

Chickpea phenology and grain yield response to sowing date – Leeton 2018

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Key findings

- Sowing time in this pre-watered site had no effect on overall yield.
- There was an interaction between sowing date and variety for phenological development, grain yield and harvest index.
- Growing degree days affected time to emergence; later sowing dates delayed emergence, but there was no effect on plant density.

Introduction

Identifying the optimum sowing date maximises yield potential by ensuring that critical growth phases such as flowering and podding do not coincide with abiotic stresses such as frost, drought and heat. This experiment aimed to determine the optimum sowing date for chickpea by identifying the phenological drivers of crop development and grain yield. The experiment site, located at Leeton NSW, was watered before sowing to ensure good establishment and to fill the soil profile. It was watered later in the season to maintain the experiment in extreme drought conditions.

This experiment was part of a series of ongoing experiments sown in central and southern NSW aiming to:

- identify the phenological drivers of chickpea in central and southern NSW
- determine variety response to sowing date across varying climatic zones
- determine optimal genotype and sowing date combinations.

This paper presents results from the Leeton site in 2018.

Site details

Location	Leeton Field Station
Soil type	Brown chromosol
Soil pH_{Ca}	6.4 (0–10 cm)
Previous crop	Barley
Target plant density	40 plants/m ²
Mineral nitrogen (N)	65 kg N/ha (0–60 cm)
Fertiliser	No base fertiliser applied
Pre-sowing watering	220 mm applied with flood irrigation on 13 March 2018
In-crop watering	10 mm applied with dripper tubes immediately after sowing 24 mm applied with overhead sprinklers, 13 September 2018 to 9 October 2018
Growing season rainfall	87 mm (1 April 2018–31 October 2018)

Weed management	Pre-emergent: 2 L/ha of Rifle® (440 g/L pendimethalin), 1.8 L/ha of Avadex® (500 g/L tri-allate) and 0.6 kg/ha of Terbyne Xtreme® (875 g/kg terbutylazine) immediately before each sowing date Post-emergent: two applications of Verdict® (520 g/L haloxyfop) at 100 mL/ha (25 May and 3 June) One application of Status® (240 g/L clethodim) at 500 mL/ha (3 June)
Disease management	Three applications of Dithane® (750 g/kg mancozeb) at 2.2 kg/ha (7 June, 5 July and 28 August) Two applications of Bravo® (720 g/L chlorothalonil) at 1 L/ha (23 July and 2 August) One application of Cheers® (720 g/L chlorothalonil) at 1.4 L/ha (10 September)
Insect management	One application of Decis® (27.5 g/L deltamethrin) at 500 mL/ha (4 October)

Treatments

Eight chickpea varieties comprising five desi and three kabuli were sown on four sowing dates.

Desi varieties	PBA Boundary [Ⓛ] , PBA Striker [Ⓛ] , PBA Slasher [Ⓛ] , CICA1521 and Neelam [Ⓛ]
Kabuli varieties	Genesis™ 079, Genesis™ 090 and Kalkee
Sowing date (SD)	SD1: 16 April 2018 SD2: 30 April 2018 SD3: 14 May 2018 SD4: 28 May 2018

Results

Growth phase duration

Time to emergence ranged from 7 days to 26 days; as sowing date was delayed, the time to emergence took longer (Figure 1). Chickpea requires a minimum threshold of approximately 115 growing degree days (GDD) to emerge. This took longer to satisfy at the later sowing date (SD4) as temperatures dropped in late autumn (Whish 2016; GRDC GrowNotes™ 2017).

Vegetative, flowering and podding phase duration were longest in the early-sown treatment (SD1) and decreased as sowing date was delayed. The longer flowering and podding phases meant that the early-sown treatment (SD1) had a higher exposure to frosts than those sown later. The low yield observed from SD1 can be partly attributed to the high number of unfilled pods resulting from frost exposure.

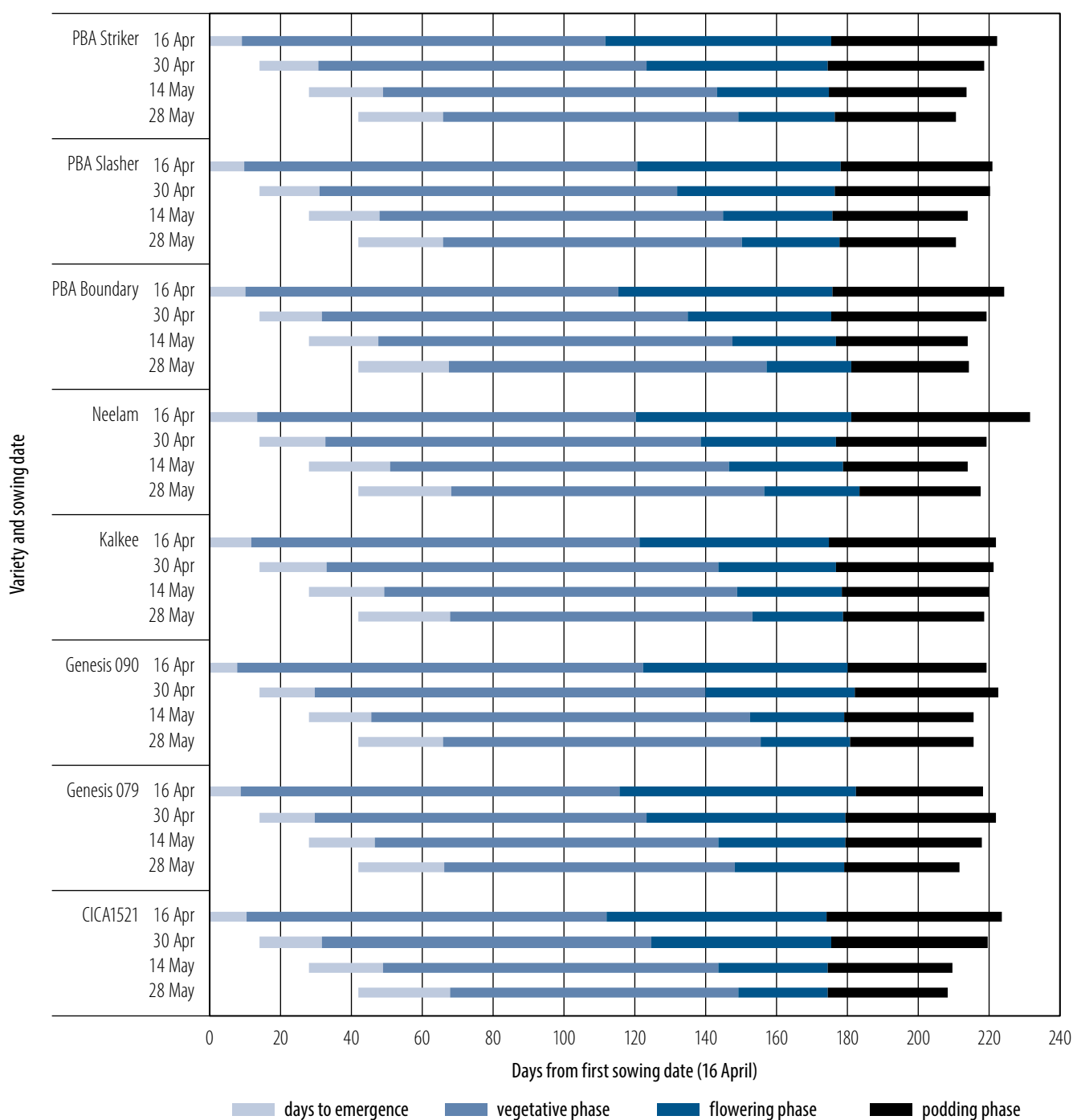


Figure 1. Chickpea variety growth stage duration; sown in 2018 at Leeton.

Yield, yield components, harvest index and harvest biomass

- Yield ranged from 1.52 t/ha for Genesis™ 090 (SD2) to 2.85 t/ha for Genesis™ 079 (SD3) (Figure 2).
- The highest average yields came from the mid May sowing (SD3), with a corresponding flowering time of around 115 days after sowing (Figure 3).
- There were different varietal yield responses and interactions with sowing date.
- High grain yield was mainly due to a larger number of seeds and pods per plant, and a larger seed size. High seed number was due to a high proportion of filled pods, or fewer unfilled pods per plant.

Harvest index ranged from 0.25 for PBA Boundary^{db} (SD1) to 0.50 for PBA Striker^{db} and Genesis™ 079 (SD4). For all varieties, SD1 had the highest harvest biomass and PBA Boundary^{db} had the highest biomass averaged across sowing times (Table 1).

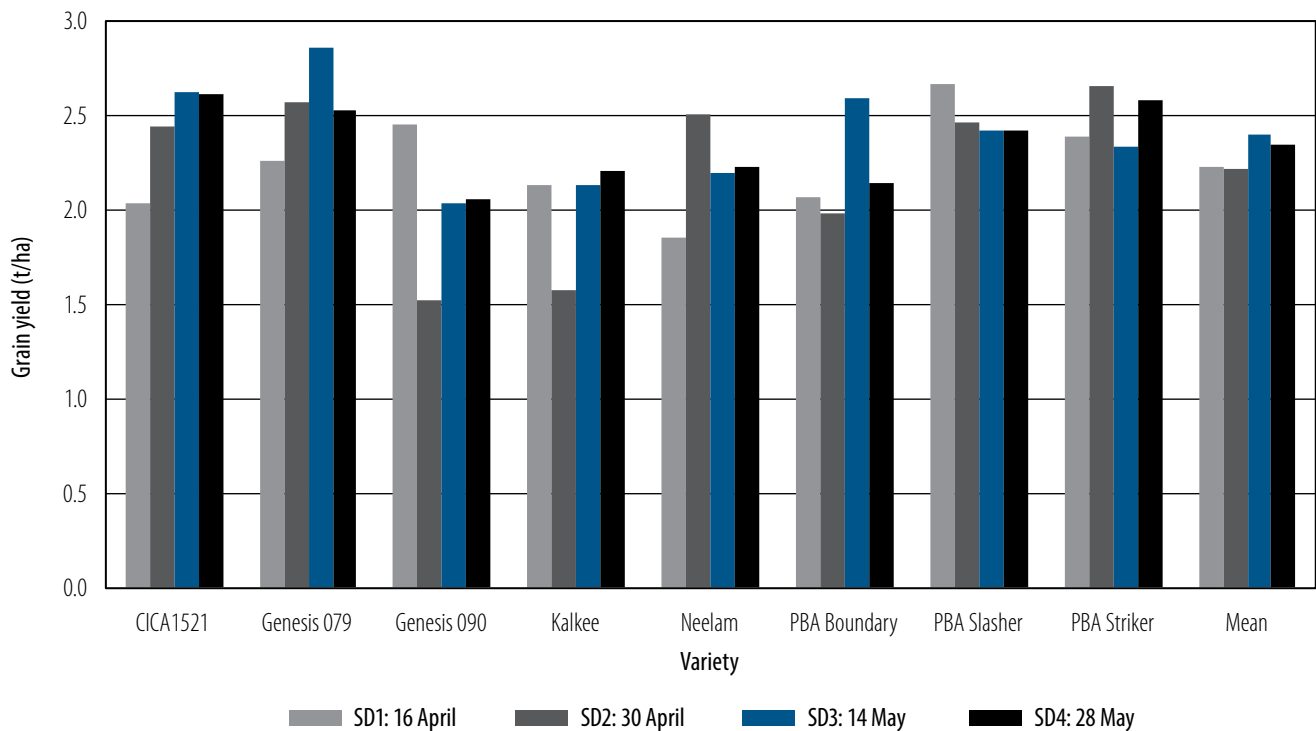


Figure 2. Grain yield of eight chickpea varieties across four sowing dates at Leeton in 2018; l.s.d. ($P = 0.05$) = 0.54 t/ha.

Table 1. Harvest index and biomass at harvest for the four sowing dates at Leeton in 2018.

Variety	Harvest index (%)					Harvest biomass (t/ha)				
	SD1	SD2	SD3	SD4	Mean	SD1	SD2	SD3	SD4	Mean
CICA1521	0.28	0.41	0.46	0.48	0.41	7.28	5.93	5.75	5.40	6.09
Genesis 079	0.32	0.45	0.46	0.50	0.43	7.07	5.67	6.17	4.99	5.98
Genesis 090	0.33	0.34	0.40	0.44	0.38	7.39	4.41	5.12	4.60	5.38
Kalkee	0.29	0.36	0.42	0.46	0.38	7.45	4.44	5.07	4.83	5.44
Neelam	0.29	0.43	0.45	0.48	0.41	6.59	5.78	5.01	4.58	5.49
PBA Boundary	0.25	0.35	0.43	0.39	0.36	8.17	5.66	6.05	5.50	6.34
PBA Slasher	0.34	0.39	0.45	0.46	0.41	7.89	6.14	5.49	5.35	6.22
PBA Striker	0.32	0.42	0.48	0.50	0.43	7.43	6.26	4.92	5.14	5.94
Mean	0.30	0.39	0.44	0.46	0.40	7.41	5.54	5.45	5.05	5.86
l.s.d ($P < 0.05$)										
Sowing date	0.04					1.02				
Variety	0.03					0.53				
Interaction (sowing date $\times$ variety)	n.s.					n.s.				

Note: n.s. indicates not significant.

Effect of temperature on flowering and podding

Low temperatures during flowering and podding affected flower and pod abortion and ultimately yield (Figure 3). Chickpea tends to abort pods at mean daily temperatures below 15 °C.

SD1 had a large number of days with temperatures below 0 °C during flowering and podding. SD2 also had temperatures below 0 °C during the same period.

The influence of mean temperature at the onset of podding is clearly visible in that, regardless of sowing date, all the lines started podding after 31 August when the mean temperature had reached 15 °C.

There were few instances after this date when the mean temperature dropped below this value. This could have led to pod abortion and the observed low yields for Genesis™ 090 (SD2) for example (Figure 3). Thus it is also the effect of individual days with low temperatures, not only the mean temperature that affected flower and pod viability.

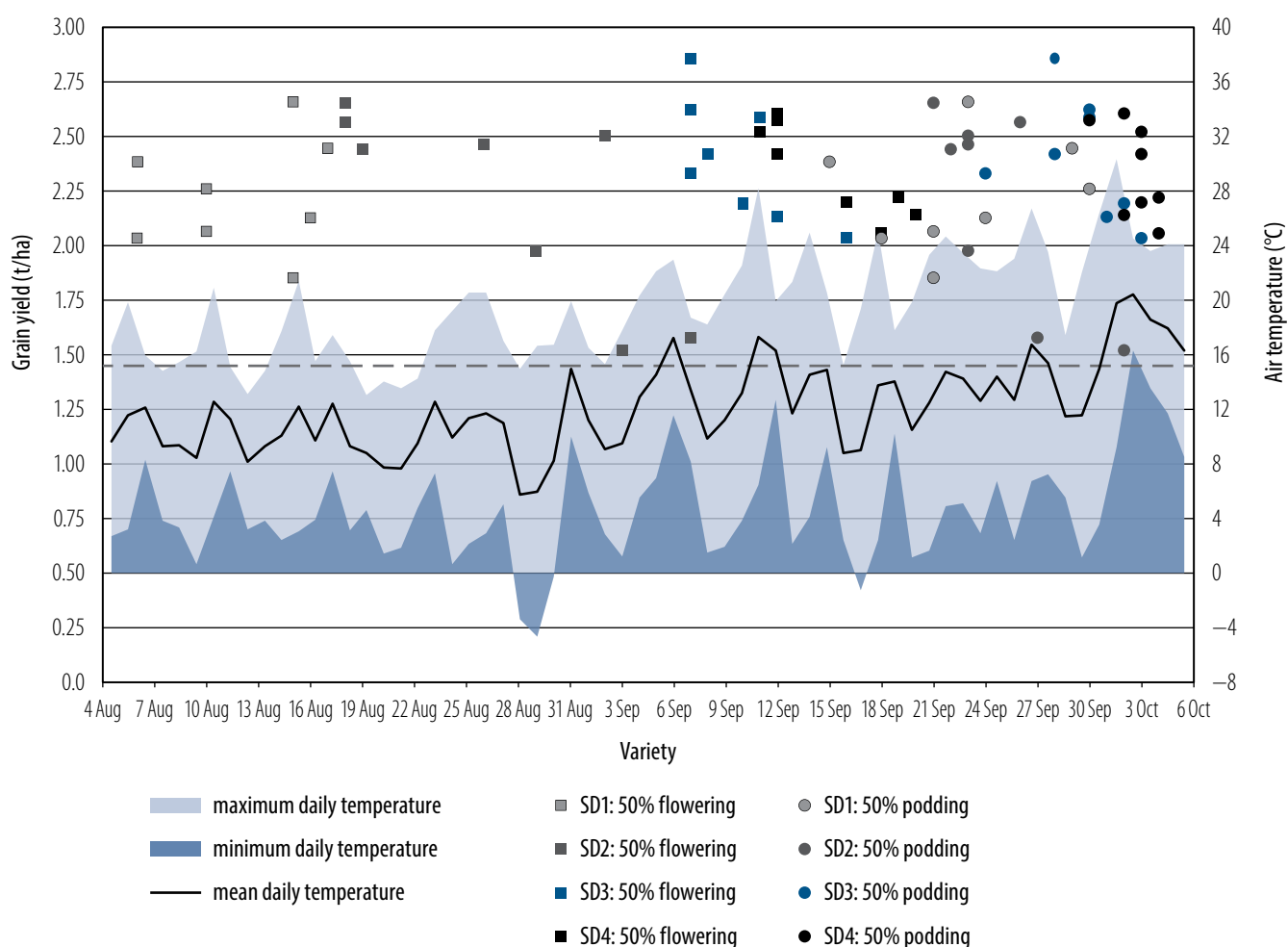


Figure 3. Chickpea yield, flowering and podding response to temperature and sowing date at Leeton 2018. Note: Same colour denotes the same SD, and squares denote flowering phase while circles denote podding phase. Dashed line indicates pod set threshold (15 °C).

Conclusion

While sowing date affected time to emergence, it did not affect plant establishment at Leeton in 2018. Sowing date did not affect yield, but variety did affect yield and there was an interaction between variety and sowing time (genotype by environment). This was driven, to a large extent, by temperatures during flowering and podding, with lower temperatures resulting in flower and pod abortion. However, yield differences between varieties were related to a number of the yield components: number of pods, filled and unfilled pods, seed number and seed weight. Exposure to chilling temperatures for long periods would have led to a high proportion of unfilled pods as seen with SD1.

References

GRDC GrowNotes™ 2017. *Plant growth and physiology*. Grains Research and Development Corporation, https://grdc.com.au/__data/assets/pdf_file/0020/301646/GRDC-GrowNotes-Chickpeas-WESTERN.pdf, viewed on 4 March 2019.

Whish J 2016. *Accessing and using day degrees in field crops as a tool to assist crop management*. GRDC Update Paper. Grains Research and Development Corporation, <https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2016/02/accessing-and-using-day-degrees-in-field-crops-as-a-tool-to-assist-crop-management>, viewed on 4 March 2019.

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