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

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Key findings

- An unfavourable growing season in 2018 has shown there are differing optimum sowing dates for different varieties, with late April and mid May sowing producing the highest and similar grain yield overall.
- Significant interaction was found with sowing date and variety for phenological development, grain yield and harvest index.
- Average yield at this site was 1.45 t/ha.
- Sowing date impacted the number of viable pods per plant. Lentils sown mid April had significantly more unfilled pods than lentils sown at all later dates due to an interaction between flowering time and frost damage.

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 lentil by identifying the phenological drivers of crop development and grain yield. The experiment was conducted at Wagga Wagga, NSW under dryland conditions, with water applied for the first three sowing dates to ensure crop establishment.

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

- identify the phenological drivers of lentil in central and southern NSW
- determine variety response to sowing dates across varying climatic zones
- determine the 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	120 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; crops were machine harvested on 19 November 2018

Treatments

Eight lentil varieties were sown on four sowing dates.

Lentil varieties	PBA Ace^{Φ}, PBA Blitz^{Φ}, PBA Bolt^{Φ}, PBA Greenfield^{Φ}, PBA Hallmark XT^{Φ}, PBA Hurricane XT^{Φ}, PBA Jumbo2^{Φ} and Nipper^{Φ}
Sowing date (SD)	SD1: 16 April 2018 SD2: 30 April 2018 SD3: 14 May 2018 SD4: 28 May 2018

Results

Growth phase duration

The total growth duration shortened as sowing was delayed. Lentil requires a minimum soil temperature of 5 °C to emerge (GRDC GrowNotes™ 2017). Days to emergence increased from four days (SD1) to 19 days (SD4) as daily temperatures started to decrease in late autumn (Figure 1).

Vegetative, flowering and podding phase durations decreased significantly as sowing date was delayed from mid April (SD1) to late May (SD4) (Figure 1). The timing of flowering and podding phases for mid April (SD1) and late April (SD2) sowings increased plant exposure to frost damage more than mid May (SD3) and late May (SD4) sowings. The low grain yield observed in the mid April sowing (SD1) can be partly attributed to the high number of unfilled pods per plant due to frost exposure. The shorter flowering and podding duration in the late May sowing (SD4), combined with moisture stress, likely had a negative effect on grain yield.

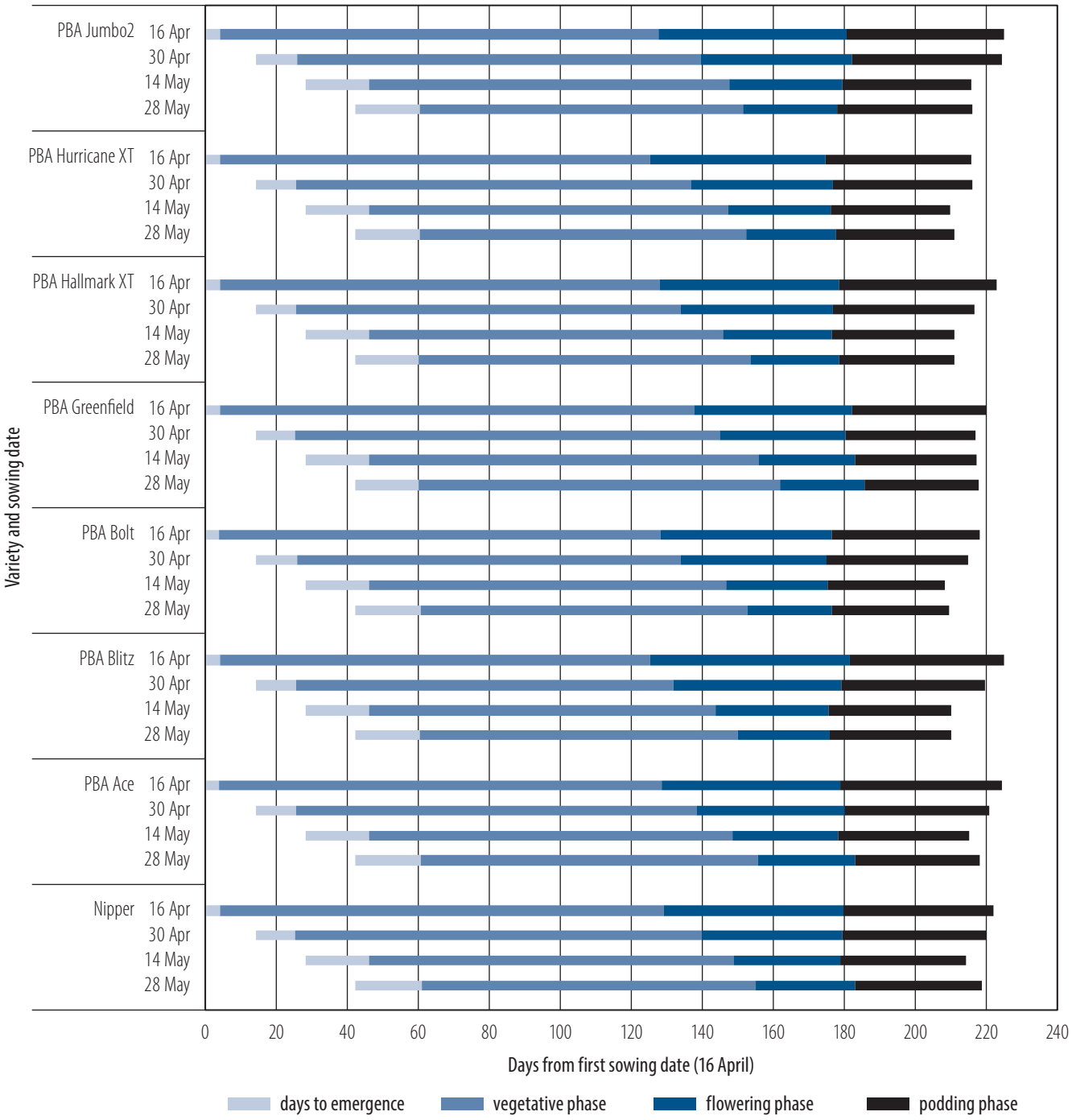

Figure 1. Duration of growth stages of eight lentil varieties sown on four dates at Wagga Wagga in 2018.

Grain yield, yield components, harvest index and harvest biomass

Significant interactions were observed between variety and sowing date for grain yield, ranging from 1 t/ha for PBA Greenfield$^{\Phi}$ (SD4) to 1.68 t/ha for PBA Ace$^{\Phi}$ (SD3) (Figure 2). The significantly lower grain yield of PBA Greenfield$^{\Phi}$ at SD3 and SD4 can be attributed to its later time to flowering and slower maturity (Figure 3) and thus higher exposure to late season heat and moisture stress in this experiment. The highest grain yields were obtained from the late April (SD2) and mid May (SD3) sowings at 1.51 t/ha and 1.55 t/ha respectively when averaged across varieties, with a corresponding flowering time of around 120–125 days after sowing (Figure 3). Some varieties also had high yields at SD4 (PBA Ace$^{\Phi}$ and PBA Hurricane$^{\Phi}$ XT) and SD1 (Nipper$^{\Phi}$) (Figure 2). The high grain yield was mainly due to a larger number of seeds and pods per plant, and a larger seed size.

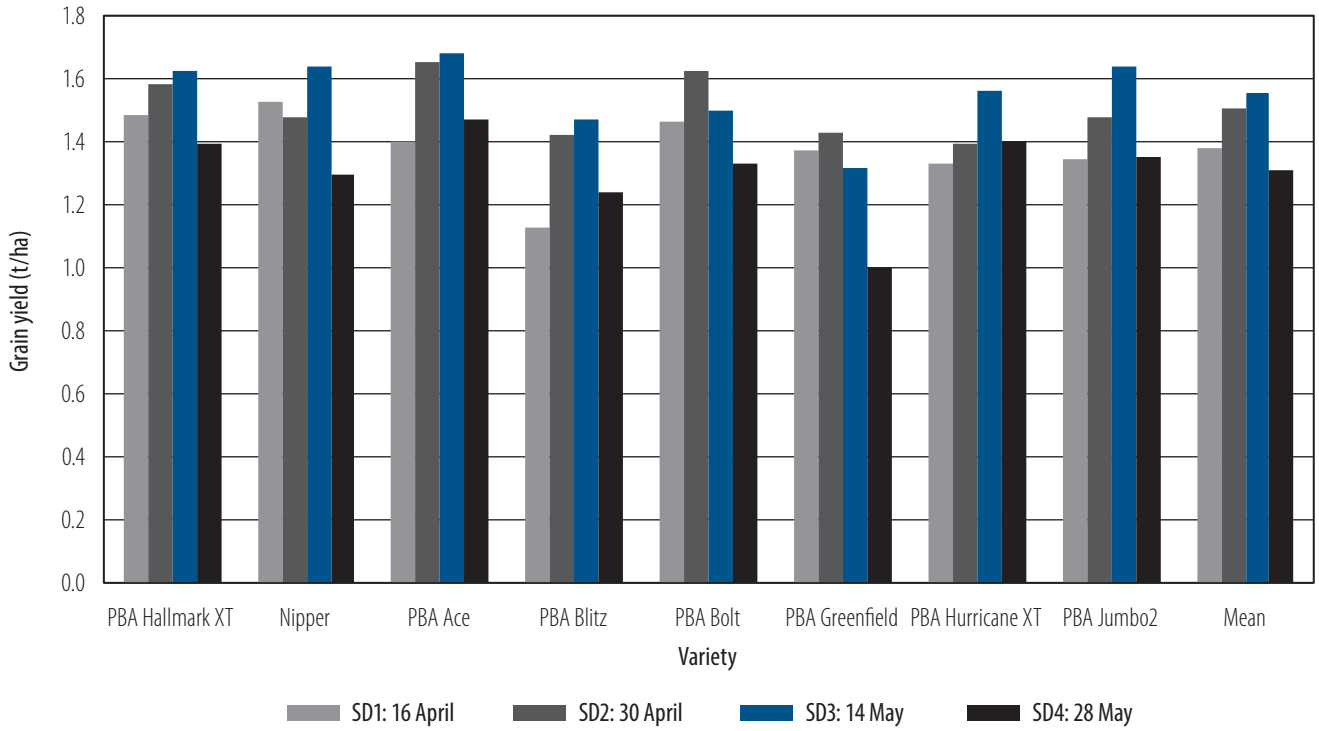

Figure 2. Grain yield of eight lentil varieties sown on four sowing dates at Wagga Wagga, 2018; l.s.d. (P = <0.001) = 0.16 t/ha.

There was a significant interaction between variety and sowing date for harvest index. Also, harvest index increased significantly from SD1 to SD4 respectively. Harvest index ranged from 0.31 for PBA Ace$^{\Phi}$ (SD1) to 0.54 for PBA Bolt$^{\Phi}$ (SD4).

Biomass at maturity decreased significantly with delayed sowing date (Table 1). PBA Ace$^{\Phi}$ had the highest biomass at maturity (3.85 t/ha) and PBA Hurricane XT$^{\Phi}$ the lowest (3.17 t/ha) averaged across sowing dates.

Table 1. Harvest index and harvest biomass across four sowing dates at Wagga Wagga, 2018.

Variety	Harvest index (%)					Biomass at maturity (t/ha)				
	SD1	SD2	SD3	SD4	Mean	SD1	SD2	SD3	SD4	Mean
PBA Hallmark XT	0.37	0.44	0.47	0.51	0.45	3.96	3.64	3.46	2.72	3.44
Nipper	0.40	0.43	0.46	0.52	0.45	3.84	3.42	3.58	2.51	3.34
PBA Ace	0.31	0.41	0.44	0.49	0.41	4.49	4.08	3.83	3.00	3.85
PBA Blitz	0.31	0.40	0.46	0.52	0.42	3.60	3.55	3.22	2.37	3.18
PBA Bolt	0.41	0.46	0.47	0.54	0.47	3.60	3.53	3.17	2.47	3.19
PBA Greenfield	0.33	0.39	0.42	0.40	0.38	4.11	3.68	3.16	2.51	3.37
PBA Hurricane XT	0.37	0.43	0.49	0.53	0.46	3.62	3.25	3.21	2.63	3.17
PBA Jumbo2	0.33	0.40	0.45	0.51	0.42	4.03	3.73	3.68	2.64	3.52
Mean	0.36	0.42	0.46	0.50	0.43	3.90	3.61	3.41	2.61	3.38
l.s.d (P<0.05)										
Sowing date	0.02					0.23				
Variety	0.02					0.20				
Interaction (sowing date × variety)	0.03					n.s.				

Note: n.s. indicates not significant.

Low temperatures during flowering and podding phases affected flower and pod viability and ultimately, grain yield.

SD1 had a large number of days with temperatures below 0 °C during flowering and podding and SD2 also had temperatures below 0 °C (Figure 3).

All varieties sown on SD1, and PBA Blitz$^{\Phi}$ sown on SD2 started flowering before a severe three-day frost event between 27 August and 30 August. This event caused flower abortion, but lentil being an indeterminate crop continued to flower. However, the loss of these flowers decreased yield potential and the final yield.

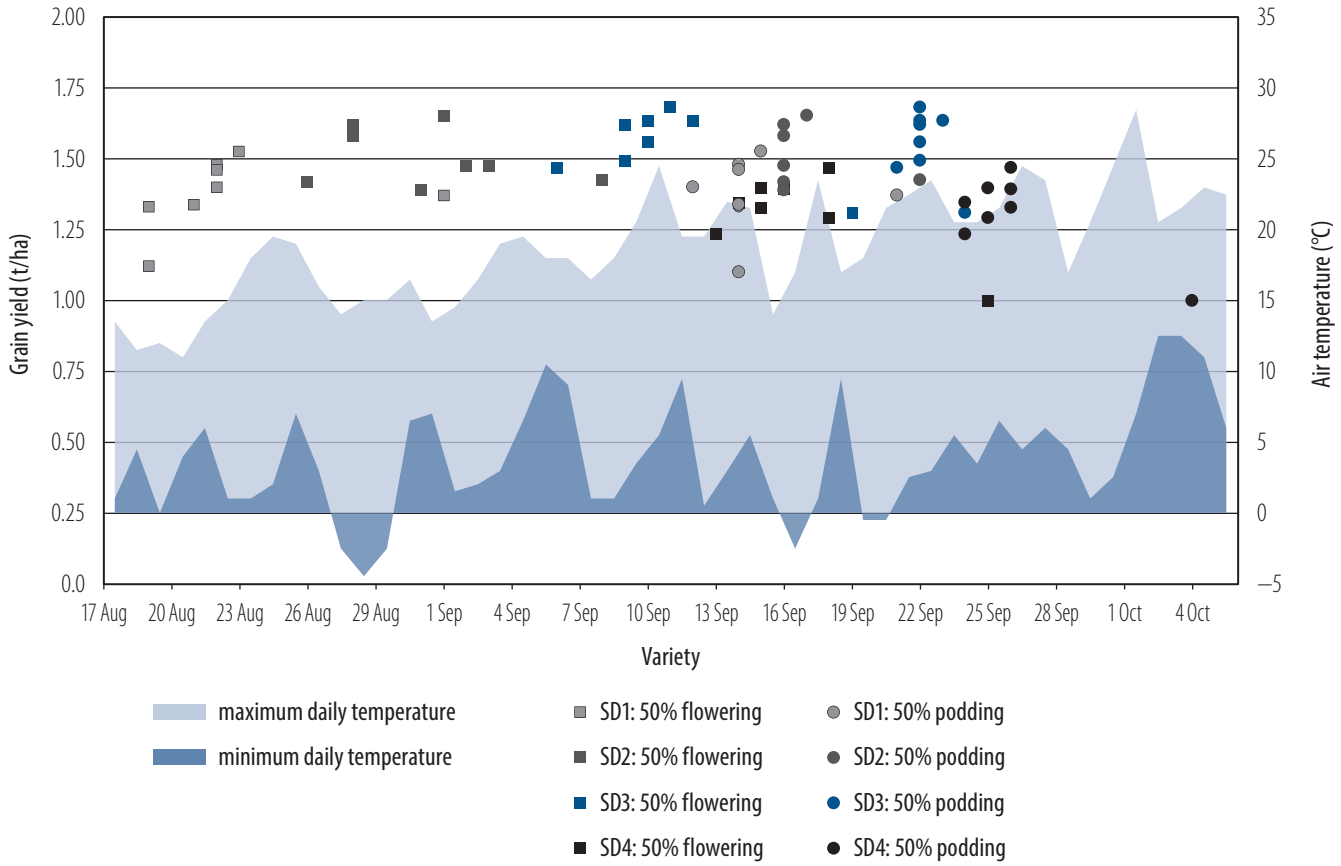

Figure 3. Lentil yield, flowering and podding response to temperature and sowing date at Wagga Wagga in 2018.
Note: Same colour denotes the same SD, and squares denote flowering phase while circles denote podding phase.

Due to the dry seasonal conditions, disease infection was not significant in this experiment. Severe frosts and moisture stress interacting with sowing date, variety and phasic development had the most significant effect on grain yield.

Conclusion

Despite an unfavourable growing season at Wagga Wagga in 2018, lentil grain yields ranged from 1.31 t/ha (SD4) to 1.55 t/ha (SD3) when averaged across varieties. At this site, the 2018 results point to late April and mid May as the best sowing dates. This is largely driven by temperatures and soil moisture levels during flowering and podding which were identified as major drivers of phenological response, with lower temperatures resulting in flower and pod abortion.

Reference

GRDC GrowNotes™ 2017. *Plant growth and physiology*. Grains Research and Development Corporation, https://grdc.com.au/__data/assets/pdf_file/0020/243281/GRDC-GrowNotes-Lentil-Southern.pdf, viewed on 4 March 2019.

Acknowledgements

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