The effect of time of sowing on phenology and yield of chickpeas at Trangie Central West, NSW, 2011

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Abstract
Chickpeas are a profitable winter pulse crop option in their own right, which also contribute through their ability to fix nitrogen and provide weed and disease breaks for subsequent crops. Disease and frost risk have been identified as two major constraints to chickpea production. In both cases, sowing date can be used as a strategy to influence yield, through the avoidance of cold temperatures during flowering, and to reduce exposure to disease infection events.

Chickpea time of sowing trials were conducted in 2011 by NSW DPI at Trangie Agricultural Research Centre (Central West NSW), to evaluate the impact of sowing date on phenology and yield of current and potential release cultivars. The approach used was to plant six chickpea varieties at four sowing dates (5 May, 18 May, 9 June and 27 June).

The impact on phenology between the four sowing dates showed that whilst the date of first flower and date of first pod was delayed as sowing time was delayed; the length of time for these events to occur was reduced at each successive sowing time. It was found that earlier flowering did not necessarily translate into higher yield, due to the impact of lower temperatures in 2011 during early flowering. The yield results showed that there were significant differences between varieties in their overall performance, and also between the four times of sowing, but there was no interaction between sowing time and variety. Optimum sowing time was found to be equal between the 18 May and 9 June sowing dates. Whilst there may be a yield penalty from later sowing (late June) chickpea plants seem more able to compensate when compared to very early sowing.

Key Words
chickpea, variety, time of sowing, agronomy, management

Introduction

Chickpeas are a popular and profitable winter pulse crop option in the northern grains region. They add to the profitability of the farming system by providing fixed nitrogen and weed/disease breaks for winter and summer cereal crops. However two major constraints to chickpea production in the northern cropping region are disease and frost damage (Whish *et al*, 2007). In both cases, sowing date can be used as a strategy to influence yield through avoidance of cold temperatures during flowering, and to reduce the effect of disease.

Current chickpea genotypes have excellent frost tolerance in the vegetative stage, and conversely display one of the highest temperature thresholds for seed set among cool season (winter) pulse crops. Flowering initiation in chickpeas has been described as a photo-thermal response, but in most environments temperature is the main determinant. Mean daily temperature of less than 15°C has been shown to cause flower abortion (Clarke and Siddique, 1998). The optimum sowing date should result in flowering occurring when the risk of cold temperatures is low (Whish *et al*, 2007).

Choosing an optimum sowing time can also be a compromise between maximising yield potential and minimising disease levels. Earlier sowing can expose the crop to more rain events which increases crop biomass but also increases the risk of Ascochyta disease, Botrytis grey mould (BGM), lodging, and soil moisture deficit during grain fill. Later sowing can result in shorter plants (harvesting difficulties) and increased heliothis pressure, but may reduce vegetative water use and reduce the exposure to Ascochyta and Phytophthora infection events and lessen the risk of BGM (Matthews and McCaffery, 2011).

A chickpea time of sowing trial was conducted in 2011 by NSW DPI at Trangie Agricultural Research Centre, to evaluate the impact of sowing date on phenology and yield of current and potential release cultivars.

Methods

2011 Trial Details:

Location:	Trangie Agricultural Research Centre	
Soil type:	grey vertosol (pH_{CaCl} 7.5)	
Plant available water:	180 mm (stored) at sowing to a depth of 1.5 m; 230 mm of rain from May-October	
Sowing dates:	TOS 1: 5 May	TOS 3: 9 June
	TOS 2: 18 May	TOS 4: 27 June
Varieties:	CICA 0511	Flipper®
	CICA 0912	PBA HatTrick®
	Genesis™ 425	Sonali®

Results: Impact of time of sowing on phenology

Meteorological data from Trangie ARC shows that the mean daily temperature was frequently below the critical value of 15°C right through August until 3 September, followed by another week of low temperatures from 8 to 14 September. This is consistent with analysis of Trangie temperature data for the last four years (2008-2011) showing that the mean daily temperature averages below 15°C until 2 September.

At temperatures below 15°C, floral initiation (flower production) can commence (in response to both temperature and daylength), but the advantage of early flowering is often negated by increased flower abortion, due to either infertile pollen being produced or lack of fertilisation during the pollination process. Frost (sub-zero temperatures) can have additional effects to low temperatures by causing the complete loss of reproductive structures at any stage, i.e. flower, pod and/or seed abortion. Maturity can also be delayed. In 2011 only two actual frosts (below 0°C) were recorded on 13 and 14 September.

The phenology data graphed below (Figure 1) shows the flowering and first pod-set dates of six chickpea varieties in response to both sowing time and temperature. As a general rule, the actual date of first flower is delayed as sowing time is delayed, but the time taken from sowing to first flower is reduced. The period from sowing to flowering for TOS 1 and TOS 2 averaged across all six varieties was roughly the same (110-111 days to flower), whereas TOS 3 averaged 96 days and TOS 4 averaged 85 days to first flower, showing that the vegetative period before flowering is reduced as sowing time is delayed. All varieties at TOS 1 had commenced flowering by 2 September, with the exception of Genesis™ 425, whereas no varieties sown at TOS 2, 3 or 4 had commenced flowering until after 2 September, with the exception of the variety Sonali®.

The variety Sonali® was used specifically as a benchmark variety. It was released in 2004 by the Department of Agriculture Western Australia and CLIMA, and bred specifically for chilling tolerance. As an early maturing (Tyson cross) line, Sonali® has been reported to start flowering 10-15 days earlier than other varieties that were current at the time of release (Sona and Howzat®), with podding commencing when the mean daily temperature is 10°C, compared to 14-15°C for other varieties. The 2011 trial was consistent with this description, with Sonali® flowering 7-10 days earlier than any other variety, and the only variety to set and hold pod before 2 September. Sonali® was never recommended for northern NSW conditions due to poor disease tolerance, and has since been out-classed in yield.

Table 1 (below) provides a summary of mean phenology data grouped for all varieties at each of the four times of sowing. Note that this represents one year's trial observations only and the phenology data was not statistically analysed.

Table 1. Mean phenology data of six chickpea varieties sown on four dates at Trangie ARC, 2011.

	Date sown (2011)	Mean date of first flower	Mean number of days to first flower	Mean date of first pod	Mean number of days to first pod
TOS 1	5 May	23 Aug	110	12 Sept	20
TOS 2	18 May	6 Sept	111	23 Sept	17
TOS 3	9 June	13 Sept	96	26 Sept	14
TOS 4	27 June	19 Sept	85	4 Oct	15

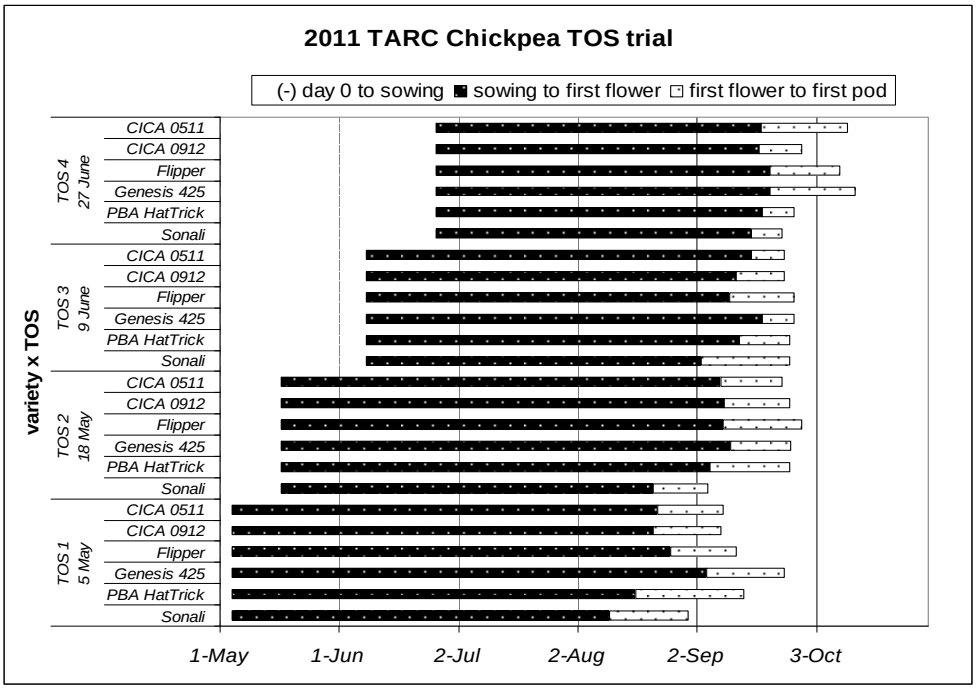

Figure 1. First flower and first pod dates for six chickpea varieties sown on four dates at Trangie ARC, 2011.

Results: Impact of time of sowing on yield

Yield results are presented in Figure 2 below. Analysis of these results showed significant differences between varieties in their overall performance, and also between the four times of sowing, but no interaction between sowing time and variety, since each variety behaved relatively the same at each time of sowing.

General response to sowing time

- TOS 1 (5 May) proved to be too early for the six varieties in this trial, with a mean yield penalty of 400-500 kg/ha below the yields of TOS 2 and TOS 3.
- There was no significant yield difference between TOS 2 (18 May) and TOS 3 (9 June). In this trial yield was optimal at either of these sowing times.
- TOS 4 (27 June) also showed an associated yield penalty for all varieties when compared to TOS 2 and TOS 3 (mean yield 300 kg less), but still yielded higher (mean yield 170 kg/ha more) than TOS 1.

These differences can be related to climatic conditions post-sowing for each time of sowing. TOS 1 sown on 5 May into warmer soils emerged within 10 days, but at about the two-leaf stage there was heavy rainfall (41 mm on 23 May) which was conducive to the development of Phytophthora root rot (PRR) (*Kevin Moore, pers. comm.*). TOS 2 had just been sown on 18 May and although PRR was evident, it did not have the same severe impact as in TOS 1. The June sowings TOS 3 and TOS 4, although sown into good moisture, had minimal post-sowing rainfall events through June and July and hence little development of PRR.. The dry period of June-July, in combination with a preventative fungicide strategy prior to predicted rainfall events, meant that there was no obvious development of the foliar disease Ascochyta and Botrytis grey mould in any of the four sowing times.

The differences can also be related to temperatures during the early part of flowering and pod development. Whilst plants sown at TOS 1 flowered earlier and set pod earlier (mean date 12 September), there was a week of low temperatures from 8 September, culminating in two frost events on 13 and 14 September. Any flowers/pods up to this point would have been aborted (with the exception perhaps of Sonali(1)). This effect was reduced with subsequent sowing dates, to the point where plants sown at TOS 4 did not begin to flower until 19 September (mean date) after those particular frost events had occurred.

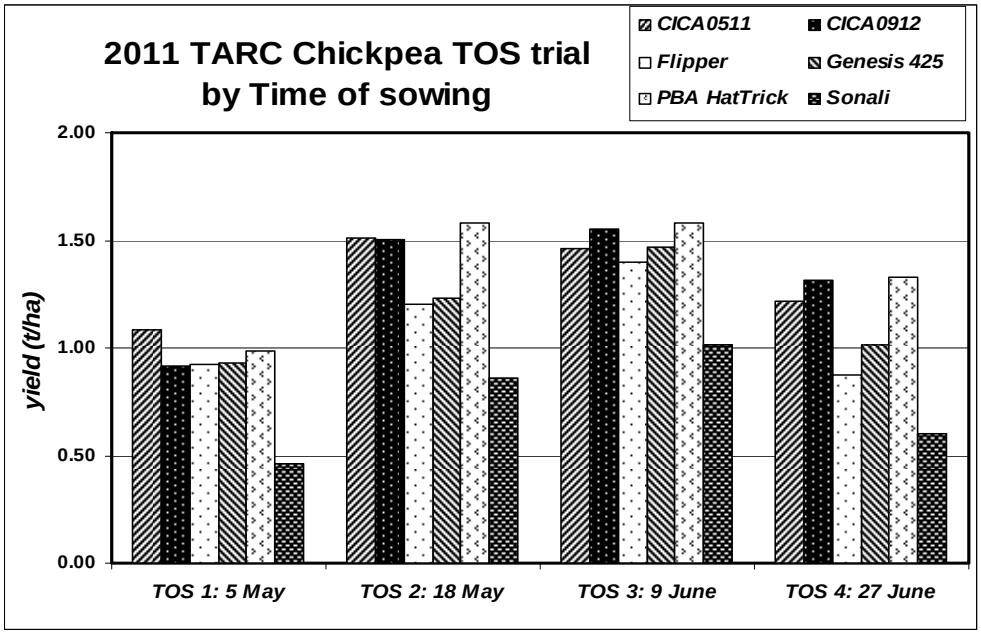

Figure 2. Yield response of six chickpea varieties sown on four dates at Trangie ARC, 2011 (average variety l.s.d. = 0.124; average TOS l.s.d. = 0.116)

General response of varieties

- PBA HatTrick⌀ was the highest overall yielding variety (mean yield 1.37 t/ha), with significant yield differences to Flipper⌀, Genesis™ 425 and Sonali⌀, but not to CICA 0511 or CICA 0912.
- There was no significant difference between the yields of CICA 0511 (since released as PBA Boundary⌀) and CICA 0912.
- There was no significant yield difference between any varieties sown at TOS 3, with the exception of Sonali⌀.
- The longer maturing lines Flipper⌀ and Genesis™ 425 appeared to incur greater yield penalties from TOS 4 but these differences are not statistically significant.
- Despite chilling tolerance, the early flowering habit of Sonali⌀ did not translate into yield and was significantly lower yielding (360–630 kg/ha less) than all other varieties.

Conclusion

The development and release of new chickpea varieties with high yielding attributes (largely due to greater regional adaptation and improved disease tolerance) has led to the belief that early sowing (early May) would optimise water use, through both increased biomass and earlier flowering. This trial showed that earlier flowering does not necessarily translate into higher yield, due to the impact of lower temperatures during early flowering and greater exposure to disease. Conversely there is also a yield penalty from later sowing (late June) but chickpea plants are able to compensate to some extent compared to very early sowing. Further research is planned to develop sound time of sowing recommendations for the northern region.

References

Clarke H and Siddique KHM (1998) “Growth and Development” in The Chickpea Book (Eds S Loss, N Brandon and KHM. Siddique), Agriculture Western Australia, Bulletin 1326.

Matthews, P and McCaffery, D (2011) “Winter crop variety sowing guide 2011”, NSW DPI Management Guide.

Whish, JPM, Castor, P and Carberry, PS (2007) “Managing production constraints to the reliability of chickpea within marginal areas of the northern grains region of Australia”. Australian Journal of Agricultural Research, **58**, 396-405.

⌀ Varieties displaying this symbol beside them are protected under the Plant Breeders Rights Act 1994. Note that CICA 0511 has since been released as PBA Boundary⌀.