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

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Key findings

- Varieties have differing optimum sowing dates, with the late April and mid May sowing dates producing higher yields overall.
- Identified sowing date and variety interactions for phenological development, grain yield and harvest index.
- Growing degree days affected time to emergence, with delayed time to emergence as the sowing date was delayed into late autumn.
- Sowing date had no effect on plant establishment.

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 was conducted at Wagga Wagga, NSW under dryland conditions, but water was applied to ensure crop establishment for the first three sowing dates.

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 dates across varying climatic zones
- determine optimal genotype and sowing date combinations.

This paper presents results from the Wagga Wagga site in 2018.

Site details

Location	Wagga Wagga Agricultural Institute
Soil type	Red chromosol
Soil pH_{Ca}	6.5 (0–5 cm), 5.3 (5–10 cm), 4.8 (10–15 cm), 5.1 (15–20 cm), 5.5 (20–25 cm)
Previous crop	Barley
Fertiliser	Granulock®Z Soygran 100 kg/ha (nitrogen [N] 5.5: phosphorus [P] 15.3: potassium [K] 0.0: sulfur [S] 7.5)
Post sowing water application	SD1: 5.1 mm – 18 April; 10.5 mm – 26 April SD2: 10.6 mm – 1 May SD3: 7.9 mm – 24 May
Growing season rainfall	152.6 mm (1 April 2018–31 October 2018)

Target plant density	40 plants/m^2
Weed management	Pre-emergent: 900 g/ha Terbyne® Xtreme (875 g/kg terbuthylazine), 1.6 L/ha Avadex® Xtra (500 g/L tri-allate), 1.7 L/ha TriflurX® (480 g/L trifluralin), incorporated by sowing (IBS) Post emergent: 300 mL/ha Select® Xtra (360 g/L clethodim), 500 mL/ha Uptake™ spraying oil (582 g/L paraffinic oil)
Disease management	Dithane® (750 g/kg mancozeb) 2.2 kg/ha – 27 June Aviator® Xpro (150 g/L prothioconazole) 600 mL/ha – 14 August
Insect management	Astound® (100 g/L alpha–cypermethrin) 300 mL/ha – 23 May, 21 September Astral 250EC (250 g/L bifenthrin) 40 mL/ha – 29 September
Harvest date	Harvest index cuts were taken as varieties reached maturity and machine harvested on 19 November 2018

Treatments

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

Desi varieties	PBA Boundary$^{\Phi}$, PBA Striker$^{\Phi}$, PBA Slasher$^{\Phi}$, CICA1521 and Neelam$^{\Phi}$
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 six days to 27 days and was longer when sowing was delayed (Figure 1). Chickpea requires a minimum threshold of approximately 115 growing degree days (GDD) to emerge (Whish 2016; GRDC GrowNotes™ 2017). The progressive delay in sowing time from SD1 to SD4 ensured that as temperatures dropped during autumn and accumulation of GDD decreased, crop emergence was delayed.

Significant interaction was observed between variety and sowing date for vegetative, flowering and podding phase durations. Vegetative, flowering and podding phase durations decreased significantly as sowing date was delayed from SD1 to SD4 (Figure 1). Earlier flowering time for SD1 and SD2 treatments resulted in more exposure to frosts and therefore flower abortion than SD3 and SD4. Lower yield observed in SD1 can be partly attributed to the high number of unfilled pods resulting from frost exposure. Days to flowering ranged from 111 days to 150 days.

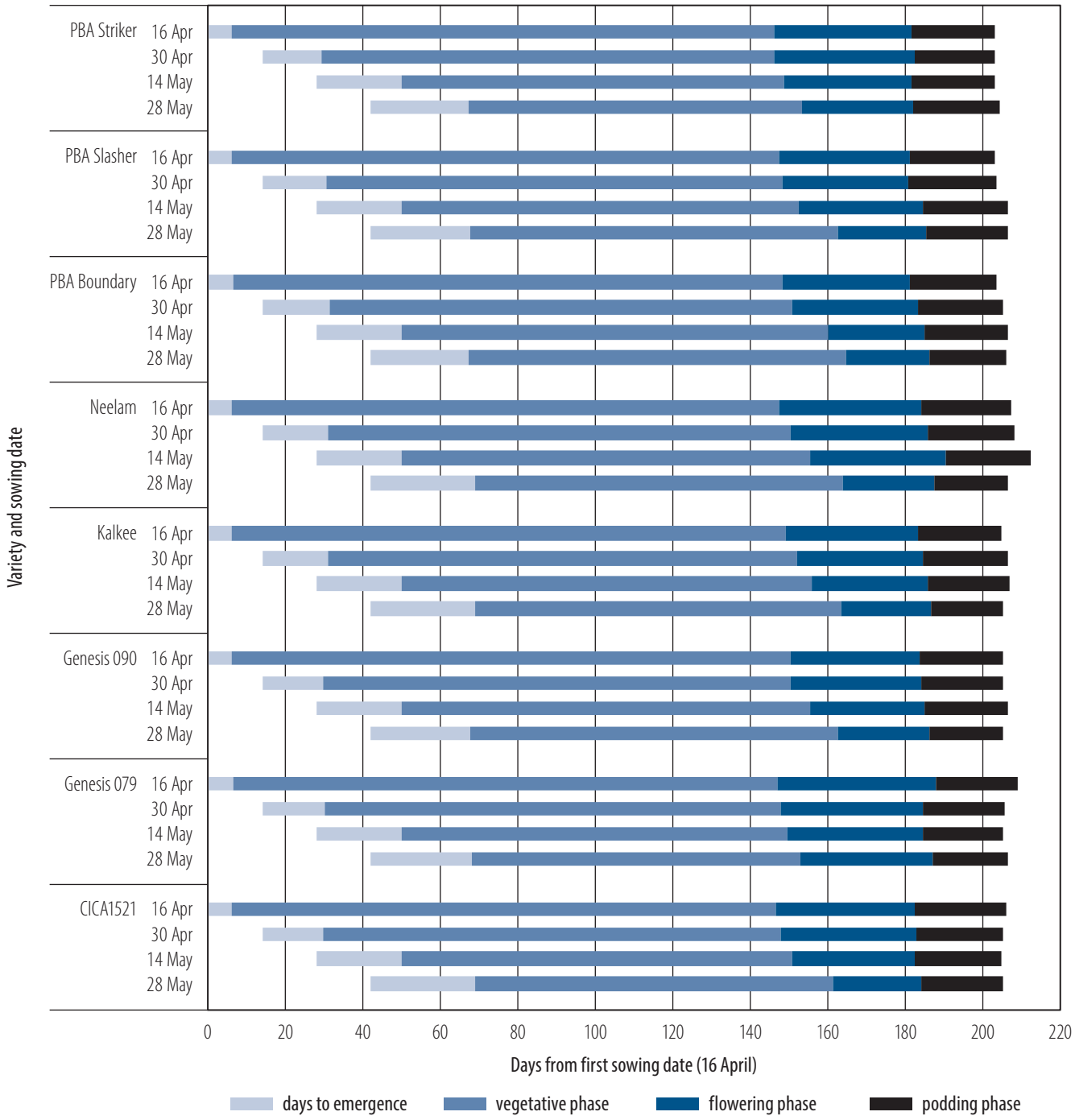

Figure 1. Duration of growth stages of eight chickpea varieties sown on four dates at Wagga Wagga in 2018.

Grain yield, yield components, harvest index and harvest biomass

Grain yield ranged from 0.97 t/ha for Kalkee (SD4) to 1.57 t/ha for PBA Striker$^{\phi}$ (SD3) (figures 2 and 3). The highest yield resulted from SD2 and SD3, with a corresponding flowering time of around 120 days after sowing (Figure 2). Varietal response differed with interactions with sowing date and grain yield observed. High grain yield was mainly due to a larger number of seeds and pods per plant, and a larger seed size.

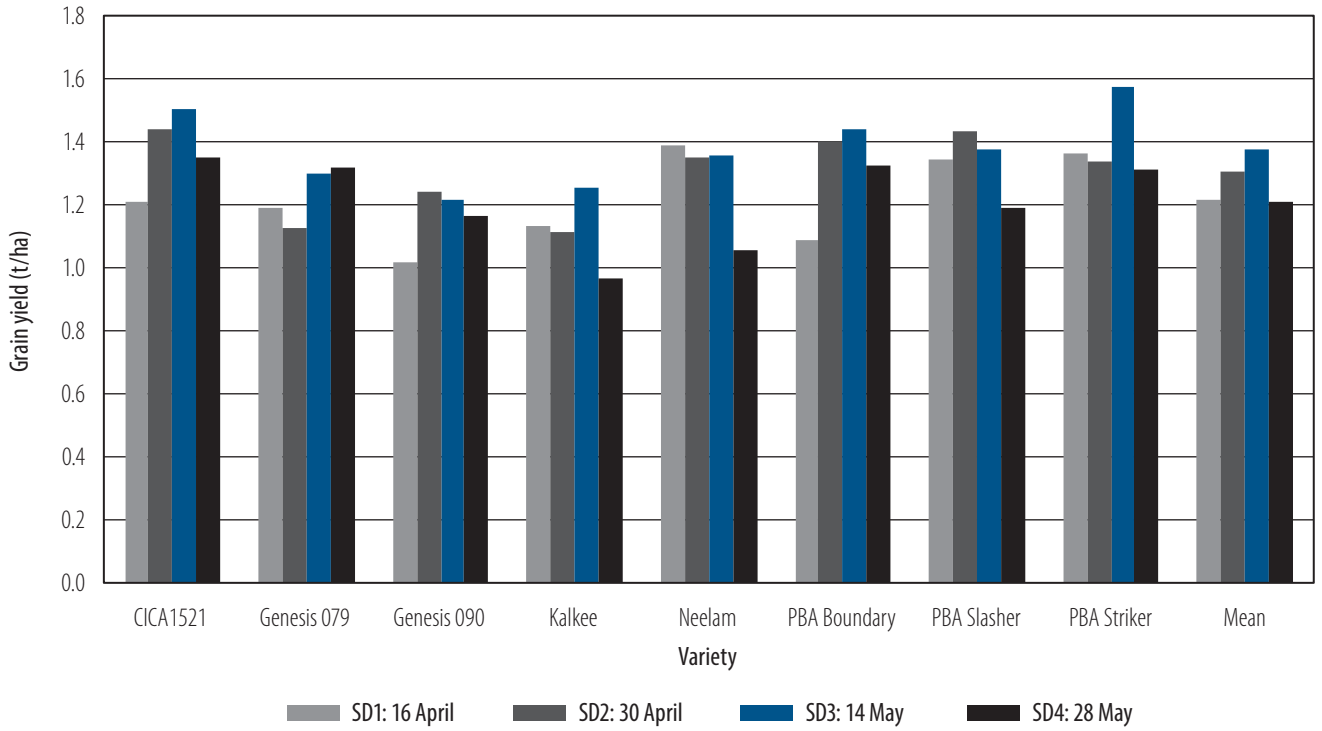

Figure 2. Grain yield of eight chickpea varieties for four sowing dates at Wagga Wagga in 2018; l.s.d. (P = <0.017) = 0.22 t/ha.

Harvest index increased with sowing date from 0.29 for PBA Boundary$^{\Phi}$ (SD1) to 0.56 for Genesis™ 079 (SD4). Biomass at harvest decreased as sowing was delayed, with PBA Boundary$^{\Phi}$ and CICA1521 having the highest biomass (3.33 t/ha and 3.32 t/ha respectively) when averaged across sowing dates (Table 1).

Table 1. Harvest index and biomass at harvest of chickpeas sown on four sowing dates at Wagga Wagga in 2018.

Variety	Harvest index (%)					Harvest biomass (t/ha)				
	SD1	SD2	SD3	SD4	Mean	SD1	SD2	SD3	SD4	Mean
CICA1521	0.31	0.39	0.49	0.54	0.43	3.94	3.72	3.11	2.51	3.32
Genesis 079	0.36	0.40	0.49	0.56	0.45	3.31	2.78	2.63	2.35	2.77
Genesis 090	0.32	0.38	0.45	0.49	0.41	3.21	3.27	2.73	2.38	2.90
Kalkee	0.33	0.38	0.45	0.46	0.40	3.44	2.95	2.79	2.11	2.82
Neelam	0.42	0.46	0.49	0.52	0.47	3.31	2.91	2.79	2.02	2.75
PBA Boundary	0.29	0.39	0.44	0.48	0.40	3.70	3.65	3.24	2.75	3.33
PBA Slasher	0.37	0.43	0.49	0.52	0.45	3.65	3.36	2.82	2.28	3.03
PBA Striker	0.40	0.42	0.50	0.55	0.47	3.41	3.16	3.13	2.40	3.02
Mean	0.35	0.41	0.48	0.51	0.44	3.49	3.22	2.90	2.35	2.99
l.s.d (P<0.05)										
Sowing date	0.04					0.30				
Variety	0.02					0.19				
Interaction (sowing date × variety)	0.05					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). SD1 had a large number of days with temperatures below 0 °C during flowering and podding. SD2 also had temperatures below 0 °C during flowering and early podding. Chickpea aborts pods at chilling temperatures below 15 °C. Temperatures rose above 15 °C from 2 October causing all cultivars, regardless of sowing date, to start podding. On average, the mean temperatures during podding were higher than 15 °C, but the effect of low temperatures on individual days was also important.

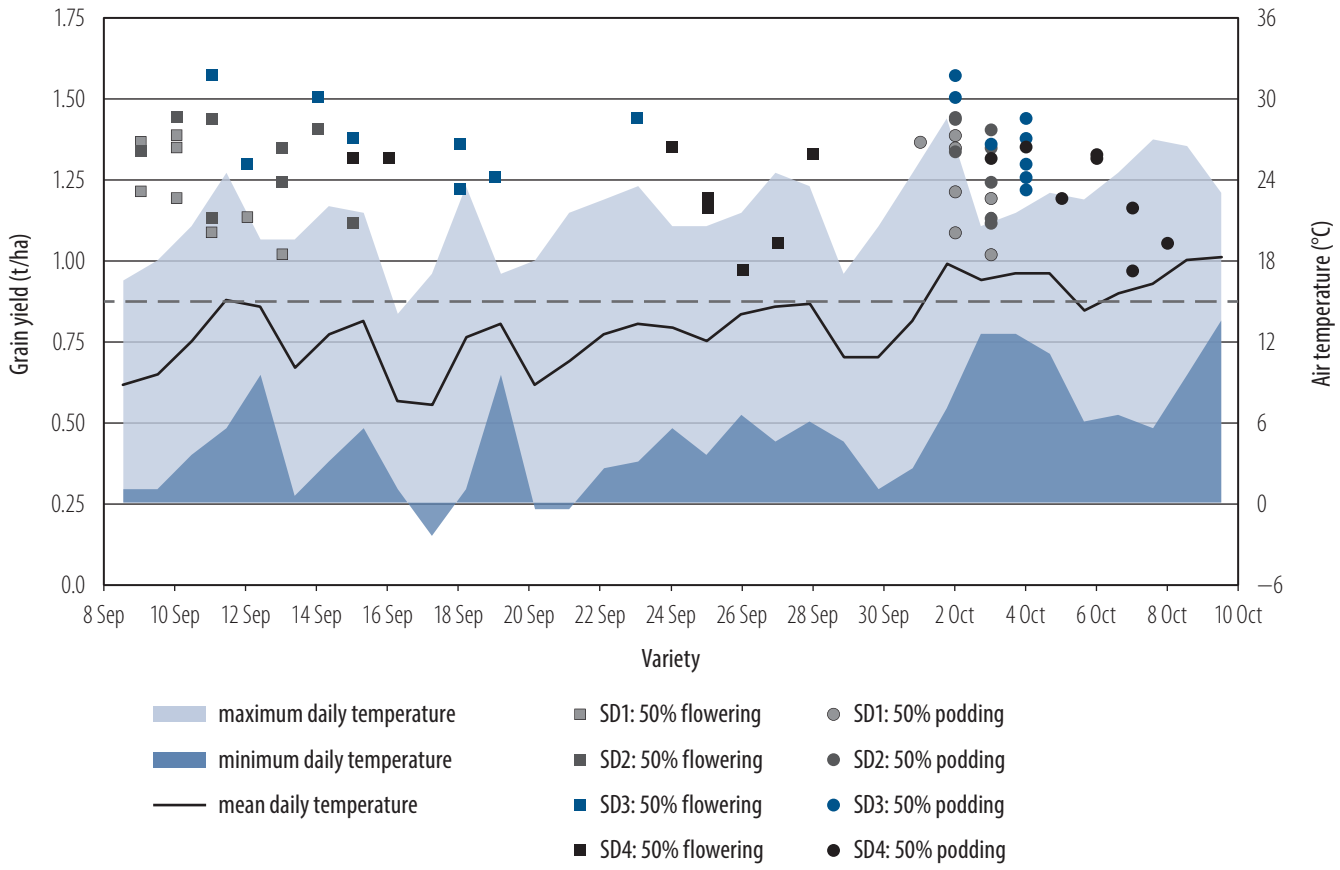

Figure 3. Chickpea grain yield, flowering and podding response to temperature and sowing date at Wagga Wagga in 2018.
Note: Same colour denotes the same SD, and squares denote flowering phase while circles denote podding phase. Dashed line indicates pod set threshold (15 °C).

Due to the dry seasonal conditions, disease infection was insignificant in this experiment with severe frosts and moisture stress having a more significant effect on grain yield.

Conclusion

Despite an unfavourable growing season at Wagga Wagga in 2018, chickpea grain yields ranged from 0.97 t/ha for Kalkee (SD4) to 1.57 t/ha for PBA Striker[b] (SD3). The highest grain yield averaged across varieties came from the late April (SD2) and mid May (SD3) sowing dates at 1.31 t/ha and 1.38 t/ha respectively. Temperature during flowering and podding were identified as major drivers of phenological response, with lower temperatures resulting in flower and pod abortion at the mid April (SD1) sowing. While lower temperatures produced a significant delay in emergence for SD3 and SD4, they did not affect plant establishment and density. A number of yield components such as the number of pods, filled and unfilled pods, seed number and seed weight per plant were identified as influencing overall yield.

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