Department of Primary Industries

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

Mark Richards[1], Dr Aaron Preston[1], Dr Lance Maphosa[1], Karl Moore[1], Scott Clark[1], Nelson West[1], Tony Napier[2], Daniel Johnston[2], Reuben Burrough[3] and Richard Maccallum[3]

[1] NSW DPI, Wagga Wagga
[2] NSW DPI, Leeton
[3] NSW DPI, Condobolin

Key findings

- Environmental and management conditions such as water availability and sowing date (SD) significantly affected phenological development, grain yield, disease levels and biomass accumulation.
- The highest yields at both Wagga Wagga and Leeton were associated with mid to late sowing (SD2 and SD3), and early sowing (SD1) at Condobolin.
- The highest yields at both Wagga Wagga and Leeton were associated with the dryland treatment; there was a significant yield penalty associated with irrigation due to increased disease incidence (Wagga Wagga) and lodging (Leeton).

Introduction

In central western and southern NSW, frost damage during the vegetative and reproductive phases, in combination with heat and moisture stress later in the season, limits chickpea yield potential. Therefore, to maximise yield, it is important to optimise sowing date and irrigation 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 (southern NSW), and Condobolin (central western NSW) in 2020, where the phenology and biomass accumulation and yield responses of diverse chickpea varieties were evaluated across three sowing dates from late April to early June (Wagga Wagga and Leeton) and two sowing dates, early May and early June (Condobolin, Figure 1), under dryland conditions, with additional irrigated treatments at Wagga Wagga and Leeton. Site details are summarised in Table 1 and the varieties and sowing dates tested at each site are summarised in Table 2.

Figure 1 Chickpea plots at Condobolin, 5 August 2020.

This research paper is an extract from the publication *Southern NSW Research Results 2021*, available at https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/southern-nsw-research-results

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 (LTA): 155mm • In-crop (April–October): 260 mm • In-crop LTA: 262 mm An additional 50 mm was applied before sowing on 9 April in order to start the experiment with a full moisture profile. The irrigated treatment further received: • 80 mm on 10 September • 80 mm on 8 October.	• Fallow (November–March): 275 mm • Fallow (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: 15.7 kg/ha • 10–60 cm: 31.8 kg/ha • 60–110 cm: 20.2 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)	Pasture King (0% nitrogen [N]; 15.7% phosphorus [P]; 0 % potassium [K]; 4.6% sulfur [S]) at 120 kg/ha
Target plant density	45 plants/m^2	45 plants/m^2	45 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 (paraquat 360 g/L) 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	• Roundup Ultra® Max (570 g/L glyphosate) 1.5 L/ha + TriflurX (480g/L trifluralin) 1.2 L/ha, cultivator incorporated on 24 April
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	• Roundup Ultra® Max (570 g/L glyphosate) 1.5 L/ha + Terbyne® Xtreme® (875 g/L terbuthylazine) 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	• Verdict® 520 (520 g/L haloxyfop) 100 mL/ha on 25 May for sowing date (SD) one (SD1) • Status® (240 g/L clethodim) 400 mL/ha on 11 June for all sowing dates • Leopard® 200 (200 g/L quizalofop-p-ethyl) 190 mL/ha on 28 June for SD2 and SD3	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 • Dithane® (750 g/kg mancozeb) 2.2 kg/ha on 23 July • 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 (500g/L pirimicarb) 250 g on 14 October
Desiccation	Gramoxone® 250 (250 g/L paraquat) 800 mL/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	Leeton	Condobolin
Variety	CBA Captain⍭ PBA HatTrick⍭ PBA Striker⍭ PBA Drummond⍭	CBA Captain⍭ PBA HatTrick⍭ PBA Striker⍭ PBA Drummond⍭	CBA Captain⍭ PBA HatTrick⍭ PBA Striker⍭ PBA Drummond⍭ PBA Slasher⍭ PBA Royal⍭ Genesis079 Genesis090
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 and irrigated	Dryland only

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). 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 were the major drivers of phenology, grain yield, biomass accumulation and physiological responses at Wagga Wagga (Table 3; Figure 2). Sowing date influenced all traits, although there were no varietal differences or effect of water treatment on bottom pod height. Grain yield did not differ amongst the four varieties, and water treatment did not affect the total biomass accumulated at harvest. Early sowing resulted in large biomass accumulation but lower grain yield (Figure 2). The dryland experiment yielded higher (2.24 t/ha) than the irrigated experiment (1.72 t/ha). This is likely due to poorer overall plot health in the irrigated plots (results not shown). The high levels of basal sclerotinia, especially in PBA Striker^(^ in SD1 and overall poor health under irrigation decreased the plant density at maturity accounting for reduced grain yield. Early sowing and irrigation resulted in a longer time to the start of flowering. CBA Captain^(^ and PBA Striker^(^ were early flowering, PBA Drummond^(^ was mid flowering, and PBA HatTrick^(^ was late flowering.

Table 3 Performance of four chickpea varieties across three sowing dates and two water treatments 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)	Days to start of flowering	Plant height (mm)	Bottom pod height (mm)	Top pod height (mm)
Sowing date								
SD 1: 24 April	10.01	1.78	0.18	1.78	142.5	1085.0	688.4	1032.7
SD 2: 15 May	9.32	2.09	0.22	2.02	124.5	994.5	597.4	949.2
SD 3: 5 June	8.08	2.07	0.26	2.27	111.0	908.2	529.3	866.1
P value	<0.001	0.009	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
l.s.d. (*P*<0.05)	0.63	0.21	0.02	0.19	1.8	47.4	77.8	45.6
Variety								
CBA Captain	9.92	2.18	0.22	2.28	124.2	1020.0	588.6	969.7
PBA Drummond	8.98	1.88	0.21	1.98	126.4	–	–	–
PBA HatTrick	9.77	1.95	0.20	1.83	128.5	971.7	621.4	929.0
PBA Striker	7.87	1.92	0.25	2.00	124.9	–	–	–
P value	<0.001	0.117	<0.001	0.001	<0.001	0.015	0.33	0.029
l.s.d. (*P*<0.05)	0.72	n.s.	0.02	0.22	2.1	38.7	n.s.	37.3
Water treatment								
Dryland	9.08	2.24	0.25	2.30	125.1	951.7	582.9	901.0
Irrigated	9.19	1.72	0.19	1.75	126.9	1040.1	627.1	997.7
P value	0.67	<0.001	<0.001	<0.001	0.02	<0.001	0.159	<0.001
l.s.d. (*P*<0.05)	n.s.	0.17	0.01	0.15	1.4	38.8	n.s.	37.0

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

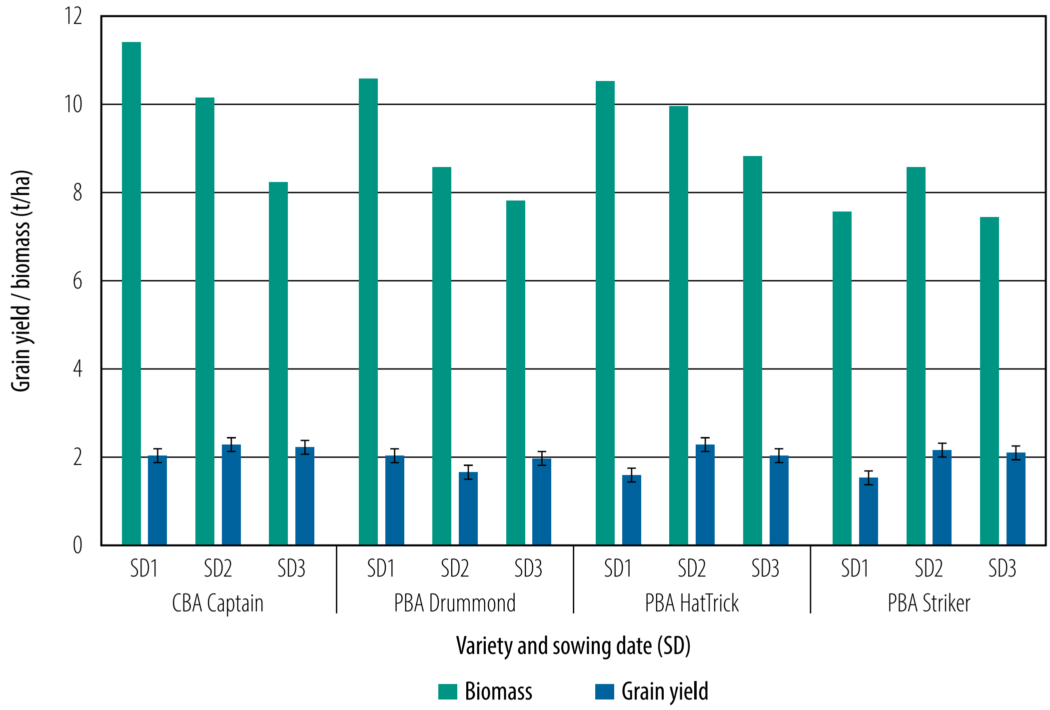

Figure 2 Grain yield and biomass (t/ha) from harvest cuts of four chickpea varieties sown on three dates at Wagga Wagga, 2020.

Leeton

Grain yield, biomass and plant phenology

At Leeton, sowing date, variety and water treatment all affected grain yield, biomass accumulation and physiological responses to varying extents (Table 4; Figure 3). Varietal differences were observed for all the traits except the start of flowering. Early sowing (SD1) resulted in a lower yield (2.68 t/ha) compared with the later sowing dates (SD2 and SD3) under both water treatments (Figure 3). CBA Captain⫚ was the highest yielding variety at 3.85 t/ha when averaged across sowing dates. It also had the highest accumulated biomass (11.96 t/ha). A decrease in yield was evident in the header yield between dryland and irrigated treatments, with irrigation reducing yield from 4.10 t/ha to 2.22 t/ha, probably due to increased lodging and disease levels (results not shown).

Table 4 Performance of four chickpea varieties across three sowing dates and two water treatments at Leeton, 2020.

	Harvest index cut			Header yield	Plant phenology
	Biomass (t/ha)	Grain yield (t/ha)	Harvest index (HI)	Grain yield (t/ha)	Days to flower – from sowing
Sowing date					
SD 1: 24 April	10.95	2.68	0.24	2.89	141.1
SD 2: 15 May	11.22	3.42	0.31	3.21	127.7
SD 3: 5 June	10.31	3.52	0.36	3.39	109
P value	0.393	0.05	<0.001	0.17	<0.001
l.s.d. (*P*<0.05)	n.s	0.71	0.02	n.s	4.284
Variety					
CBA Captain	11.96	3.85	0.33	3.86	126.1
PBA Drummond	10.98	3.18	0.30	3.35	125.3
PBA HatTrick	11.35	3.24	0.30	3.05	127.1
PBA Striker	9.02	2.56	0.29	2.38	125.2
P value	<0.001	<0.001	<0.001	<0.001	0.771
l.s.d. (*P*<0.05)	0.597	0.268	0.02	0.25	n.s
Water treatment					
Dryland	9.75	3.55	0.37	4.10	125.3
Irrigated	11.90	2.86	0.23	2.22	126.5
P value	<0.001	<0.001	<0.001	<0.001	0.458
l.s.d. (*P*<0.05)	0.47	0.21	0.013	0.20	n.s.

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

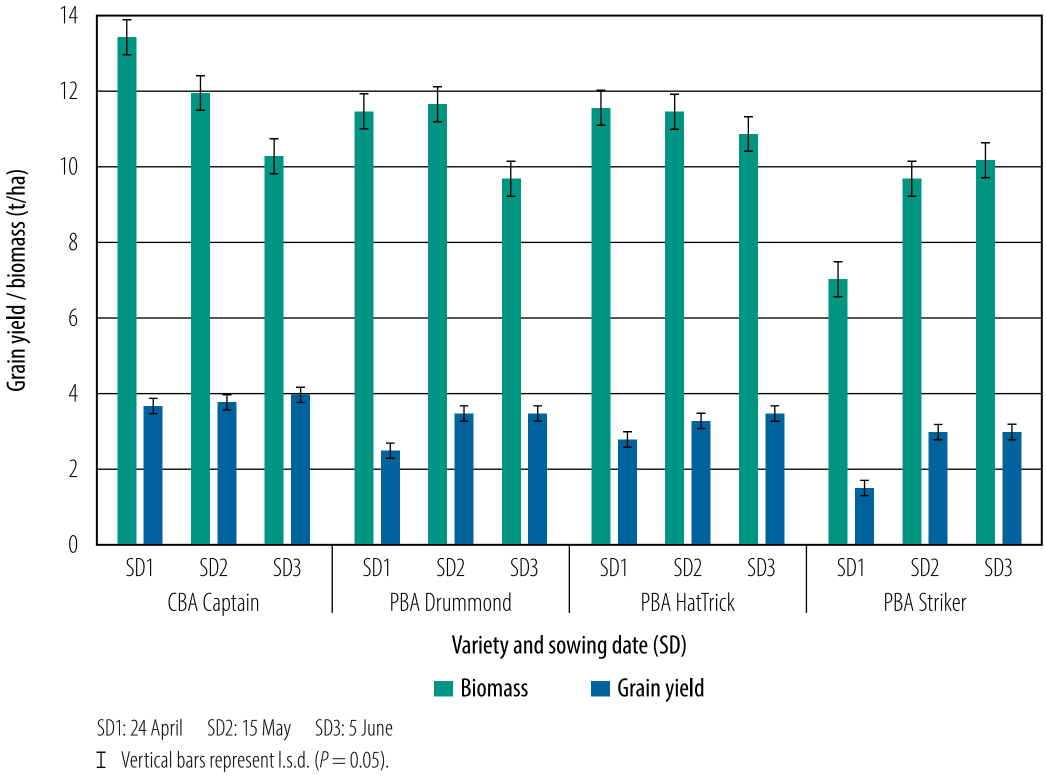

Figure 3 Grain yield and biomass (t/ha) from harvest cuts of four chickpea varieties sown on three dates at Leeton, 2020.

Condobolin

Grain yield and biomass

At Condobolin, sowing date affected all traits (Table 5). There was a decrease in grain yield and biomass accumulation as sowing was delayed (Figure 4). Early sowing (SD1) increased grain yield from 1.90 t/ha to 2.34 t/ha, while biomass increased from 3.81 t/ha to 6.18 t/ha (Table 5). However, harvest index was higher at the later sowing date (SD2), increasing from 0.37 to 0.46 (Table 5). There were no varietal differences in the measured traits.

Table 5 Performance of eight chickpea varieties across two sowing dates at Condobolin, 2020.

	Grain yield (t/ha)	Harvest index	Biomass (t/ha)
Sowing date			
SD 1: 8 May	2.34	0.37	6.18
SD 2: 5 June	1.90	0.46	3.81
P value	<0.001	<0.001	<0.001
l.s.d. (*P*<0.05)	0.21	0.03	0.59
Variety			
CBA Captain	2.40	0.39	5.60
Genesis079	2.13	0.47	4.68
Genesis090	1.80	0.43	4.10
PBA Drummond	2.10	0.42	5.44
PBA HatTrick	2.21	0.40	5.50
PBA Royal	2.00	0.42	4.59
PBA Slasher	2.25	0.40	4.89
PBA Striker	2.09	0.42	5.17
P value	0.296	0.10	0.148
l.s.d. (*P*<0.05)	n.s.	n.s.	n.s.

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

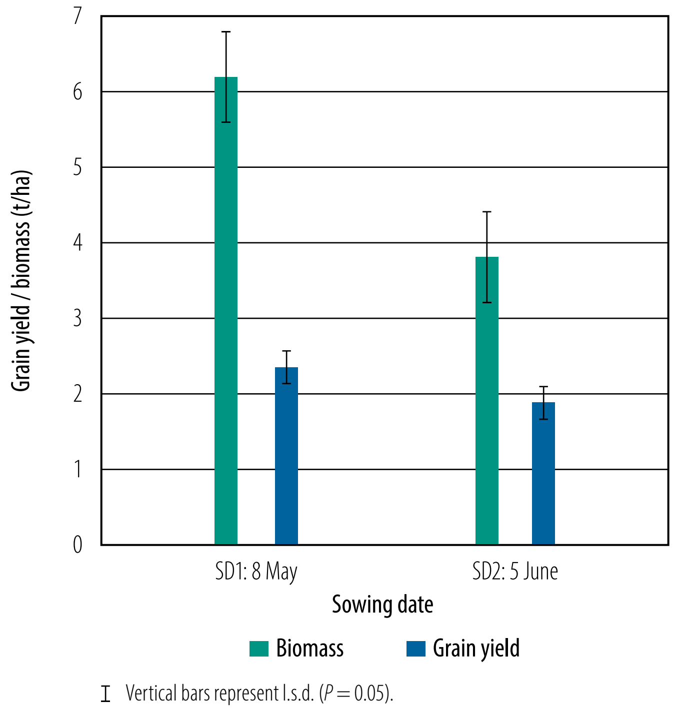

Figure 4 Grain yield and biomass (t/ha) from harvest cuts from chickpea sown on two dates at Condobolin, 2020.

Summary

In 2020, seasonal conditions significantly influenced grain yield responses to sowing date and water treatment at Wagga Wagga and Leeton, and Condobolin (dryland only). Sowing date significantly affected grain yield responses with the lowest yields at Wagga Wagga and Leeton associated with the April sowing (SD1) and with the June sowing (SD2) at Condobolin.

High levels of sclerotinia infection were observed in the late April sowing (SD1) at Wagga Wagga with lower incidence as sowing was delayed. At both Wagga Wagga and Leeton, which had an irrigation treatment, the highest yields were in the dryland treatment; there was a significant yield penalty associated with irrigation due to increased disease incidence (lodging at Leeton). Irrigation, in a wet year (2020) with close to average rainfall did not offer any production advantage and in fact decreased grain yield. Therefore, the rainfall received was enough to maximise yield without the need for additional irrigation water. Atypical rainfall, low heat and minimal frost stress lengthened the growing season, allowing later sowing dates to produce higher yields and minimise yield penalties.

Acknowledgements

This experiment was part of the 'Matching adapted pulse genotypes with soil and climate to maximise yield and profit, with manageable risk in Australian cropping systems' project, BLG118, 2020–22, a joint investment by GRDC and NSW DPI under the Grains Agronomy and Pathology Partnership (GAPP).

Thanks to Daryl Reardon, NSW DPI Condobolin for technical assistance.

Contact

Mark Richards
Wagga Wagga Agricultural Institute, Wagga Wagga
mark.richards@dpi.nsw.gov.au
0428 630 429