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Lentil response to sowing date and water treatment – Wagga Wagga, Leeton and Condobolin 2020

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Key findings

- Sowing date and water availability significantly affected grain yield responses.
- The highest yields at Wagga Wagga were associated with the early June sowing date; there was no significant difference in yield between sowing dates at Leeton or Condobolin.
- The highest yields at Wagga Wagga were obtained in the dryland treatment; there was a significant yield penalty associated with irrigation due to increased disease.
- Atypical rainfall, low heat and no frost stress lengthened the growing season, allowing later sowing dates to yield higher (or remove the yield penalty).

Introduction

In central western and southern NSW, abiotic stresses such as heat and moisture stress late in the season and frost damage during the vegetative and reproductive phases limit lentil yield potential. To maximise yield, it is important to optimise sowing date to ensure that critical growth phases coincide with a period of low abiotic stress risk. This paper reports the findings of field experiments conducted at Wagga Wagga and Leeton (both southern NSW), and Condobolin (central western NSW) in 2020, where lentil variety yield responses were evaluated across three sowing dates from late April to early June (Wagga Wagga, Figure 1, and Leeton) and two sowing dates, early May and early June (Condobolin), under dryland conditions, with an additional irrigated treatment at Wagga Wagga. Table 1 summarises site details and Table 2 summarises the varieties and sowing dates tested at each location.

Figure 1 Lentil plots at Wagga Wagga, 21 July 2020.

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Table 1 Summary of site conditions and experiment management at Wagga Wagga, Leeton and Condobolin, 2020.

Site	Wagga Wagga	Leeton	Condobolin
Location	Wagga Wagga Agricultural Institute	Leeton Field Station	Condobolin Agricultural Research and Advisory Station
Soil type	Red kandosol	Grey vertosol	Red chromosol
Previous crop	Wheat	Barley	2019 fallow
Rainfall	• Fallow (November–March): 192 mm • Fallow long-term average (LTA): 198 mm • In-crop (April–October): 345 mm • In-crop LTA: 330 mm An additional 56 mm was applied periodically during the season for the irrigated treatment as follows: • 8.1 mm on 21 September • 9.9 mm on 14 October • 13.9 mm on 16 November • 14.1 mm on 22 November.	• Fallow (November–March): 188 mm • Fallow long-term average (LTA): 155 mm • In-crop (April–October): 260 mm • In-crop LTA: 262 mm Approximately 200 mm was applied before sowing in order to start the experiment with a full moisture profile.	• Fallow (November–March): 275 mm • Fallow long-term average (LTA): 192 mm • In-crop (April–October): 396 mm • In-crop LTA: 240 mm
Soil nitrogen	• 0–10 cm: 48.9 kg/ha • 10–60 cm: 20.2 kg/ha • 60–120 cm: 8.4 kg/ha	• 0–10 cm: 14.7 kg/ha • 10–60 cm: 112.0 kg/ha • 60–120 cm: 57.1 kg/ha	• 0–10 cm: 44.2 kg/ha • 10–60 cm: 69.0 kg/ha • 60–110 cm: 120.0 kg/ha
Starter fertiliser	Granulock®Z Soygran 100 kg/ha (nitrogen [N]: 5.5; phosphorus [P]: 15.3; potassium [K]: 0.0; sulfur [S]: 7.5)	Utiliser pulse mix 120.0 kg/ha (nitrogen [N]: 7.48; phosphorus [P]: 17.64; potassium [K]: 6.24; calcium [Ca]: 6.4; zinc [Z]: 0.32; manganese [Mn]: 3.2)	70 kg/ha mono-ammonium phosphate (MAP)
Target plant density	120 plants/m^2	120 plants/m^2	120 plants/m^2
Weed management			
Fallow management and pre-sowing knockdown	• Gladiator® CT (450 g/L glyphosate) 2 L/ha + Striker® (240 g/L oxyfluorfen) 100 mL/ha on 24 February • Gladiator® CT (450 g/L glyphosate) 2 L/ha + Triclopyr 600 (600 g/L triclopyr) 80 mL/ha on 11 March • Panzer 450 (450 g/L glyphosate) 2 L/ha + Triclopyr 600 (600 g/L triclopyr) 80 mL/ha on 14 May • Spray.Seed® 250 (135 g/L paraquat and 115 g/L diquat) 2 L/ha on 27 April • Paraquat 360 (360 g/L paraquat) 2 L/ha + Genfarm Genwet 1000 250 mL/ha	• Roundup Ultra® Max (570 g/L glyphosate) 3.0 L/ha + Hammer® 400 EC (400 g/L carfentrazone-ethyl) 50 mL/ha on 21 April	Nil
Pre-emergence (at sowing)	• Treflan™ (480 g/L trifluralin) 1.2 L/ha + Terbyne® Xtreme® (875 g/L terbuthylazine) 900 g/ha	• Rifle® 440 (440 g/L pendimethalin) 2.0 L/ha + Terbyne® Xtreme® (875 g/L terbuthylazine) 1.2 kg/ha + Avadex® Xtra (500 g/L tri-allate) 1.6 L/ha	• Triflur X (480 g/L trifluralin) 1.2 L/ha on 24 April (pre-sowing) • Roundup Ultra Max (570 g/L glyphosate) 1.5 L/ha + Terbyne® Xtreme® (875 g/kg) 1.2 kg/ha

Site	Wagga Wagga	Leeton	Condobolin
Post-emergence	• Verdict® 520 (520 g/L haloxyfop) 75 mL/ha + Platinum® XTRA 360 (360 g/L clethodim) 330 mL/ha + Uptake™ 500 mL/ha on 29 June • Verdict® 520 (520 g/L haloxyfop) 75 mL/ha + Factor® WG (250 g/kg butroxydim) 180 g/ha + Supercharge® 1 L/ha on 3 August	• Rifle® 440 (440 g/L pendimethalin) 2.0 L/ha + Terbyne® Xtreme® (875 g/L terbuthylazine) 1.2 kg/ha +Avadex® Xtra (500 g/L tri-allate) 1.6 L/ha	Nil
Disease management	• Dithane® (750 g/kg mancozeb) 2.2 kg/ha on 30 June • Aviator® Xpro® (150 g/L prothioconazole and 75 g/L bixafen) 650 mL/ha on 4 August • Veritas® (200 g/L tebuconazole and 120 g/L azoxystrobin) 1 L/ha on 15 September • Echo® 900WDG (900 g/kg chlorothalonil) 1.2 kg/ha on 29 September, 9 October, 22 October, 10 November	• Aviator® Xpro® (150 g/L prothioconazole and 75 g/L bixafen) 600 mL/ha on 11 June • Dithane® (750 g/kg mancozeb) 2.2 kg/ha on 3 July and 23 July • Veritas® (200 g/L tebuconazole and 120 g/L azoxystrobin) 1.0 L/ha on 3 August • Cheers® 720 (720 g/L chlorothalonil) 1.8 L/ha on 3 August, 17 August, 4 September, 20 October, 29 October	• Penncozeb® 750DF (750 g/kg mancozeb) 1 kg/ha + 0.1% Bond on 8 July • Aviator® Xpro® (150 g/L prothioconazole and 75 g/L bixafen) 600 mL/ha on 6 August • Veritas® (200 g/L tebuconazole and 120 g/L azoxystrobin) 1.0 L/ha on 29 September
Pest management	• Lemat® (290 g/L omethoate) 200 mL/ha on 29 May • Chlorpyrifos 500EC (500 g/L chlorpyrifos) 300 mL/ha on 30 June • Astound® (100 g/L alpha-cypermethrin) 200 mL/ha on 17 September • Astound® (100 g/L alpha-cypermethrin) 200 mL/ha on 15 October • Trojan® (150 g/L gamma-cyhalothrin) 35 mL/ha on 19 November	• Decis® options (27.5 g/L deltamethrin) 500 mL/ha on 20 October and 29 October	• Karate Zeon® (250 g/L lambda-cyhalothrin) 36 mL/ha + Aphidex® WG (500 g/L pirimicarb) 250 g on 14 October
Desiccation	• Gramoxone® (250 g/L paraquat) 800mL/ha on 2 December and 8 December	Nil	Nil

Table 2 Summary of the experiment treatments: variety, sowing date, and water treatment at Wagga Wagga, Leeton and Condobolin, 2020.

Site	Wagga Wagga – WWAI	Leeton – LFS	Condobolin – CARAS
Variety	PBA Hallmark XTⓓ PBA Jumbo2ⓓ PBA Boltⓓ PBA Kelpie XTⓓ	PBA Hallmark XTⓓ PBA Jumbo2ⓓ PBA Boltⓓ PBA Kelpie XTⓓ	PBA Highland XTⓓ PBA Hallmark XTⓓ PBA Jumbo2ⓓ PBA Blitzⓓ PBA Aceⓓ PBA Greenfieldⓓ PBA Boltⓓ PBA Kelpie XTⓓ
Sowing date (SD)	SD1: 24 April SD2: 15 May SD3: 5 June	SD1: 24 April SD2: 15 May SD3: 5 June	SD1: 8 May SD2: 5 June
Water treatment	Dryland and irrigated	Dryland only	Dryland only

Note: PBA Kelpie XTⓓ previously known as CIPAL1721.

Results

Seasonal conditions

In 2020, southern and central western NSW growing season rainfall was close to the long-term average. Rainfall, though appearing average across the growing season, was atypical for Wagga Wagga, Leeton and Condobolin with above average rainfall during the pre-sowing period (April) and again in spring (October), and less than average rainfall between these periods. This rain pattern prevented significant decline in soil moisture throughout much of the growing season.

Wagga Wagga

Grain yield, biomass and plant phenology

Sowing date, variety and water treatment all influenced grain yield and harvest index at Wagga Wagga (Table 3). Generally, earlier sowing reduced grain yield and harvest index as did irrigation.

Lentils sown on SD3 (5 June) had the highest grain yield in the experiment, although this is uncharacteristic for this environment, which generally favours mid May sowing (Richards et al. 2020). PBA Kelpie XT⁽ᵖ⁾ was the highest yielding variety (2.84 t/ha) across all sowing dates, with no significant difference between PBA Bolt⁽ᵖ⁾, PBA Hallmark XT⁽ᵖ⁾, PBA Jumbo2⁽ᵖ⁾.

Maximum biomass (9.06 t/ha) occurred with lentil sown on SD2 (15 May), with SD1 and SD3 producing significantly less biomass (7.57 and 7.89 t/ha respectively). No differences in the amount of biomass produced was detected between varieties and adding the water treatment only served to reduce the biomass produced across all sowing dates. Irrigation increased the severity of disease (botrytis grey mould), which ultimately reduced the biomass and yield produced. Additionally, early sowing facilitated virus infection and spread by aphids.

Table 3 Summary of means of each treatment for yield from biomass cuts taken at harvest, header yield, start of flowering, plant height, top and bottom pod height at Wagga Wagga, 2020.

	Harvest index cut			Header yield	Plant phenology			
	Biomass (t/ha)	Grain yield (t/ha)	Harvest index (HI)	Grain yield (t/ha)	Start of flowering	Plant height (mm)	Bottom pod height (mm)	Top pod height (mm)
Sowing date								
SD 1: 24 April	7.57	1.51	0.19	1.02	3 Sept	640.00	27.90	64.31
SD 2: 15 May	9.06	2.72	0.30	1.94	16 Sept	522.65	25.15	53.88
SD 3: 5 June	7.89	3.34	0.42	2.91	21 Sept	464.03	20.62	47.21
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001
l.s.d. (*P*<0.05)	0.430	0.220	0.020	0.150	2.740	44.194	4.013	3.965
Variety								
PBA Kelpie XT	8.42	2.84	0.34	2.02	9 Sept	n.c.	n.c.	n.c.
PBA Bolt	8.13	2.26	0.27	1.63	12 Sept	566.25	22.40	55.04
PBA Hallmark XT	8.07	2.47	0.30	1.93	16 Sept	n.c.	n.c.	n.c.
PBA Jumbo2	8.08	2.52	0.30	2.25	16 Sept	518.20	26.71	55.23
P value	0.628	0.002	<0.001	<0.001	<0.001	0.015	0.023	0.978
l.s.d. (*P*<0.05)	n.s.	0.263	0.024	0.169	3.167	35.42	3.24	n.s.
Water treatment								
Dryland	8.63	2.87	0.33	2.22	14 Sept	555.65	25.33	55.39
Irrigated	7.72	2.17	0.28	1.70	13 Sept	528.80	23.78	54.88
P value	<0.001	<0.001	<0.001	<0.001	0.292	0.12	0.32	0.79
l.s.d. (*P*<0.05)	0.35	0.18	0.02	0.12	n.s.	n.s.	n.s.	n.s.

l.s.d. = least significant difference; n.s. = not significant; n.c. = not collected.

Variety × sowing date interactions were observed for biomass and grain yield with delayed sowing increasing yield for all varieties (Figure 2). As with the sowing date mean trend, biomass generally peaked for all varieties at SD2.

Delayed sowing also delayed the start of flowering (Table 3), with varieties performing as expected; PBA Kelpie XT⁽ᵈ⁾ and PBA Bolt⁽ᵈ⁾ flowered earlier than PBA Hallmark XT⁽ᵈ⁾ and PBA Jumbo2⁽ᵈ⁾. Given bottom pod height is an important factor affecting harvest efficiency, SD 3 (5 June) had a significantly lower bottom pod height of 20.62 cm compared to SD1 and SD2 (27.9 and 25.15 respectively). Only PBA Bolt⁽ᵈ⁾ and PBA Jumbo2⁽ᵈ⁾ were measured at maturity for height, and although PBA Bolt⁽ᵈ⁾ was significantly taller than PBA Jumbo2⁽ᵈ⁾, PBA Jumbo2⁽ᵈ⁾ had a higher bottom pod height (22.4 mm and 26.7 mm respectively).

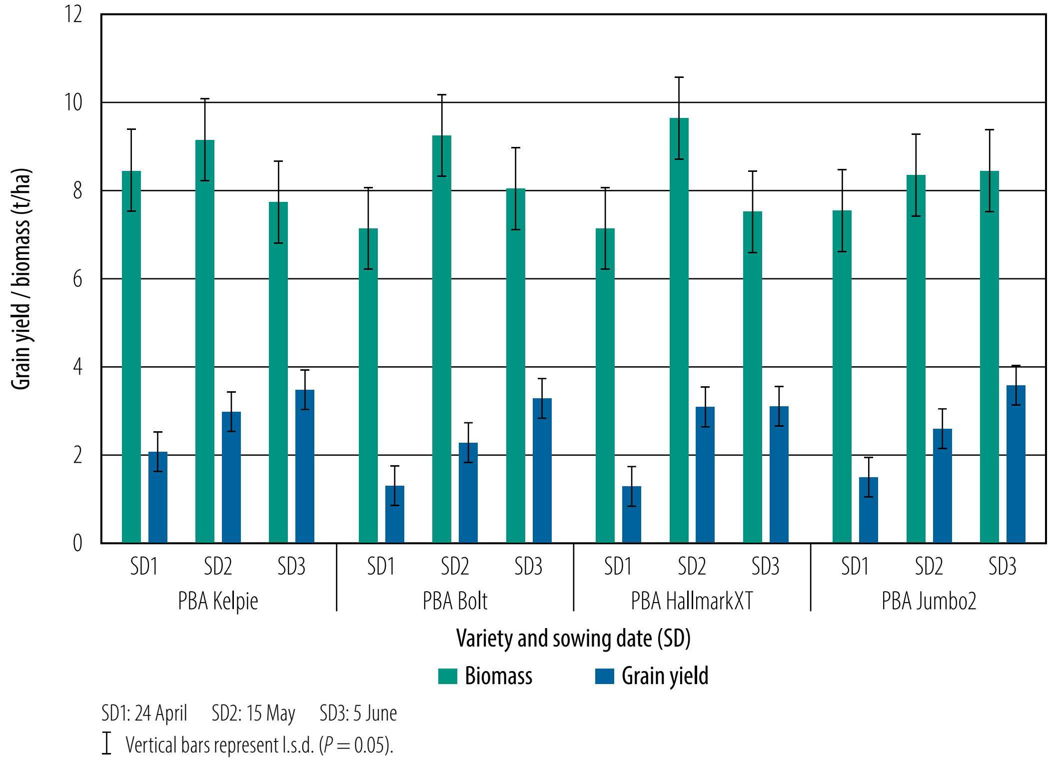

Figure 2 Grain yield and biomass (t/ha) from harvest cuts of four lentil varieties sown on three dates at Wagga Wagga, 2020.

Leeton

Grain yield and biomass

At Leeton, greater biomass was associated with earlier sowing (SD1 and SD2) with no differences between varieties (Table 4). Sowing date did not affect grain yield however, although varietal differences were detected with PBA Hallmark XT⁽ᵈ⁾ yielding lower than all other varieties. No interaction was found between sowing date × variety for biomass, however, interactions were evident for yield (Figure 3). SD1 and PBA Jumbo2⁽ᵈ⁾ was the highest yielding combination (4.42 t/ha), with SD3 and PBA Hallmark XT⁽ᵈ⁾ the lowest (3.04 t/ha).

Table 4 Summary of means of each treatment for yield from biomass cuts taken at harvest and header yield at Leeton, 2020.

	Harvest index cut			Header yield
	Biomass (t/ha)	**Grain yield (t/ha)**	**Harvest index (HI)**	**Grain yield (t/ha)**
Sowing date				
SD 1: 24 April	9.59	3.82	0.40	2.80
SD 2: 15 May	9.14	3.50	0.39	2.73
SD 3: 5 June	8.79	3.73	0.43	3.10
P value	<0.001	n.s.	<0.001	0.002
l.s.d. ($P<0.05$)	0.645		0.02	0.204
Variety				
PBA Bolt	9.53	3.70	0.39	3.10
PBA Hallmark XT	9.09	3.34	0.37	2.84
PBA Kelpie XT	8.73	3.73	0.43	2.67
PBA Jumbo2	9.33	3.96	0.43	2.90
P value	n.s.	0.009	0.002	0.019
l.s.d. ($P<0.05$)		0.47	0.03	0.47

l.s.d. = least significant difference; n.s. = not significant.

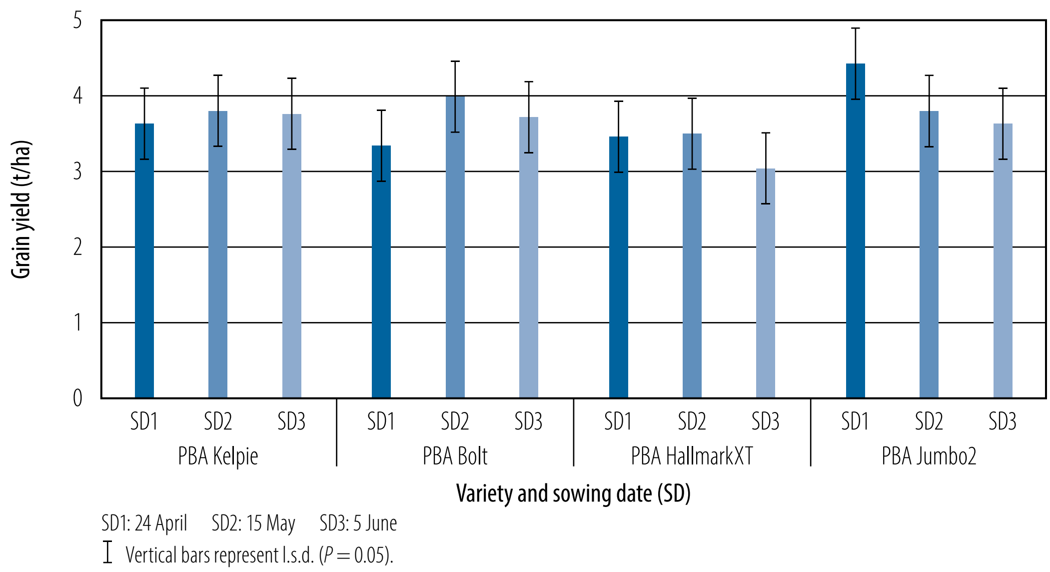

Figure 3 Grain yield from harvest cuts of four lentil varieties sown on three dates at Leeton, 2020.

Condobolin

Grain yield and biomass

At Condobolin, greater biomass was associated with the earlier sowing date (SD1) with significant differences between the varieties, mostly due to low biomass in PBA Blitz⁽ᴰ⁾ (Table 5). However, sowing date did not affect grain yield, nor were any varietal differences detected. No interaction was found between sowing date × variety for biomass or yield.

Table 5 Performance of four lentil varieties across two sowing dates at Condobolin, 2020.

	Harvest index cut			Header yield
	Biomass (t/ha)	Grain yield (t/ha)	Harvest index (HI)	Grain yield (t/ha)
Sowing date				
SD 1: 8 May	3.03	1.36	0.45	0.54
SD 2: 5 June	2.43	1.22	0.50	0.57
P value	<0.001	n.s.	<0.001	n.s.
l.s.d. (P<0.05)	0.034		0.029	
Variety				
PBA Kelpie XT	2.89	1.48	0.51	0.61
PBA Bolt	2.60	1.19	0.47	0.60
PBA Hallmark XT	3.02	1.50	0.50	0.68
PBA Jumbo2	2.89	1.35	0.47	0.63
PBA Blitz	2.10	1.08	0.51	0.28
PBA Greenfield	2.42	1.10	0.44	0.35
PBA Highland XT	2.90	1.24	0.46	0.71
PBA Ace	3.05	1.41	0.46	0.61
P value	0.027	n.s.	n.s.	<0.001
l.s.d. (*P*<0.05)	0.579			0.141

l.s.d. = least significant difference; n.s. = not significant.

Summary

In 2020, seasonal conditions significantly influenced grain yield responses to sowing date at Wagga Wagga, Leeton and Condobolin. Irrigation at Wagga Wagga in a wet year (2020) with above average rainfall increased viral disease incidence and decreased overall plant health, ultimately decreasing grain yield. The decrease was more pronounced for the early sowing date (SD1). Rainfall in 2020 was sufficient to maximise yield without additional irrigation water and associated complications in the form of increased disease severity.

Reference

Richards M, Preston A, Maphosa L, Maheswaran R, Moore K, Clark S, Johnston D, Burrough R and Napier T 2020. Lentil phenology and grain yield response to sowing date – Wagga Wagga and Leeton 2019; D Slinger, T Moore and C Martin (eds), *Southern NSW research results 2020*, pp. 51–58, NSW Department of Primary Industries.

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