

Caragabal site attributes

2024

Background

The Caragabal trial site was a sodic clay loam soil. Above average rain fell right through summer 2023/24 providing excellent seedbed moisture for the first sowing date. The soil was wet (sticky) for the second sowing date and with more rain post-sowing, establishment from the second sowing date was reduced. Late winter and spring rain was below average, but grain yield potential was high due to stored water from earlier rain. A frost event of -2.8°C was recorded on 16 September which impacted grain yield.

Weather data

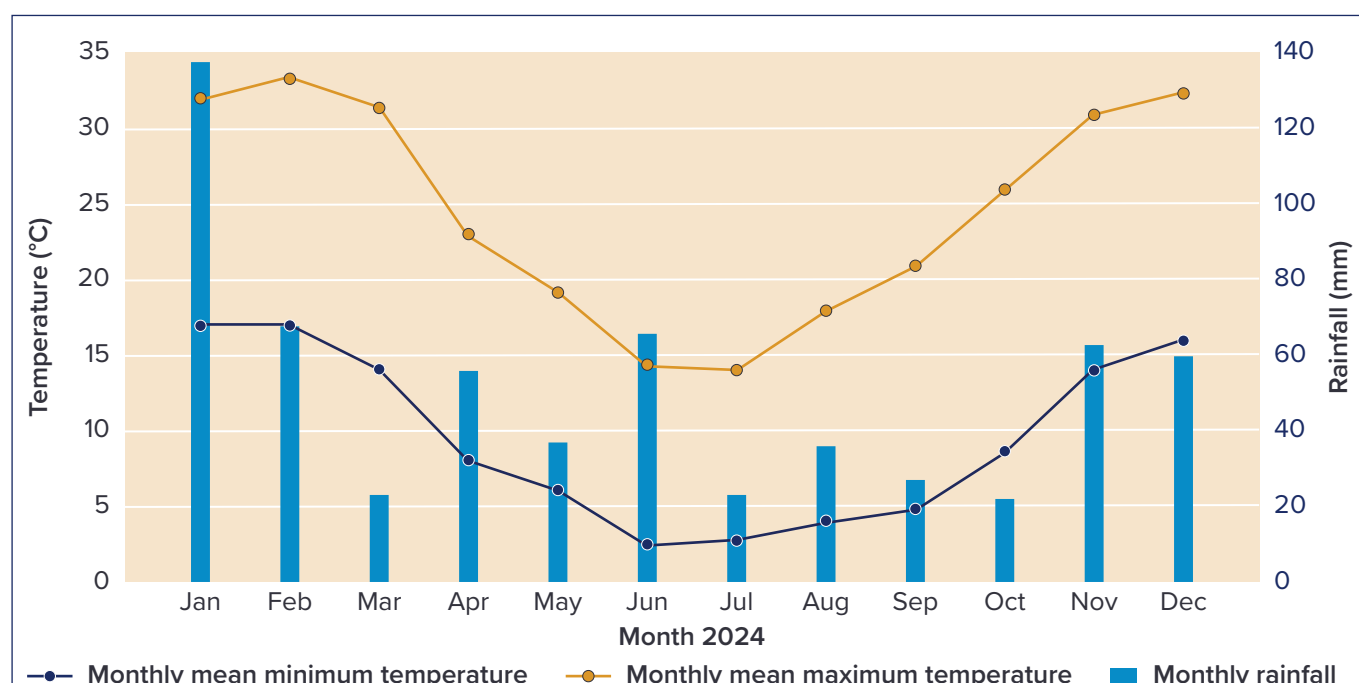


Figure 1: Monthly rainfall and mean minimum and maximum temperature at Caragabal in 2024.

Crop sequence and key management dates

Crop sequence			Key management dates 2024		
Year	Crop	Cultivar	Activity	Date	Comments
2023	Wheat	Scepter [®]	Sowing	23 April	Sowing date 1: chickpea, faba bean, field pea, lentil, lupin and vetch TOS trials
2022	Canola	Pioneer 44Y94 CL			Faba bean phosphorus management trial
2021	Wheat	Scepter [®]	Harvest	21 May	Sowing date 2: chickpea, faba bean, field pea, lentil, lupin and vetch TOS trials
				15 November	All faba beans, field peas, lentils and vetch
				5 December	All chickpeas and lupins

Soil characteristics

The soil was a clay loam with some acidity and sodicity in the soil surface. Both sodicity and pH increased with soil depth. The electrochemical stability index (ESI) was less than 0.05 in the top 10 cm, indicating that the soil is likely dispersive. The site had good background soil phosphorus fertility. There were 36 rhizobia/g soil from Group G/S (lupins and serradella), 78.7 rhizobia/g soil from Groups E/F (faba bean, field pea, lentil, vetch), with no chickpea rhizobia detected.

Table 1: Soil characteristics at Caragabal pulse site, sampled 30 April 2024.

Characteristic	Unit	Soil depth (cm)			
		0–5	5–10	10–15	15–20
pH [1:5 CaCl ₂]		4.78	5.02	5.44	5.88
Organic carbon	%	1.75	1.55	–	–
Phosphorus [Colwell]	mg/kg	56	54	–	–
Cation exchange capacity (CEC)	meq/100 g	12.6	15.0		
Exchangeable calcium (Ca)	%	55.6	50.5		
Exchangeable magnesium (Mg)	%	31.8	37.8		
Exchangeable potassium (K)	%	6.9	4.6		
Exchangeable sodium (Na)	%	4.9	6.8		
Exchangeable aluminium (Al)	%	0.4	0.1		
Exchangeable hydrogen (H)	%	0.5	0.3		
Salinity EC (1:)	dS/m	0.14	0.18		
Texture					
Sand	%	54.5	9.7		
Silt	%	21.8	22.8		
Clay	%	23.8	27.5		

Table 2: Soil nitrogen status at Caragabal pulse site, sampled 30 April 2024.

Characteristic	Unit	Soil depth (cm)				
		0–10	10–20	20–50	50–80	80–120
Nitrate (NO ₃) N (ppm)	mg/kg	12.8	7.2	2.1	3.9	1.2
Ammonium (NH ₄) N (ppm)	mg/kg	2	1.9	1.2	1.5	1.3



Waterlogging impacted crop establishment and subsequent growth of the second sowing date (21 May) trials, even in faba beans at Caragabal – 14 August 2024

Pulse species: variety x sowing date comparisons

Caragabal 2024

Key findings

- Establishment of all pulse species from early sowing (23 April) was good, but rain fell soon after the later sowing date (21 May) which reduced establishment of those plots. Plant counts are reported and need to be considered when comparing trial outcomes across sowing dates.

Chickpea variety by sowing date

- The average plant density for chickpeas was 37.3 plants/m² from the early sowing but reduced to 17.6 plants/m² from the later sowing.
- Peak biomass (mid-podding) was measured in CBA Captain[Ⓢ] and PBA HatTrick[Ⓢ]. The biomass of the two varieties was similar but early sowing resulted in more biomass (8.0 t/ha) than later sowing (4.4 t/ha).
- CBA Captain[Ⓢ] and PBA HatTrick[Ⓢ] yielded similarly, at or close to 2 t/ha. PBA Seamer[Ⓢ] and PBA Slasher[Ⓢ] were both lower yielding. There was no effect of sowing date on grain yield of chickpeas in this trial.
- Early sowing generally resulted in larger seed size, with 23 April sown PBA Seamer[Ⓢ] and CBA Captain[Ⓢ] having the largest seed (25.6 and 25.5 g/100 seeds).
- Grain nitrogen (N) concentration (CBA Captain[Ⓢ] and PBA HatTrick[Ⓢ]) averaged 3.5% and was unaffected by sowing date or variety.
- Plant available water (PAW) and soil mineral nitrogen were measured to a depth of 150 cm in January 2025 in CBA Captain[Ⓢ] plots. Soil nitrogen averaged 120 kg N/ha and PAW averaged 134 mm.

Faba bean variety by sowing date

- The average plant density for faba beans was 22 plants/m² from the early sowing but reduced to 8 plants/m² from the later sowing.
- Biomass of PBA Nasma[Ⓢ] and PBA Samira[Ⓢ] was similar, but early sowing resulted in more biomass (12.5 t/ha) than later sowing (6.5 t/ha).
- Grain yield of the early sowing (4.00 t/ha) was 2.32 t/ha higher than later the sowing (1.68 t/ha), with early sown PBA Nasma[Ⓢ] the highest at 4.22 t/ha. All varieties yielded at least 3.9 t/ha from the early sowing date, but each had a similar magnitude of yield loss from later sowing.
- Harvested seed size was larger from early sowing compared with the later sowing (65.9 g/100 seeds versus 58.4 g/100 seeds). PBA Samira[Ⓢ] had the largest seed (average 65.6 g/100 seeds) and FBA Ayla[Ⓢ] the smallest (average 57.8 g/100 seeds).
- Grain N concentration (PBA Nasma[Ⓢ] and PBA Samira[Ⓢ]) was unaffected by sowing date, averaging 4.7%.

- Plant available water (PAW) and soil mineral nitrogen were measured to a depth of 150 cm in January 2025 in PBA Samira[®] plots. Soil nitrogen averaged 132 kg N/ha and PAW averaged 101 mm.

Field pea variety by sowing date

- Biomass of field peas (PBA Butler[®]) was 7.2 t/ha from early sowing and 5.6 t/ha from later sowing (plant counts were not completed).
- Grain yield from later sowing was double the early sowing (2.44 versus 1.22 t/ha). All varieties had higher yield with delayed sowing, with APB Bondi[®] the highest at 3.2 t/ha. PBA Butler[®] and Sturt both yielded less than 2 t/ha from the later sowing date.
- Seed size was slightly larger from early sowing (20.8 v 19.3 g/100 seeds). APB Bondi[®] and PBA Taylor[®] had the largest seed from both sowing dates, and Sturt the smallest.
- Grain N concentration (PBA Butler[®] only) was 4.6% from early sowing and 4.2% from later sowing.

Lentil variety by sowing date

- The average plant density for lentils was 98.1 plants/m² from the early sowing but reduced to 66.1 plants/m² from the later sowing.
- Despite the reduced plant numbers from later sowing, biomass of lentils was higher from the later sowing date than the early sowing date (5.6 versus 3.3 t/ha).
- All varieties were heavily penalised by early sowing, with more than double the yield from the 21 May sowing (2.17 t/ha) compared with 23 April sowing (1.07 t/ha). GIA Thunder[®] was the highest yielding variety, yielding 2.62 t/ha from 21 May sowing date.
- Seed size was largest in PBA Kelpie XT[®], with an average (across sowing dates) of 4.5 g/100 seeds. Seed was slightly larger from early sowing than later sowing (4.0 versus 3.8 g/100 seeds).
- Grain N concentration (measured in PBA Hallmark XT[®] and PBA Kelpie XT[®]) was unaffected by sowing date, averaging 4.5%.
- Plant available water (PAW) and soil mineral nitrogen were measured to a depth of 150 cm in January 2025 in PBA Hallmark XT[®] plots. Soil nitrogen averaged 126 kg N/ha and PAW averaged 99 mm.

Lupin variety by sowing date

- Early sown lupins (on average) achieved above 90% of their plant population target (40 plants/m²), but establishment from the 21 May sowing date was reduced to 18.4 plants/m² (45% of target). Establishment of albus lupins was lower than narrow-leaf lupins from the later sowing date (12 v 25 plants/m²).
- Early sowing resulted in higher biomass of both Luxor[®] and PBA Bateman[®], with 6.9 t/ha versus 4.0 t/ha from later sowing. PBA Bateman[®] narrow-leaf lupins had an average of ~70% more biomass than Luxor[®].
- Due to variability caused by early waterlogging, there were minimal yield differences between treatments with an average of 1.52 t/ha.
- Seed size was generally larger from early sowing. Albus lupin varieties

Luxor[♢] and Murringo[♢] had approximately double the seed size of narrowleaf varieties Mandelup[♢] and PBA Bateman[♢].

- Luxor[♢] (albus) had an average N concentration of 6.0%, while PBA Bateman[♢] (narrowleaf) had an average of 5.4%.

Vetch variety by sowing date

- Early sown vetch had ~65% of target establishment (60 plants/m²), which was reduced to ~30% in the later sowing date. All varieties had lower establishment from later sowing.
- Biomass of vetch (Timok[♢]) was higher from early sowing (11.1 t/ha) than later sowing (9.4 t/ha).
- Grain yield of vetch was unaffected by sowing date. Morava was the highest yielding variety (2.91 t/ha) and Volga[♢] the lowest yielding variety (1.47 t/ha).
- Seed size was unaffected by sowing date. Volga[♢] had the largest seed (8.3 g/100 seeds) and Rasina the smallest seed (6.4 g/100 seeds).
- Grain N concentration (measured in Timok[♢]) averaged 4.9%.

Trial details

Six separate pulse variety trials (chickpea, faba bean, field pea, lentil, lupin and vetch) each with 4 varieties and 2 sowing dates were conducted at Caragabal on a sodic clay loam soil. The first sowing date was 23 April and the second date 21 May. All varieties were harvested for grain and assessed for seed size (hundred seed weight). Select varieties from each trial had further samples taken to determine peak biomass and nitrogen fixation, and grain nitrogen concentration to determine overall nitrogen balance of the different varieties and species.

Table 1: Trial management of the pulse species and varieties x sowing time trials at Caragabal in 2024.

Management	2024
Sowing dates	Sowing date 1: 23 April Sowing date 2: 21 May
Starter fertiliser	MAP (10% nitrogen, 21.9% phosphorus, 1.5% sulphur, 1.6% calcium) @ 113 kg/ha
Pre-emergent herbicide	Pre-sowing: Simazine 900 @ 500 g/ha + Reflex® @ 0.9 L/ha
Sowing rate	Calculated from seed size for target plant population, see Table 2

Table 2: Varieties and target plant population for each sowing date trial at Caragabal in 2024.

Trial	Target plant population (plant/m ²)	Variety			
Chickpea	40	CBA Captain [♢]	PBA HatTrick [♢]	PBA Seamer [♢]	PBA Slasher [♢]
Faba bean	25	FBA Ayla [♢]	PBA Amberley [♢]	PBA Nasma [♢]	PBA Samira [♢]
Field pea	40	APB Bondi [♢]	PBA Butler [♢]	PBA Taylor [♢]	Sturt
Lentil	120	ALB Terrier [♢]	GIA Thunder [♢]	PBA Hallmark XT [♢]	PBA Kelpie XT [♢]
Lupin	40	Luxor [♢]	Mandelup [♢]	Murringo [♢]	PBA Bateman [♢]
Vetch	60	Morava	Rasina	Timok [♢]	Volga [♢]

[♢] Varieties displaying this symbol beside them are protected under the Plant Breeders Rights Act 1994.

Results

Chickpea

Table 3: Plant establishment on 27 June of four chickpea varieties sown on two dates at Caragabal in 2024.

Variety	Establishment plant density (plants/m ²)		
Sowing date	23 April	21 May	Variety average
CBA Captain	43.0	25.5	34.3
PBA HatTrick	34.4	19.6	27.0
PBA Seamer	37.4	14.3	25.8
PBA Slasher	34.4	10.9	22.6
Sow date average	37.3	17.6	
I.s.d. ($P = 0.05$) sow date	5.07		
I.s.d. ($P = 0.05$) variety	4.38		
I.s.d. ($P = 0.05$) variety $\times$ sow date	n.s.		

n.s. = not significantly different

Table 4: Peak biomass of CBA Captain[Ⓛ] and PBA HatTrick[Ⓛ] chickpeas sown on two dates at Caragabal in 2024.

Variety	Peak biomass (t/ha)		
Sowing date	23 April	21 May	Variety average
CBA Captain	7.9	4.7	6.3
PBA HatTrick	8.0	4.1	6.1
Sow date average	8.0	4.4	
I.s.d. ($P = 0.05$) sow date	2.8		
I.s.d. ($P = 0.05$) variety	n.s.		
I.s.d. ($P = 0.05$) variety $\times$ sow date	n.s.		

n.s. = not significantly different

Table 5: Grain yield of four chickpea varieties sown on two dates at Caragabal in 2024.

Variety	Grain yield (t/ha)		
Sowing date	23 April	21 May	Variety average
CBA Captain	2.0	2.1	2.0
PBA HatTrick	1.9	2.0	1.9
PBA Seamer	1.4	1.6	1.5
PBA Slasher	1.3	1.3	1.3
Sow date average	1.7	1.7	
I.s.d. ($P = 0.05$) sow date	n.s.		
I.s.d. ($P = 0.05$) variety	0.37		
I.s.d. ($P = 0.05$) variety $\times$ sow date	n.s.		

n.s. = not significantly different

Table 6: Harvested seed size (hundred seed weight) of four chickpea varieties sown on two dates at Caragabal in 2024.

Variety	Seed size (g/100 seeds)		
Sowing date	23 April	21 May	Variety average
CBA Captain	25.5	22.2	23.8
PBA HatTrick	23.2	22.0	22.6
PBA Seamer	25.6	22.2	23.9
PBA Slasher	22.9	19.9	21.4
Sow date average	24.3	21.6	
I.s.d. (<i>P</i> = 0.05) sow date	1.4		
I.s.d. (<i>P</i> = 0.05) variety	1.3		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Faba bean

Table 7: Plant establishment on 27 June of four faba bean varieties sown on two dates at Caragabal in 2024.

Variety	Establishment plant density (plants/m²)		
Sowing date	23 April	21 May	Variety average
FBA Ayla	20.9	9.9	15.4
PBA Amberley	21.5	7.0	14.3
PBA Nasma	24.5	10.5	17.5
PBA Samira	21.3	4.8	13.0
Sow date average	22.0	8.0	
I.s.d. (<i>P</i> = 0.05) sow date	5.48		
I.s.d. (<i>P</i> = 0.05) variety	2.93		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Table 8: Peak biomass of PBA Nasma[Ⓛ] and PBA Samira[Ⓛ] faba beans sown on two dates at Caragabal in 2024.

Variety	Peak biomass (t/ha)		
Sowing date	23 April	21 May	Variety average
PBA Nasma	11.9	6.5	9.2
PBA Samira	13.2	6.4	9.8
Sow date average	12.5	6.5	
I.s.d. (<i>P</i> = 0.05) sow date	1.5		
I.s.d. (<i>P</i> = 0.05) variety	n.s.		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Table 9: Grain yield of four faba bean varieties sown on two dates at Caragabal in 2024.

Variety	Grain yield (t/ha)		
Sowing date	23 April	21 May	Variety average
FBA Ayla	3.94	1.81	2.87
PBA Amberley	3.90	1.49	2.69
PBA Nasma	4.22	1.99	3.11
PBA Samira	3.94	1.45	2.69
Sow date average	4.00	1.68	
I.s.d. (<i>P</i> = 0.05) sow date	0.98		
I.s.d. (<i>P</i> = 0.05) variety	0.28		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Table 10: Harvested seed size (hundred seed weight) of four faba bean varieties sown on two dates at Caragabal in 2024.

Variety	Seed size (g/100 seeds)		
Sowing date	23 April	21 May	Variety average
FBA Ayla	61.5	54.1	57.8
PBA Amberley	66.3	59.4	62.8
PBA Nasma	65.8	59.1	62.4
PBA Samira	70.1	61.1	65.6
Sow date average	65.9	58.4	
I.s.d. (<i>P</i> = 0.05) sow date	3.75		
I.s.d. (<i>P</i> = 0.05) variety	2.15		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Field pea

Table 11: Grain yield of four field pea varieties sown on two dates at Caragabal in 2024.

Variety	Grain yield (t/ha)		
Sowing date	23 April	21 May	Variety average
APB Bondi	1.52	3.20	2.36
PBA Butler	0.74	1.85	1.29
PBA Taylor	1.17	2.87	2.02
Sturt	1.47	1.86	1.67
Sow date average	1.22	2.4	
I.s.d. (<i>P</i> = 0.05) sow date	0.30		
I.s.d. (<i>P</i> = 0.05) variety	0.73		
I.s.d. (<i>P</i> = 0.05) variety × sow date	0.96		

Table 12: Harvested seed size (hundred seed weight) of four field pea varieties sown on two dates at Caragabal in 2024.

Variety	Seed size (g/100 seeds)		
Sowing date	23 April	21 May	Variety average
APB Bondi	23.8	21.0	22.4
PBA Butler	18.6	18.1	18.4
PBA Taylor	23.8	22.5	23.1
Sturt	17.2	15.7	16.5
Sow date average	20.8	19.3	
I.s.d. (<i>P</i> = 0.05) sow date	0.58		
I.s.d. (<i>P</i> = 0.05) variety	0.73		
I.s.d. (<i>P</i> = 0.05) variety × sow date	0.96		

Lentil

Table 13: Plant establishment on 27 June of four lentil varieties sown on two dates at Caragabal in 2024.

Variety	Establishment plant density (plants/m²)		
Sowing date	23 April	21 May	Variety average
ALB Terrier	103.5	63.8	83.6
GIA Thunder	86.0	64.0	75.0
PBA Hallmark XT	109.8	74.2	92.0
PBA Kelpie XT	93.2	62.5	77.9
Sow date average	98.1	66.1	
I.s.d. (<i>P</i> = 0.05) sow date	8.0		
I.s.d. (<i>P</i> = 0.05) variety	10.5		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Table 14: Grain yield of four lentil varieties sown on two dates at Caragabal in 2024.

Variety	Grain yield (t/ha)		
Sowing date	23 April	21 May	Variety average
ALB Terrier	0.89	2.33	1.61
GIA Thunder	1.59	2.62	2.10
PBA Hallmark XT	1.26	1.97	1.61
PBA Kelpie XT	0.56	1.77	1.17
Sow date average	1.07	2.17	
I.s.d. (<i>P</i> = 0.05) sow date	0.39		
I.s.d. (<i>P</i> = 0.05) variety	0.33		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Table 15: Harvested seed size (hundred seed weight) of four lentil varieties sown on two dates at Caragabal in 2024.

Variety	Seed size (g/100 seeds)		
Sowing date	23 April	21 May	Variety average
ALB Terrier	3.8	3.6	3.7
GIA Thunder	3.8	3.6	3.7
PBA Hallmark XT	3.9	3.7	3.8
PBA Kelpie XT	4.6	4.5	4.5
Sow date average	4.0	3.8	
I.s.d. (<i>P</i> = 0.05) sow date	0.17		
I.s.d. (<i>P</i> = 0.05) variety	0.09		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Lupin

Table 16: Plant establishment on 27 June of four lupin varieties sown on two dates at Caragabal in 2024.

Variety	Establishment plant density (plants/m²)		
Sowing date	23 April	21 May	Variety average
Luxor	34.1	13.1	23.6
Mandelup	37.0	29.3	33.1
Murringong	34.0	10.9	22.4
PBA Bateman	41.1	20.4	30.8
Sow date average	36.6	18.4	
I.s.d. (<i>P</i> = 0.05) sow date	5.12		
I.s.d. (<i>P</i> = 0.05) variety	3.55		
I.s.d. (<i>P</i> = 0.05) variety × sow date	5.60		

Table 17: Peak biomass of Luxor^{db} and PBA Bateman^{db} lupins sown on two dates at Caragabal in 2024.

Variety	Peak biomass (t/ha)		
Sowing date	23 April	21 May	Variety average
Luxor	5.2	2.8	4.0
PBA Bateman	8.6	5.2	6.9
Sow date average	6.9	4.0	
I.s.d. (<i>P</i> = 0.05) sow date	1.29		
I.s.d. (<i>P</i> = 0.05) variety	1.36		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Table 18: Grain yield of four lupin varieties sown on two dates at Caragabal in 2024.

Variety	Grain yield (t/ha)		
Sowing date	23 April	21 May	Variety average
Luxor	1.38	1.60	1.49
Mandelup	1.26	2.11	1.69
Murringo	2.04	1.18	1.61
PBA Bateman	1.25	1.36	1.30
Sow date average	1.48	1.56	
I.s.d. (<i>P</i> = 0.05) sow date	n.s.		
I.s.d. (<i>P</i> = 0.05) variety	n.s.		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Table 19: Harvested seed size (hundred seed weight) of four lupin varieties sown on two dates at Caragabal in 2024.

Variety	Seed size (g/100 seeds)		
Sowing date	23 April	21 May	Variety average
Luxor	38.8	26.4	32.3
Mandelup	17.4	14.7	16.1
Murringo	36.1	25.8	30.9
PBA Bateman	18.2	15.4	16.8
Sow date average	27.6	20.6	
I.s.d. (<i>P</i> = 0.05) sow date	3.45		
I.s.d. (<i>P</i> = 0.05) variety	4.40		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Vetch

Table 20: Plant establishment on 27 June of four vetch varieties sown on two dates at Caragabal in 2024.

Variety	Establishment plant density (plants/m²)		
Sowing date	23 April	21 May	Variety average
Morava	34.1	13.1	23.6
Rasina	41.1	20.4	30.8
Timo	34.0	10.9	22.4
Volga	37.0	29.3	33.1
Sow date average	36.6	18.4	
I.s.d. (<i>P</i> = 0.05) sow date	5.12		
I.s.d. (<i>P</i> = 0.05) variety	3.55		
I.s.d. (<i>P</i> = 0.05) variety × sow date	5.60		

Table 21: Grain yield of four vetch varieties sown on two dates at Caragabal in 2024.

Variety	Grain yield (t/ha)		
Sowing date	23 April	21 May	Variety average
Morava	2.67	3.16	2.91
Rasina	2.15	2.96	2.56
Timok	2.10	2.59	2.34
Volga	1.06	1.88	1.47
Sow date average	1.48	1.56	
I.s.d. (<i>P</i> = 0.05) sow date	n.s.		
I.s.d. (<i>P</i> = 0.05) variety	0.52		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

Table 22: Harvested seed size (hundred seed weight) of four vetch varieties sown on two dates at Caragabal in 2024.

Variety	Seed size (g/100 seeds)		
Sowing date	19 April	21 May	Variety average
Morava	6.9	6.6	6.8
Rasina	6.7	6.2	6.4
Timok	7.2	7.2	7.2
Volga	8.2	8.3	8.3
Sow date average	7.2	7.1	
I.s.d. (<i>P</i> = 0.05) sow date	n.s.		
I.s.d. (<i>P</i> = 0.05) variety	0.24		
I.s.d. (<i>P</i> = 0.05) variety × sow date	n.s.		

n.s. = not significantly different

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