The effect of sowing depth on the establishment of several commercial wheat varieties

Rohan Brill[1], Guy McMullen[2] and Matt Gardner[2]
[1]NSW Department of Primary Industries, Coonamble. email: rohan.brill@dpi.nsw.gov.au
[2]NSW Department of Primary Industries, Tamworth

Abstract
Field experiments over three seasons (2009 - 2011) in the Coonamble district examined the establishment of commercial wheat varieties sown at two or three different depths, with seed placement ranging between 35 mm to 105 mm. The effect of the fungicidal seed treatment triadimenol was also evaluated at the middle sowing depth treatment in 2009 and 2010. Progressively deeper sowing of wheat reduced establishment in all trials, but there was no significant interaction between variety and sowing depth. Secondly, yield was also reduced by the deepest sowing treatment (105 mm), but to a lesser extent than the reduction in crop establishment and lastly, the fungicide triadimenol (2009 and 2010 trials) reduced establishment at the 70 mm sowing depth treatment relative to untreated seed at the same depth.

Key words
Wheat, establishment, sowing depth, triadimenol

Introduction

For successful crop establishment, seed needs to be placed into soil with enough seedbed moisture for germination to occur, or into dry soil with the anticipation of rainfall to increase soil moisture levels to where germination may occur. In north-west New South Wales it is common for soil profiles to have high levels of plant available water in the root zone coupled with a dry seedbed. This scenario may require the practice of 'moisture seeking' to be implemented where seed is placed deeper in the soil than is generally recommended, with the main aim being to ensure timely crop establishment. This practice generally involves the use of tines to open a furrow to a depth of > 7.5 cm, where the seed is then placed, followed by a press wheel to close moist soil around the seed. Cox and Chapman (2007) reported that 'moisture seeking' increases cropping frequency and improves timeliness of crop establishment.

Most wheat varieties currently grown in Australia contain a reduced height gene that results in shorter plants and shorter coleoptiles than standard height varieties (Gooding *et al*. 2006). Whan (1976*b*) reported that there is a positive correlation between coleoptile length and crop establishment, which infers that widely grown semi-dwarf varieties would have reduced establishment compared with standard height varieties when sown deep.

There have been regular claims across the grains industry in north-western NSW that the milling wheat variety *EGA Gregory* established poorly from deep sowing relative to other varieties. Hence, trial work was conducted over three seasons (2009-2011) in the Coonamble region to evaluate differences between commonly grown commercial bread wheat and durum varieties in their ability to establish from deep sowing. Further to this the effect of the fungicide triadimenol on wheat establishment was determined in 2009 and 2010. In 2011 a sowing time factor was also examined, to determine the link between the level of establishment achieved and the timing of crop establishment.

Methods

Trial designs

Three field experiments were conducted from 2009 to 2011 (Table 1) with a range of popular commercial wheat varieties.

1. In 2009 twelve wheat varieties were sown at three depths, with the addition of a triadimenol treatment on the 70 mm sowing depth (Table 1). This was sown as a randomised split plot design, with sowing depth and fungicide as the main plot and variety as the sub-plot.
2. In 2010 ten wheat varieties were sown with the same trial design as 2009.
3. In 2011 five wheat varieties were sown at two sowing depths and two sowing times. This trial was sown within a randomised split-split plot design, with sowing time as main plot, sowing depth as the primary split plot and variety as the secondary split plot.

Table 1: Site details, rainfall pre and post seeding and sowing depth treatments for three trials at Coonamble from 2009 to 2011

Location	*Season*	*Soil type*	*Sowing date*	*Rain (mm) <2 weeks pre-sow*	*Rain (mm) <2 weeks post-sow*	*Sowing depths*
Coonamble 30º41' S 148º10' E	2009	Grey vertosol	25th June	11	6	35 mm 70 mm (+/- triad.) 105 mm
Coonamble 30º48' S 148º16' E	2010	Grey vertosol	10th May	3	0	35 mm 70 mm (+/- triad.) 105 mm
Coonamble 30º40' S 148º14' E	2011	Grey vertosol	20th May 21st June	2 20	18 2	35 mm 100 mm

Varieties sown
2009 – Axe, Baxter, Crusader, EGA Bellaroi (durum), EGA Bounty, EGA Gregory, EGA Wylie, Ellison, Hyperno (durum), Jandaroi (durum), Lang, Lincoln, Livingston, SUN436E, Sunvex, Sunzell, Ventura.
2010 – Crusader, EGA Bellaroi (durum), EGA Gregory, EGA Wylie, Ellison, Hyperno (durum), Jandaroi (durum), Livingston, Spitfire, SUN436E, Sunvex.
2011 – EGA Bounty, EGA Gregory, Lincoln, Livingston, Spitfire

Results
2009
Compared with the 35 mm sowing depth treatment, the 70 mm and 105 mm sowing depth treatments significantly reduced establishment by 15 and 30 % respectively. There was no significant interaction between variety and sowing depth (Figure 1).

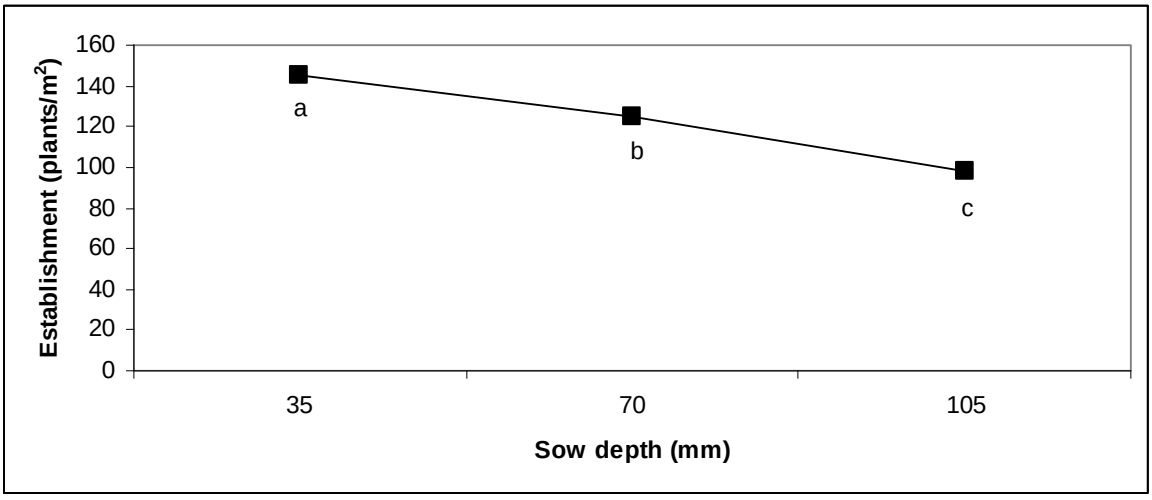

Figure 1: Effect of sowing depth on the establishment of twelve wheat varieties at Coonamble in 2009

Triadimenol (applied only to the 70 mm sowing depth) reduced overall establishment by 25 % compared with the untreated seed at the same depth (data not shown). Establishment of fungicide treated seed at the 70 mm sowing depth treatment was similar to untreated seed at the 105 mm sowing depth treatment. Similar to the overall effect of sowing depth, all varieties were affected by fungicide treatment to a similar degree. Grain yield results reflected plant establishment, as the 35 mm sowing depth treatment had significantly higher grain yield than all other treatments, and the 70 mm sowing depth treatment also had significantly higher yield than the fungicide treated seed at the same depth and the untreated seed at the 105 mm sowing depth treatment (data not shown).

2010
Compared with the 35 mm sowing depth treatment, the 70 mm and 105 mm sowing depth treatments significantly reduced establishment by 17 % and 61 % respectively (Figure 2). There was no significant interaction between variety and sowing depth for the bread wheat varieties, however the durum varieties EGA Bellaroi and Hyperno did not have reduced establishment at the 70 mm sowing depth treatment compared with the 35 mm sowing depth.

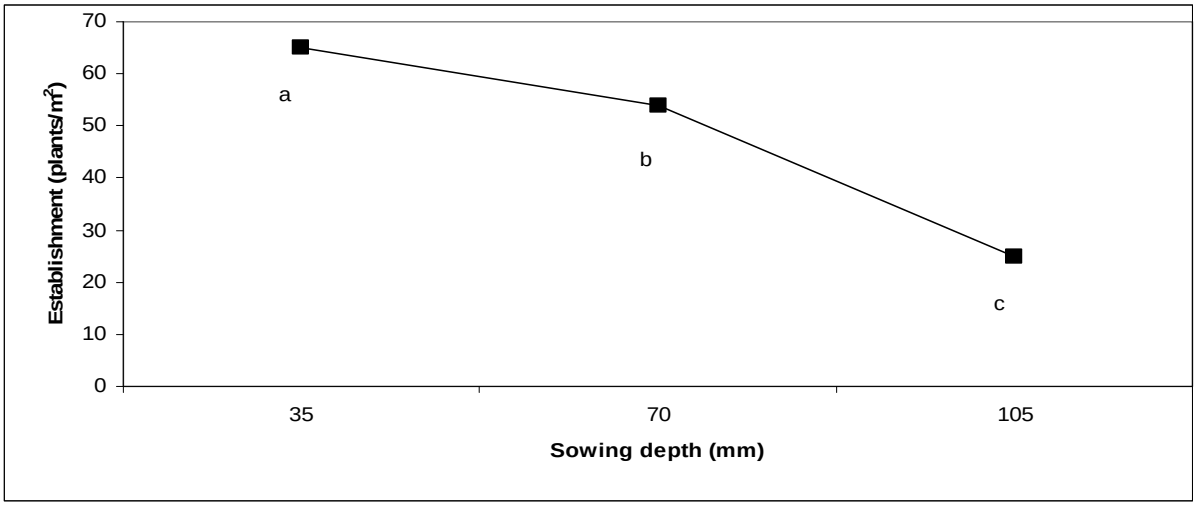

Figure 2: Effect of sowing depth on the establishment of 10 wheat varieties in a trial at Coonamble in 2010.

Triadimenol (applied only to the 70 mm sowing depth) significantly reduced establishment by 20 % compared with the untreated seed at the same depth.
Grain yield was significantly reduced for the 105 mm sowing depth treatment relative to the 35 mm sowing depth.

2011
Relative to the 35 mm sowing depth treatment, establishment of the 100 mm sowing depth treatment was reduced by 48 and 67 % for TOS 1 and 2 respectively (Figure 3). There was no significant interaction of variety and sowing depth.

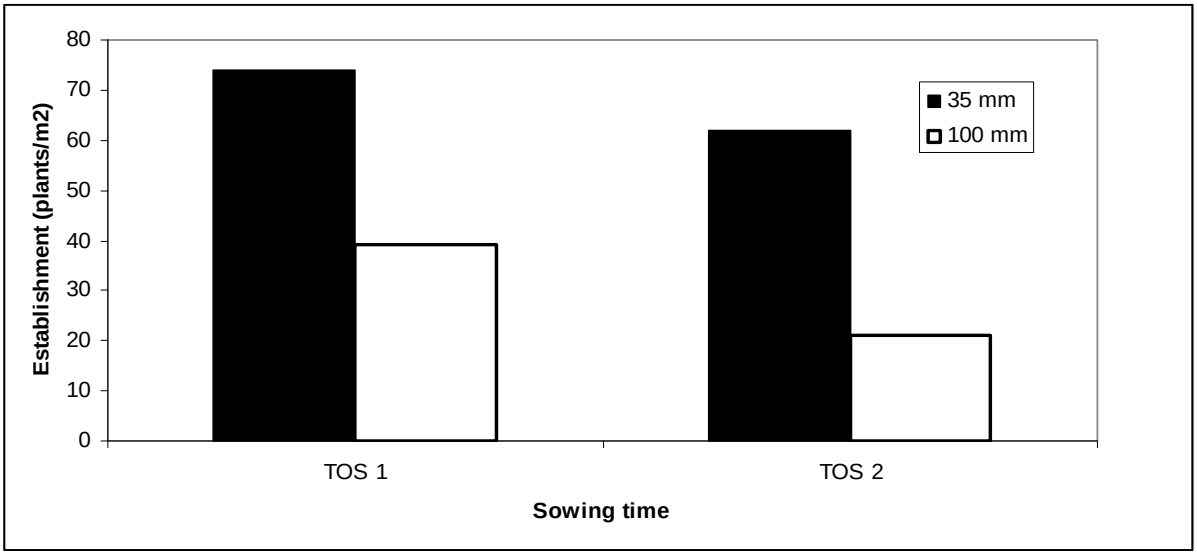

Figure 3: The effect of sowing depth and time of sowing on wheat establishment in a trial at Coonamble in 2011

Grain yield was reduced by the deep sowing treatment at TOS 1 but not at TOS 2. The yield reduction of deep sowing at TOS 1 was 1.4 t/ha, with no interaction between variety and sowing depth or variety and sowing time.

Although there were fewer plants established from TOS 1 deep than TOS 2 shallow, The TOS 1 deep sowing treatment yielded 0.7 t/ha more than the TOS 2 shallow treatment (data not shown).

Conclusion

The trials from 2009 to 2011 showed that deep sowing can have a significant affect on the establishment and yield of wheat; however, none of the varieties evaluated showed an enhanced ability to establish from deep sowing than other commonly grown varieties in north-west NSW. There are several decisions producers need to make when considering moisture seeking; however, there appears no resultant advantage in crop establishment from changing varieties.

It was unclear from the work whether the reduced yield from deep sowing was due to a reduced plant population or due to subsequent affects on crop growth and development. McMullen *et al.* (2011) reported that for trials sown at the same site and season as the 2009 sowing depth trial, there was no significant difference in wheat yield from plant population in a range from 60 to 180 plants/m², however the lower plant populations in that work were still higher than the populations achieved in the deep sowing treatments of the sowing depth trials. Fischer *et al.* (2005) reported that maximum yield can be achieved by plant populations as low as 24 plants/m², provided the plants are arranged in a perfect matrix. This was not the case for the trials reported in this paper, hence there was likely to be some yield effect due to reduced population. Herbek *et al.* (2005) report that deep sowing reduces tillering and subsequent head number per plant and per unit area which may also have reduced yield in these trials.

The 2011 trial highlighted the potential benefits of moisture seeking, where in that season reduced establishment from a relatively early sowing sown deep resulted in higher yield than a shallow late sowing that achieved a higher plant population. In this trial the effect of delayed sowing on wheat yield was greater than the effect of deep sowing on wheat yield. Doyle and Marcellos (1973) reported that from trial work in northern NSW there was a 9 to 13.5 % yield loss of wheat for each week that flowering was delayed beyond the optimal time for a particular region. Where producers and agronomists are faced with situations of low seed bed moisture but high plant available water beyond the seedbed (> 5cm soil depth), planting decisions need to balance the potential effect of reduced yield from deep sowing with the potential yield loss from delayed sowing.

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