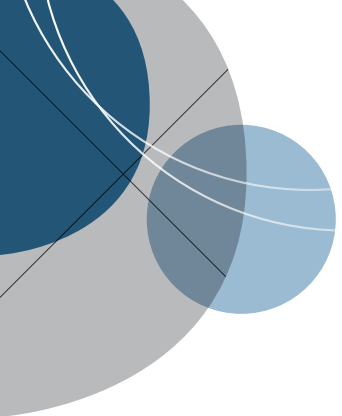




Agronomy – pulses

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

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Key findings

- The low mean yield averaged across sowing dates and varieties (1.23 t/ha) at this site was largely attributed to limited pre-sowing moisture and low (87 mm) in-crop rainfall.
 - Genesis™ 090 showed more signs of susceptibility to drought stress than other varieties.
 - Late April and mid May sowing dates produced higher yields overall.
 - There was an interaction between sowing date and variety for phenological development and harvest index, but not for grain yield.
 - Growing degree days affected time to emergence, with delayed time to emergence as sowing date was delayed into late autumn, but there was no effect on plant density.
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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. The aim of this experiment was to determine the optimum sowing date for chickpea by identifying the phenological drivers of crop development and grain yield. The experiment was conducted at Yanco, NSW under dryland conditions, but water was applied to ensure crop establishment, and later in the season to maintain the experiment during 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 Yanco site in 2018.

Site details

Location	Yanco Agricultural Institute
Soil type	Brown chromosol
Soil pH _{Ca}	6.0 (0–10 cm)
Previous crop	Fallow
Target plant density	40 plants/m ²

Mineral nitrogen (N)	109 kg N/ha (0–60 cm)
Fertiliser	Energiser Plus at 80 kg/ha (N 13.5: phosphorus [P] 13.5: potassium [K] 0.0: sulfur [S] 9.5)
Pre-sowing watering	77 mm applied with overhead sprinklers from 20 March 2018 to 19 April 2018
In-crop watering	10 mm applied with dripper tubes immediately after sowing 64 mm applied with overhead sprinklers from 23 August 2018 to 24 September 2018
Growing season rainfall	87 mm (1 April 2018–31 October 2018)
Pre-emergent herbicides	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 terbuthylazine) immediately before each sowing date
Post emergent herbicides	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)
Fungicides	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)
Insecticides	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 varieties were sown on four sowing dates.

Varieties	Desi varieties: PBA Boundary [®] , PBA Striker [®] , PBA Slasher [®] , CICA1521, Neelam [®] Kabuli varieties: Genesis™ 079, Genesis™ 090, 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 eight 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, and this took longer to satisfy in the experiments at later sowing dates as temperatures dropped in late autumn (Whish 2016; GRDC GrowNotes™ 2017).

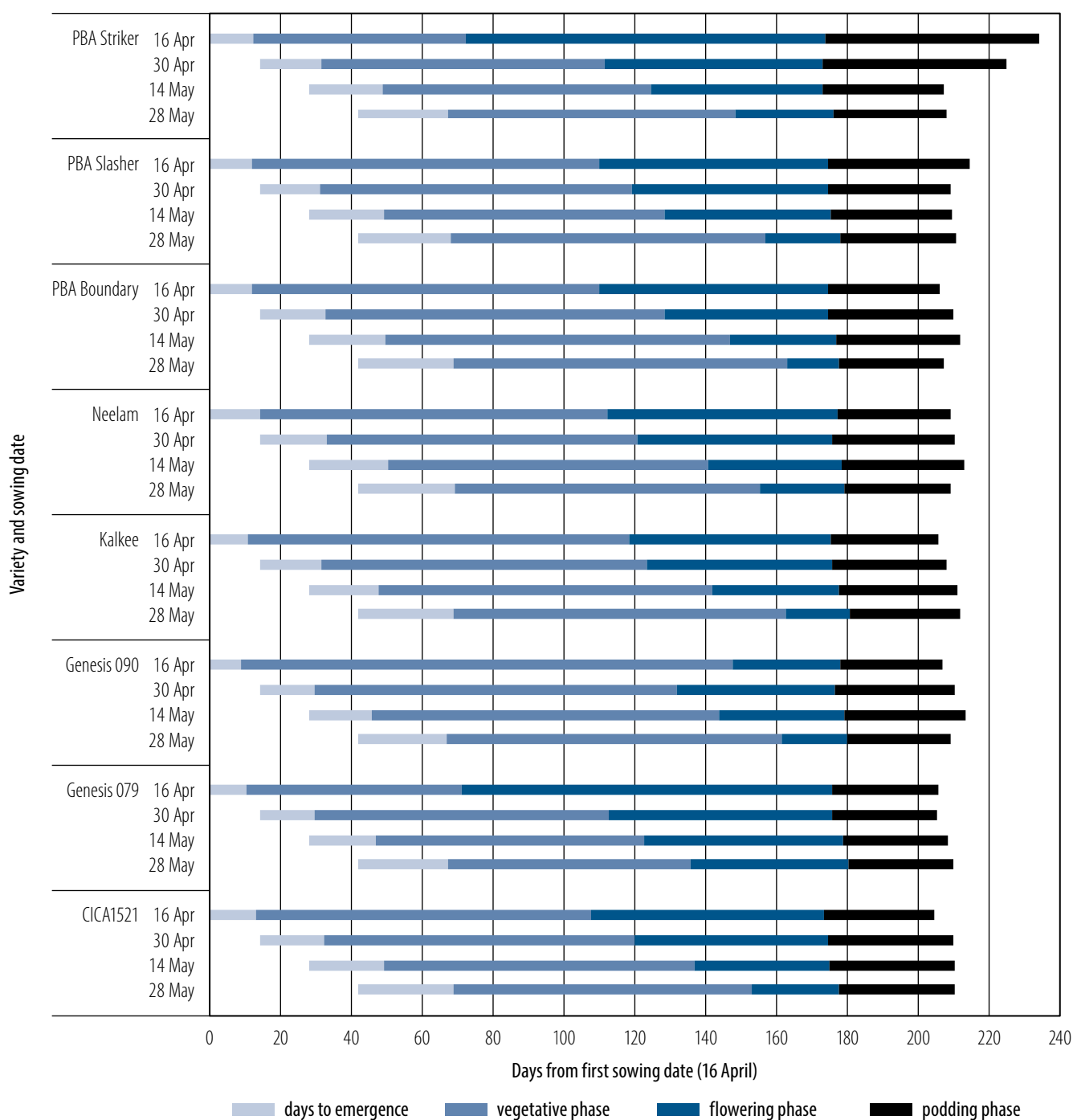


Figure 1. Duration of growth stages of eight chickpea varieties sown on four dates at Yanco, 2018.

Moisture stress induced varietal responses to flowering time and flowering duration, with PBA Striker[®] and Genesis[™] 079 flowering very early (72 days and 71 days after sowing respectively) (Figure 1). Vegetative, flowering and podding phase duration were longest in SD1 and decreased as sowing date was delayed. The longer flowering and podding phases meant that the early-sown treatments had a higher exposure to frosts than those sown later.

Grain yield, yield components, harvest index and harvest biomass

Mean grain yield of varieties ranged from 0.87 t/ha for SD1 to 1.44 t/ha for SD3 (Figure 2), while across sowing time it ranged from 0.99 t/ha for Genesis™ 090 to 1.49 t/ha for PBA Striker[®] (Figure 3). Across all sowing times, Genesis™ 090 showed signs of drought stress earlier than other varieties, but recovered after watering. This could have reduced its yield potential. The highest yields came from SD3, with a corresponding flowering time of around 90 days after sowing (Figure 4). There were different varietal yield responses to sowing date. High grain yield was mainly due to a larger number of seeds and pods per plant, and a larger seed size.

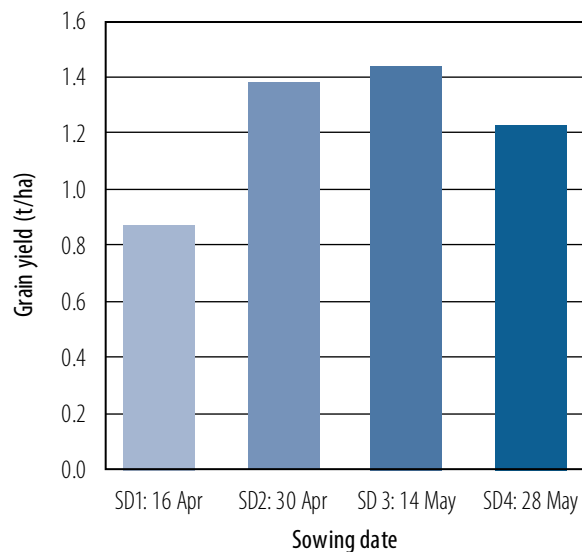


Figure 2. Grain yield of chickpeas sown on four dates meaned over eight varieties at Yanco, 2018; l.s.d. ($P < 0.001$) = 0.18 t/ha.

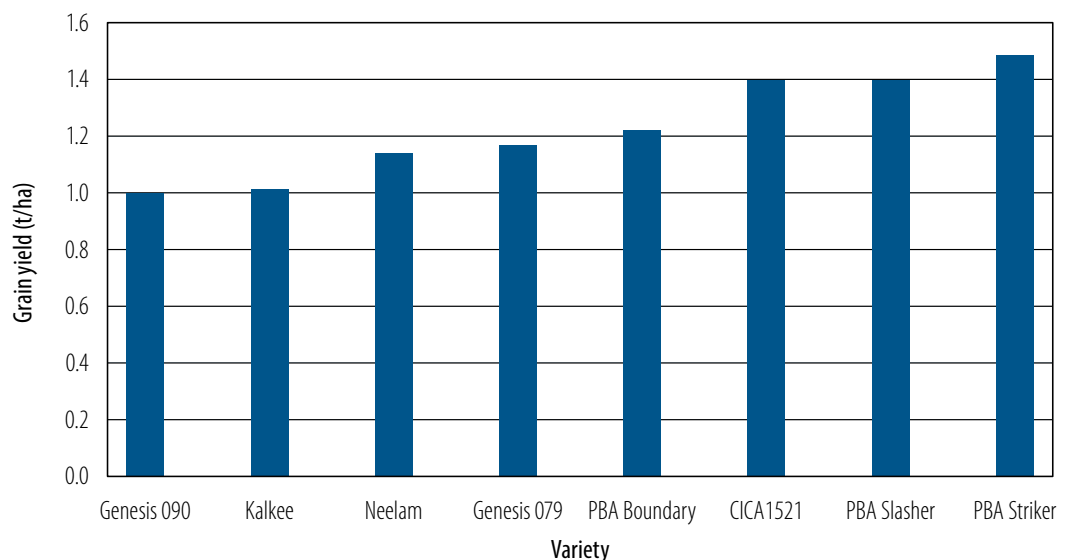


Figure 3. Grain yield of eight chickpea varieties meaned over four sowing dates at Yanco, 2018; l.s.d. ($P < 0.001$) = 0.21 t/ha.

Averaged across sowing dates, the mean harvest index increased from 0.29 for Genesis™ 090 to 0.38 for PBA Striker[®]; mean of final harvest biomass ranged from 3.14 t/ha for Neelam[®] to 4.16 t/ha for PBA Slasher[®] (Table 1).

Table 1. Harvest index and harvest biomass of eight chickpea varieties across four sowing dates at Yanco in 2018.

Variety	Harvest index (%)	Harvest biomass (t/ha)
CICA1521	0.36	4.04
Genesis 079	0.35	3.50
Genesis 090	0.29	3.56
Kalkee	0.31	3.44
Neelam	0.37	3.14
PBA Boundary	0.31	3.92
PBA Slasher	0.36	4.16
PBA Striker	0.38	3.93
Mean	0.34	3.71
I.s.d ($P < 0.05$)		
Sowing date	0.04	0.40
Variety	0.04	0.50
Interaction (sowing date $\times$ variety)	0.07	n.s.

Note: n.s. indicates not significant.

Effect of temperature on flowering and podding

Temperatures during flowering and podding affected flower and pod abortion and ultimately yield. Figure 4 details the mean temperatures during the flowering and podding phases and the phase durations. SD1 and SD2 had more days with temperatures below 0 °C during flowering and podding than SD3 and SD4. Chickpea tends to abort pods at mean daily temperatures below 15 °C. Mean temperature rose above this threshold on 30 August. However, the early cultivar PBA Striker[®] sown on SD1, which reached flowering on 28 June, reached peak podding on 29 August which is before the date when the threshold was met. After 30 August there were periods of low temperatures that did not appear to have affected PBA Striker[®] from SD1, as it was the second highest yielding variety across all sowing dates. All other varieties, averaged across sowing dates, reached podding around 21 September in response to rising mean temperatures.

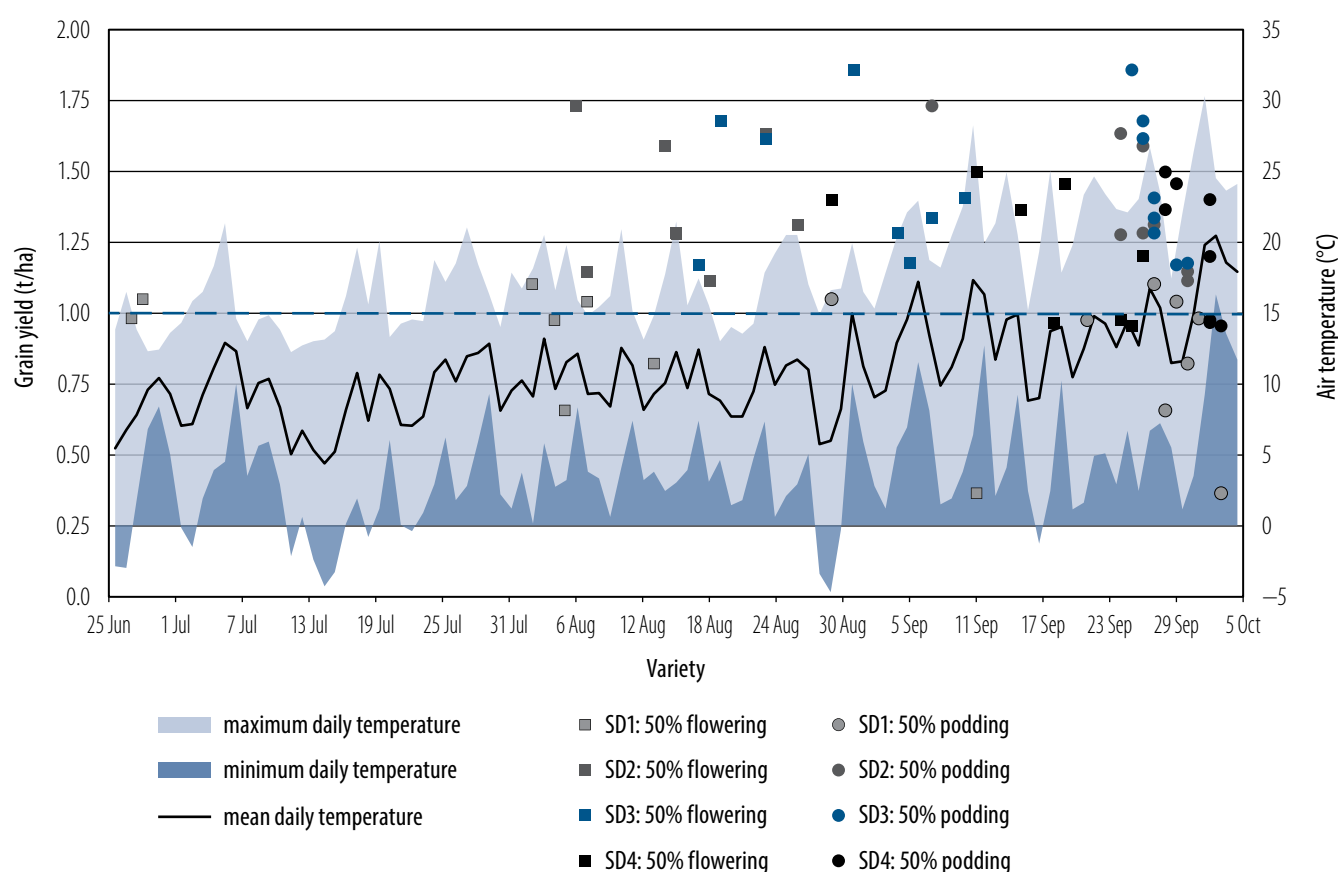


Figure 4. Chickpea grain yield, flowering and podding response to temperature and sowing date at Yanco 2018. Same colour denotes the same SD, and squares denote flowering phase while circles denote podding phase. Dashed line indicates pod set threshold (15 °C).

Conclusion

Limited pre-sowing moisture affected plant growth, biomass accumulation and final grain yield at Yanco in 2018. The late April (SD2) and mid May (SD3) sowing dates produced the highest yields (1.38 t/ha and 1.44 t/ha respectively) when averaged across varieties. Yield was related to a number of yield components: number of pods, filled and unfilled pods, seed number and seed weight. The low mean grain yield (0.87 t/ha) observed from SD1 could be partly attributed to the high number of unfilled pods from frost damage during flowering and podding. Lack of soil moisture shortened the growing season and caused some varieties such as PBA Striker[®] and Genesis[™] 079 to flower and pod earlier than normal. There are differing optimum sowing dates for different varieties, with the late April (SD2) and mid May (SD3) sowing dates producing higher yields overall.

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