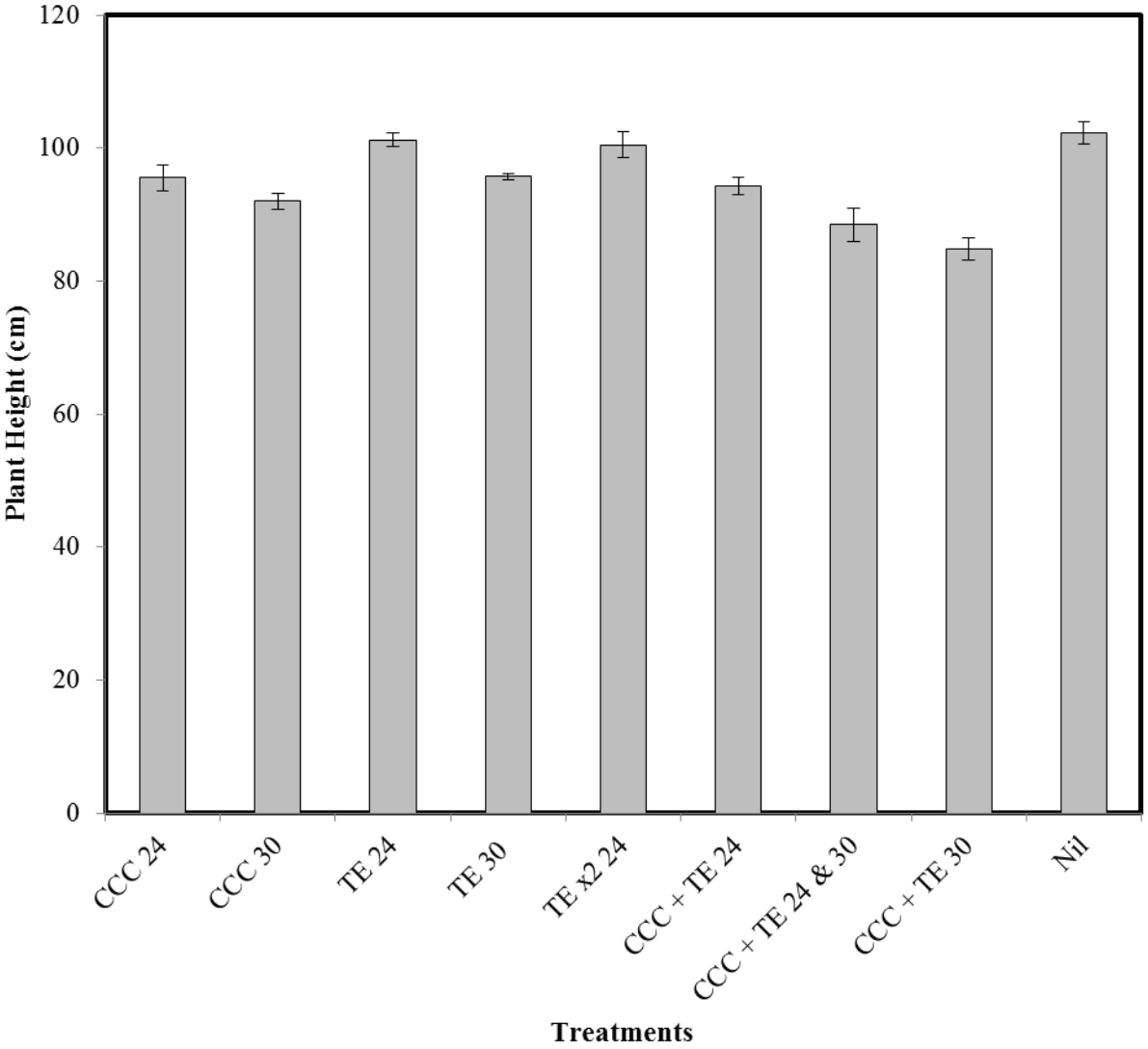

Figure 1. Effect of PGR treatments on crop height in the 2012 trial. Bars represent ± SE. PGR treatments of chlormequat (CCC) and trinexapac-ethyl (TE) applied alone or in combination were applied at mid tillering (GS 24) and/or early stem elongation (GS 30).

The effects of chlormequat and trinexapac-ethyl on grain yield

In three out of the four years there were increases in grain yield as a result of PGR application. In 2009 a single application of TE at early stem elongation increased grain yield, and this treatment was only also applied in 2012 and it tended to increase yield (Figure 2). Results indicate that generally CCC applied alone at mid tillering had the greatest increase on yield (e.g. Figure 2), though results were variable between years.

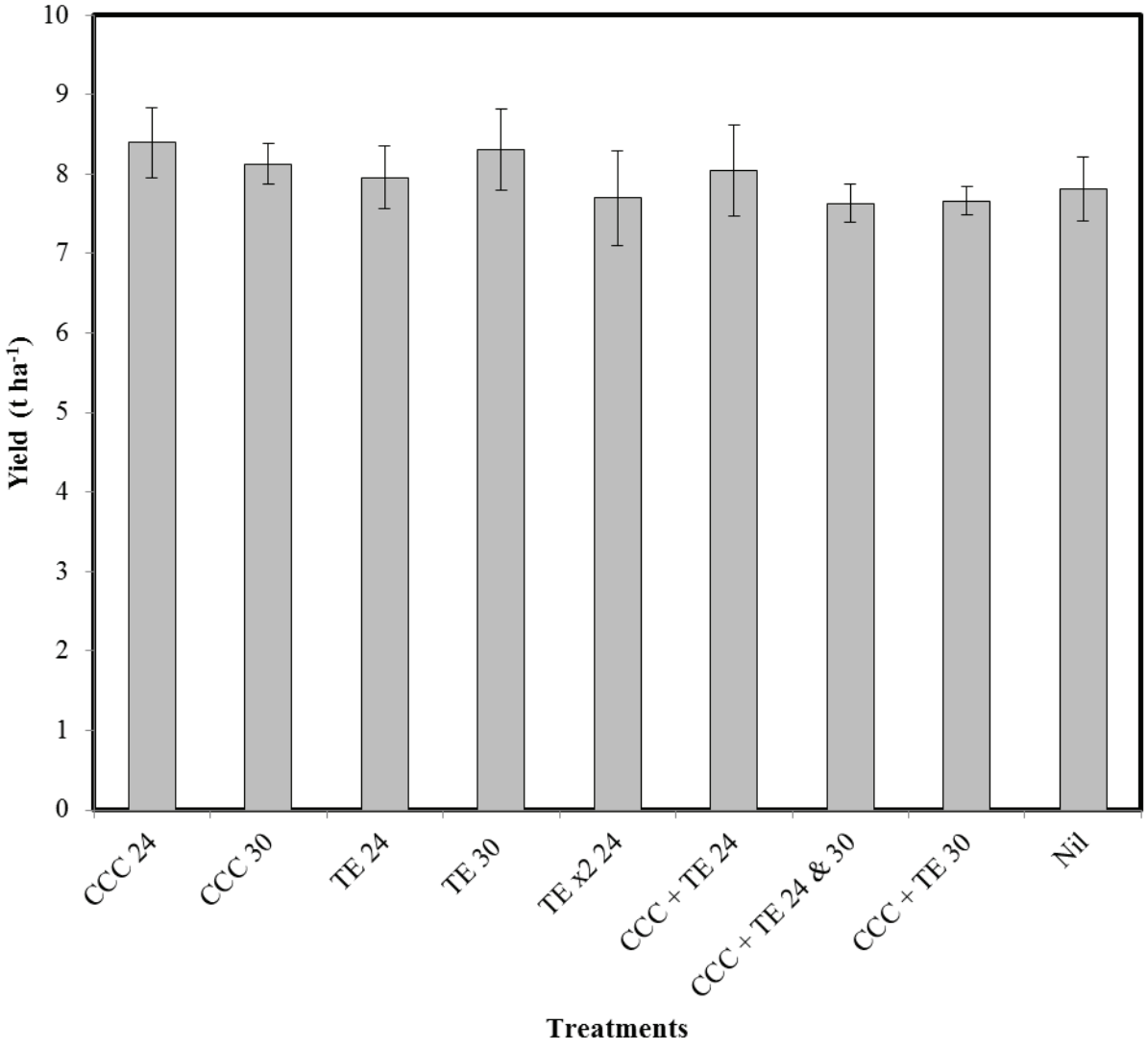

Figure 2. Effect of PGR treatments on crop yield in the 2012 trial. Bars represent ± SE. PGR treatments of chlormequat (CCC) and trinexapac-ethyl (TE) applied alone or in combination were applied at mid tillering (GS 24) and/or early stem elongation (GS 30).

Discussion and Conclusion

There was no lodging in any treatments in any year meaning PGR treatment could not be assessed to improve the stand ability of the crop. PGR treatment did however reduce height. CCC and TE applied in combination at early stem elongation (GS 30) tended to reduce plant height and hence lodging risk but in these trials did not increase yield. The double dose treatment of TE at GS 24 did not increase the height reduction as it has in other studies such as Wiersma *et al*. (2011) though these authors did suggest GS 37 as the optimum time for application of TE. CCC applied alone at mid tillering (GS 24) increased grain yield in most years, results consistent with Shekoofa and Emam (2008) and reduced plant height, though not to the extent of CCC and TE combined. TE applied at early stem elongation did reduce height (by 6% in 2012) though not to the extent of the CCC treatments, but tended increase yield. CCC applied at mid tillering and TE applied at early stem elongation decreased lodging risk through height reduction compared with the control, though not to the extent of the other treatments. They did however, tend to increase yield, so would be suggested strategy to decrease lodging risk whilst potentially having yield benefits in years when lodging risk was not high.

Acknowledgements

The authors acknowledge and thank Greg Gibson and James Clutterbuck who offered their land on which the trials were conducted and managed. Input and guidance from growers and advisors for the development of strategies is also gratefully acknowledged. We thank Rebecca Fish, Brett Davey and Rob Howard for technical assistance. The project was funded by GRDC (Project UT00016), TIA, UTAS and CSIRO.

References

Espindula, MC, Rocha, VS, Grossi, JAS, Souza, MA, Souza, LT, Favarato, LF (2009) Use of Growth Retardants in Wheat. *Planta Daninha* **27**, 379-387.

Shekoofa, A, Emam, Y (2008) Effects of Nitrogen Fertilization and Plant Growth Regulators (PGRs) on Yield of Wheat (Triticum aestivum L.) cv. Shiraz. *Journal of Agricultural Science and Technology* **10**, 101-108.

Tolbert, NE (1960) (2-Chloroethyl)Trimethylammonium Chloride and Related Compounds as Plant Growth Substances .2. Effect on Growth of Wheat. *Plant Physiology* **35**, 380-385.

Wiersma, JJ, Dai, J, Durgan, BR (2011) Optimum Timing and Rate of Trinexapac-ethyl to Reduce Lodging in Spring Wheat. *Agronomy Journal* **103**, 864-870.

Zagonel, J, Fernandes, EC (2007) Rates and application times of growth reducer affecting wheat cultivars at two nitrogen rates. *Planta Daninha* **25**, 331-339.