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The effect of sowing date and irrigation management on faba bean – Leeton 2020

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Key findings

- Irrigating faba bean on a border check layout significantly increased grain yield for all sowing dates (24 April, 15 May and 5 June).
 - Sowing date affected grain yield under both irrigated and non-irrigated treatments. Delayed sowing after 24 April resulted in reduced grain yields for both dryland and irrigated treatments.
 - An irrigation efficiency of 1.51 t/ML was achieved with faba bean when sown on 24 April. Any delay in sowing after 24 April resulted in reduced irrigation efficiency.
 - Sowing on 24 April resulted in a header yield of 6.86 t/ha averaged across all varieties when irrigated.
 - In the irrigated treatment, PBA Nasma[®] achieved the highest grain yield of 5.73 t/ha when averaged across sowing dates.
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Introduction

To maximise faba bean productivity and yield, it is important to optimise sowing time and amount of irrigation water applied. Faba bean is affected by a range of abiotic stresses such as moisture stress and extreme temperatures (low and high). An irrigated faba bean experiment was established at Leeton Field Station in 2020 to determine the effect of sowing time and irrigation on four varieties of faba bean in southern NSW. This paper reports the findings from this experiment.

Site details

Location	Leeton Field Station
Soil type	Grey vertosol
Previous crop	2019 Barley
Rainfall	<ul style="list-style-type: none">• Non-irrigated (1 May to 15 October): 115 mm• Irrigated (1 May to 30 October): 144 mm
Starter fertiliser	120 kg/ha Utiliser pulse mix (nitrogen [N]: 7.48, phosphorus [P]: 17.64, potassium [K]: 6.24, calcium [Ca]: 6.4, zinc [Z]: 0.32)
Herbicides	<ul style="list-style-type: none">• 2.0 L/ha Rifle[®] 440 (440 g/L pendimethalin)• 1.2 kg/ha Terbyne[®] Xtreme (875 g/L terbutylazine)• 1.6 L/ha Avadex[®] Xtra (500 g/L tri-allate)• 0.1 L/ha Verdict[®] 520 (520 g/L haloxyfop), first sowing date only• 0.4 L/ha Status[®] (240 g/L clethodim), all sowing dates

	<ul style="list-style-type: none"> 0.19 mL/ha Leopard® (200 g/L quizalofop-p-ethyl), second and third sowing date only
Fungicide	<ul style="list-style-type: none"> 600 mL/ha Aviator® Xpro® (150 g/L prothioconazole and 75 g/L bixafen) 1.0 L/ha Veritas® (200 g/L tebuconazole and 120 g/L azoxystrobin) 2.2 kg/ha Dithane® (750 g/kg mancozeb), 3 July and 23 July 1.8 L/ha Cheers® 720 (720 g/L chlorothalonil), 17 August, 4 September, 20 October and 29 October
Harvest dates	<ul style="list-style-type: none"> Hand harvest, 23 October to 17 November 2020 All plots were machine harvested on 7 December 2020

Treatments

The experiment included four varieties (Table 1) replicated three times, on three sowing dates (Table 2) and with two irrigation treatments (Table 3).

Table 1 Varieties evaluated in the Leeton Field Station faba bean experiment, 2020.

Variety	Comment
PBA Bendoc ^{db}	Released in 2018 and is the first faba bean variety with tolerance to imidazolinone herbicides
PBA Marne ^{db}	Shorter season variety released in 2018 and recommended for lower rainfall areas
PBA Nasma ^{db}	Large seed variety released in 2015 and recommended for northern NSW
PBA Samira ^{db}	Mid-season variety released in 2014 and recommended for southern NSW

Table 2 Sowing dates evaluated in the Leeton Field Station faba bean experiment, 2020.

Sowing date (SD)	Comment
SD1: 24 April 2020	Earlier than recommended sowing window (irrigated)
SD2: 15 May 2020	Late in recommended sowing window (irrigated)
SD3: 5 June 2020	Later than recommended sowing window

Table 3 Irrigation treatments evaluated in the Leeton Field Station faba bean experiment, 2020.

Irrigation treatment	Irrigation applications
Irrigated	Two spring irrigations applied 10 September and 8 October
Non-irrigated	No spring irrigations applied

Experiment details

The experiment was a split-split plot design with water treatment as main plots, sowing date as subplots and varieties randomised within the subplots.

The whole paddock was pre-irrigated 15 days before the first sowing date to provide a full moisture profile across all plots. The irrigated treatments received a total of 355 mm (including rainfall and irrigation) while the non-irrigated treatments received a total of 165 mm (Table 4). All trial plots were 1.5 m wide (six rows at 250 mm row spacing) and 10 m long with a 500 mm wide empty buffer between rows.

Table 4 Rainfall and irrigation totals for the Leeton Field Station faba bean experiment, 2020.

	Irrigated treatments	Non-irrigated treatments
Pre-irrigation	50 mm (0.50 ML)	50 mm (0.50 ML)
In-season rainfall	144 mm (1.44 ML)	115 mm (1.15 ML)
10 September irrigation	80 mm (0.80 ML)	0 mm
8 October irrigation	80 mm (0.80 ML)	0 mm
Total	354 mm (3.54 ML)	165 mm (1.65 ML)

The in-season rainfall was higher in the irrigated treatments due to the growing season being approximately two weeks longer.

Assessments

At physiological maturity, 2 m² biomass cuts were collected to determine hand yield. Total biomass, harvest index and 1000 grain weights were measured and calculated from the 2 m² biomass samples. The header yield was collected from the remainder of the plots at harvest maturity.

Results

Grain yield

The header grain yield averaged 4.44 t/ha across all variety, sowing date and irrigation treatments. PBA Nasma[®] was the highest yielding variety (4.82 t/ha) and PBA Bendoc[®] had the lowest header yield (4.04 t/ha) (Table 5). A consistent trend was observed in the hand yields with PBA Nasma[®] as the highest yielding variety (6.25 t/ha) and PBA Bendoc[®] as the lowest yielding variety (5.45 t/ha). Hand cuts, although not representative of likely achievable yields in a header, demonstrated the maximum potential yield.

Table 5 Variety results averaged across all sowing dates and irrigation treatments in the Leeton Field Station faba bean experiment, 2020.

Variety	Machine yield (t/ha)	Hand yield (t/ha)	Total biomass (t/ha)	Harvest index	Grain weight (g/1000 grains)
PBA Nasma	4.82	6.25	12.82	0.49	744.3
PBA Marne	4.50	5.78	11.35	0.51	693.4
PBA Samira	4.40	5.76	12.42	0.47	732.5
PBA Bendoc	4.04	5.45	11.51	0.48	604.6
Average	4.44	5.81	12.03	0.49	693.7
I.s.d. (<i>P</i><0.05)	0.14	0.38	0.79	0.01	10.4

I.s.d. = least significant difference.

Early sowing (SD1) achieved the highest header yield (5.66 t/ha) and SD3 recorded the lowest header yield (3.39 t/ha) (Table 6). A similar trend was observed when measuring the hand harvested yield with the highest yield achieved in SD1 (6.35 t/ha) while SD3 recorded the lowest yield (5.30 t/ha).

Table 6 Sowing date results averaged across all variety and irrigation treatments in the Leeton Field Station faba bean experiment, 2020.

Sowing date	Machine yield (t/ha)	Hand yield (t/ha)	Total biomass (t/ha)	Harvest index	Grain weight (g/1000 grains)
SD1	5.66	6.35	13.77	0.46	691.1
SD2	4.27	5.78	11.96	0.49	697.0
SD3	3.39	5.30	10.34	0.52	693.0
Average	4.44	5.81	12.02	0.49	693.7
I.s.d. (<i>P</i><0.05)	0.12	0.38	0.76	0.01	n.s.

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

The irrigated treatments achieved a significantly higher header yield than the non-irrigated treatments when averaged across all varieties and sowing dates. The irrigated treatments averaged 5.09 t/ha while the non-irrigated treatments averaged 3.78 t/ha (Table 7). A similar trend was observed when measuring the hand yield with the irrigated treatments averaging 6.93 t/ha while the non-irrigated treatments recorded a significantly lower hand yield of 4.69 t/ha.

Table 7 Irrigation treatment results averaged across all variety and sowing date treatments in the Leeton Field Station faba bean experiment, 2020.

Irrigation treatment	Header yield (t/ha)	Hand yield (t/ha)	Total biomass (t/ha)	Harvest index	Grain weight (g/1000 grains)
Irrigated	5.09	6.93	14.35	0.48	739.7
Non-irrigated	3.78	4.69	9.70	0.49	647.7
Average	4.44	5.81	12.02	0.49	693.7
I.s.d. ($P < 0.05$)	0.09	0.24	0.48	n.s.	9.1

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

A significant interaction between the irrigation treatments and varieties was observed in header yields. PBA Nasma^ϕ achieved a significantly higher header yield than all other varieties in the irrigated treatments (5.73 t/ha) while PBA Bendoc^ϕ recorded a significantly lower header yield than all other varieties in the irrigated treatments (4.40 t/ha) (Table 8). There were no statistical differences observed in header yields in the non-irrigated treatments across all varieties.

Table 8 Header yield results for irrigation treatment × varieties (averaged across all sowing dates) in the Leeton Field Station faba bean experiment, 2020.

Treatment	Grain yield (t/ha)			
	PBA Nasma	PBA Marne	PBA Samira	PBA Bendoc
Irrigated	5.73	5.24	4.90	4.40
Non-irrigated	3.80	3.75	3.90	3.68
I.s.d. ($P < 0.05$)	0.20			

I.s.d. = least significant difference.

There was a significant interaction between the sowing dates and irrigation treatments for header yields. The irrigation treatments in SD1 achieved the highest header yields when averaged across all varieties (6.86 t/ha) and was significantly higher than all other treatments (Table 9). The non-irrigated treatments in SD3 recorded the lowest header yields when averaged across all varieties (3.07 t/ha).

Table 9 Header yield results for irrigation treatment × sowing date treatment (averaged across varieties) in the Leeton Field Station faba bean experiment, 2020.

Irrigation treatment	Grain yield (t/ha)		
	SD1	SD2	SD3
Irrigated	6.86	4.71	3.71
Non-irrigated	4.46	3.83	3.07
I.s.d. ($P < 0.05$)	0.17		

I.s.d. = least significant difference.

Total biomass

Total biomass averaged 12.03 t/ha across all variety, sowing date and irrigation treatments. PBA Nasma^ϕ achieved the highest average total biomass (12.82 t/ha) and PBA Marne^ϕ recorded the lowest average total biomass (11.35 t/ha) and was statistically similar in total biomass with PBA Bendoc^ϕ (Table 5).

SD1 achieved the highest total biomass (13.77 t/ha) and SD3 recorded the lowest total biomass (10.34 t/ha) (Table 6).

The irrigated treatments (14.35 t/ha) produced significantly more total biomass than the non-irrigated treatments (9.70 t/ha) when averaged across all varieties and sowing dates (Table 7).

Harvest index

Harvest index (HI) averaged 0.49 across all variety, sowing date and irrigation treatments. PBA Marne^{db} achieved the highest average HI (0.51) and PBA Samira^{db} recorded the lowest average HI (0.47) (Table 5).

SD3 achieved the highest average HI (0.52) and SD1 recorded the lowest average HI (0.46) (Table 6).

The irrigated treatment achieved a HI of 0.48, which was statistically similar to the non-irrigated treatment of 0.49 (Table 7) indicating that irrigation did not affect HI.

Grain weight

Grain weight averaged 693.7 g/1000 grains across all variety, sowing date and irrigation treatments. PBA Nasma^{db} achieved the highest average thousand grain weight (744.3 g) while PBA Bendoc^{db} recorded the lowest average thousand grain weight (604.6 g) (Table 5).

Sowing date did not affect grain weight.

The irrigated treatment achieved a significantly higher grain weight than the non-irrigated treatment when averaged across all varieties and sowing dates. The irrigated treatment averaged 739.7 g/1000 grains while the non-irrigated treatment averaged 647.7 g/1000 grains (Table 7).

Water use and irrigation efficiency

SD1 in the non-irrigated treatments achieved the highest average water use efficiency (2.70 t/ML) and SD3 in the irrigated treatments recorded the lowest average water use efficiency (1.05 t/ML) (Table 10).

Table 10 Water use efficiency for the three sowing dates (averaged across all varieties) in the Leeton Field Station faba bean experiment, 2020.

Treatments	Water use efficiency (t/ML)		
	SD1	SD2	SD3
Irrigated	1.94	1.33	1.05
Non-irrigated	2.70	2.32	1.86

SD1 achieved the highest irrigation efficiency of 1.51 t/ML with an average header yield increase of 2.41 t/ha, while SD3 recorded the lowest irrigation efficiency of 0.41 t/ML with an average header yield increase of 0.65 t/ha (Table 11).

Table 11 Irrigation efficiency for the three sowing dates (averaged across all varieties) in the Leeton Field Station faba bean experiment, 2020.

Treatments	SD1	SD2	SD3
Header yield increase from irrigation	2.41 t/ha	0.89 t/ha	0.65 t/ha
Irrigation quantity	1.60 ML/ha	1.60 ML/ha	1.60 ML/ha
Irrigation efficiency	1.51 t/ML	0.56 t/ML	0.41 t/ML

Summary

With the application of two spring irrigations, the irrigated treatments achieved a significantly higher header yield than the non-irrigated treatments for all three sowing dates. SD1 had the highest yield increase due to irrigation with a gain of 2.41 t/ha compared with the non-irrigated treatments. With 2.41 t/ha grain yield increase from the application of 1.6 ML of irrigation water, SD1 achieved an irrigation efficiency of 1.51 t/ML.

Sowing date had a significant effect on grain yield with average header yields significantly decreasing as the sowing date was delayed. In the irrigated treatments, header yields decreased from 6.86 t/ha to 3.71 t/ha when sowing was delayed by six weeks from 24 April to 5 June. In the non-irrigated treatments, header yields decreased from 4.64 t/ha to 3.07 t/ha when sowing was delayed by the same time period. Even though this experiment demonstrated that sowing faba bean on 24 April achieved the highest yield in the 2020 Leeton Field Station faba bean experiment, the sowing date is earlier than recommended for the Murrumbidgee Irrigation Area (MIA). This experiment will be repeated in 2021 to confirm any yield increase to the earlier sowing date for faba bean.

PBA Nasma[®] was the best performing variety, achieving the highest grain yield when averaged across sowing dates and irrigation treatments. PBA Nasma[®] achieved an average header grain yield of 5.73 t/ha in the irrigation treatments, which was more than any other variety. While there were significant yield differences between varieties in the irrigated treatments, there was no varietal differences observed for grain yield in the non-irrigated treatments.

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