



Effect of Planting at Different Spacings on the Growth and Yield of Faba Bean

Israa A. K. Al-Khafaji¹, Ali R. Alhasany² and Nasser H. Muhaibis³

123 Department of Field Crops, College of Agriculture, Al-Muthanna University, Al-Muthana, Iraq

1E-mail: agr.grad.israa.a24@mu.edu.iq

2 E-mail: Ali-raheem2002@mu.edu.iq

3 E-mail: naserhabeeb32@gmail.com

Abstract

A field experiment was conducted in Al-Muthanna Governorate during the 2024–2025 winter season on a private farmer's land to study the effect of row spacing (55, 65, and 75 cm) and plant spacing (15, 20, 25, and 30 cm) on vegetative growth and yield traits of faba beans. The experiment followed a split-plot arrangement within a randomized complete block design (RCBD) with three replications. Row spacing treatments were assigned to the main plots, while plant spacing treatments were allocated to the sub-plots. The results indicated that increasing row spacing had a significant effect on chlorophyll content in the leaves. The 75 cm row spacing recorded the highest average SPAD value of 50.35, while the 55 cm spacing gave the lowest at 46.88. Narrow row spacing (55 cm) resulted in the highest values for leaf area index, seed yield, and biological yield, reaching 6.56, 4.64, and 22.13 tons ha⁻¹, respectively. In contrast, the widest spacing (75 cm) recorded the lowest averages at 4.03, 2.96, and 16.87 tons ha⁻¹, respectively. Row spacing had no significant effect on fertilization rate or protein content. For plant spacing, 30 cm produced the highest chlorophyll content (50.16 SPAD), while 15 cm gave the lowest (46.22 SPAD). However, the closest spacing (15 cm) resulted in the highest leaf area index and biological yield (6.22 and 25.09 tons ha⁻¹), whereas 30 cm spacing showed the lowest values (3.58 and 13.46 tons ha⁻¹). The 25 cm spacing gave the highest seed yield (4.97 tons ha⁻¹), while 30 cm recorded the lowest (2.34 tons ha⁻¹). Fertilization rate peaked at 25 cm spacing with 10.42%, though this was not statistically significant. In terms of interaction, the combination of 55 cm (row) × 15 cm (plant) produced the highest leaf area index (9.56), while 55 cm × 25 cm resulted in the highest seed yield (5.91 tons ha⁻¹). Additionally, the 65 cm × 25 cm combination gave the highest harvest index at 41.53%.

Keywords: Faba bean, plant spacing, row spacing.

Introduction

Faba bean (*Vicia faba* L.) is considered one of the most important winter legume crops due to its high nutritional value and significant

role in improving soil fertility. This improvement occurs through its symbiotic relationship with *Rhizobium* spp., which enables the plant to fix atmospheric nitrogen. The seeds of faba bean are rich in plant-based

protein and essential nutrients such as iron, magnesium, and dietary fiber, making them beneficial for both human and animal nutrition[1]. With the growing global demand for plant proteins amid environmental and economic challenges, researchers have focused on enhancing the productivity of faba bean by improving agronomic practices. Among these, plant density and spacing between rows and plants are crucial, as they have a direct influence on plant growth, flowering, and yield components[2]. Environmental factors, particularly climate change and fluctuating temperatures, significantly impact plant development, thus requiring adaptive agricultural strategies. Despite ongoing research to improve faba bean productivity, achieving food security remains a challenge, especially in regions suffering from soil degradation and water scarcity. One agronomic practice that has shown promise is optimizing the distance between plants and rows, which improves light interception, reduces competition, and enhances vegetative growth, ultimately improving both yield quantity and quality. Selecting the optimal plant spacing is essential to reduce intra-specific competition for water, nutrients, and light[3]. While high plant density can lead to intense competition and limited growth, optimal spacing allows for better resource utilization and canopy development. “This study aims to investigate the effect of plant density on the growth and yield of faba bean.”.

Material and Methods

A field experiment was conducted in Al-Muthanna Governorate during the 2024–2025 winter season on farmland belonging to a local farmer in the eastern orchards, located approximately 2 km from the city center (longitude: 31.312184° E, latitude: 45.2845512° N). The study aimed to evaluate the impact of three row spacings (55, 65, and 75 cm) and four plant spacings (15, 20, 25, and 30 cm) on the growth performance of faba bean (*Vicia faba* L.). The experimental layout

followed a split-plot arrangement within a randomized complete block design (RCBD) with three replications. Row spacing treatments were assigned to the main plots, while plant spacing treatments occupied the subplots. Each experimental unit measured 3 × 2.5 meters.

Standard agronomic practices were applied, including soil preparation, crop management, weed control as needed, and fertilization according to recommended guidelines.

Data Collection Procedures:

Chlorophyll Content: Measured during the flowering stage, prior to pod formation, using a SPAD chlorophyll meter. Five plants were randomly selected from the central rows of each plot, and readings were taken from five leaflets per plant. The values were averaged to represent the plot's chlorophyll level.

Leaf Area Index (LAI): Calculated using the formula:

$$\text{LAI} = \frac{\text{Leaf Area}}{\text{Area Occupied by One Plant}}$$

Fertilization Percentage: Determined by tagging five randomly selected plants per plot and counting the total number of flowers per plant. The percentage was calculated as:

$$\text{Effective Fertilization Percentage} = \frac{\text{Number of Pods per Plant}}{\text{Total Number of Flowers per Plant}} \times 100$$

Total Seed Yield: Ten plants from the central rows of each plot were harvested. Seeds were removed from pods, cleaned, dried to a suitable moisture content, and weighed. The average weight per plant was multiplied by the plant density in each plot and converted to tons per hectare.

Biological Yield: Determined from the average dry weight of five randomly chosen plants from the two middle rows of each plot after

complete drying of above-ground plant parts. This value was multiplied by plant density and expressed as tons per hectare.

Protein Percentage: Analyzed in the laboratory using standard procedures.

Table.1 Shows the physical and chemical properties of the table footnote

Soil Property		Value	Unit
pH		7.37	
E.C (1:1)		4.6	dS/m
Available Nitrogen		10	mg/kg soil ⁻¹
Available Potassium		243	
Available Phosphorus		13.05	
Soil Separates	Clay	34.37	%
	Silt	59.38	%
	Sand	6.25	%
Soil Texture		Silty loam	

The soil was analysed in the Soil Sciences and Water Resources Laboratory, College of Agriculture, University of Basrah

Results and Discussion

1. Chlorophyll Content (SPAD)

The results in Table 2 show that row spacing had a significant effect on leaf chlorophyll content. The widest spacing (75 cm) recorded the highest SPAD value (50.35), which was significantly greater than the values recorded at 65 cm (48.18) and 55 cm (46.88). The latter two spacings did not differ significantly from each other. The higher chlorophyll content at wider row spacing may be attributed to reduced shading among plants, allowing more sunlight to reach the leaves,

thus enhancing photosynthesis and promoting better chloroplast arrangement, in agreement with [4].

Plant spacing also had a significant effect. A spacing of 30 cm between plants produced the highest SPAD value (50.15), significantly higher than 25 cm (47.96), 20 cm (48.45), and 15 cm (47.59). The wider spacing likely provided better air circulation and reduced competition for light and nutrients, leading to improved gas exchange and photosynthetic activity, as supported by [5]. No significant interaction was found between row spacing and plant spacing for this trait.

Table.2 Effect of Row Spacing, Plant Spacing, and Their Interaction on Leaf Chlorophyll Content (SPAD Value)

Distance between lines A (cm)	Distance between plants B (cm)				Average Distance between lines A
	15	20	25	30	
55	42.78	48.22	50.22	48.31	47.38
65	46.56	46.82	48.56	49.43	47.84
75	49.32	49.56	50.70	52.74	50.58
Average Distance between plants B	46.22	48.20	49.83	50.16	
L.S.D(0.05)	Distance between lines		Distance between plant		Interaction
	1.19		2.27		N.S

2. Leaf Area (cm²):

The results presented in Table 2 indicate that different row spacings did not significantly influence leaf area. However, significant differences were observed among plant spacing treatments. The 25 cm spacing between plants resulted in the highest leaf area with a mean value of 9408 cm², whereas the 15 cm spacing recorded the lowest value (5812 cm²). This increase in leaf area at 25 cm spacing may be attributed to better light penetration and improved air circulation

among plants, reducing competition for nutrients and thereby enhancing leaf expansion [10]. These findings are consistent with previous studies [11,13], which also reported that wider plant spacing improves leaf area. Moreover, the interaction between row and plant spacing was significant. The combination of 75 cm row spacing and 25 cm plant spacing produced the highest leaf area (11226 cm²), while the combination of 65 cm × 15 cm resulted in the lowest value (4478 cm²).

Table.3 Impact of Line and Plant Distances and Their Interaction on Leaf Area (cm²)

Distance between lines A (cm)	Distance between plants B (cm)				Average Distance between lines A
	15	20	25	30	
55	7886	6320	9410	6782	7600
65	4478	7615	7587	8196	6969
75	5071	4777	11226	5452	6631
Average Distance between plants B	5812	6237	9408	6810	
L.S.D(0.05)	Distance between lines		Distance between plant		Interaction
	N.S		1175.3		1853.1

3 . Fertilization Percentage (%):

As shown in Table 3, row spacing had no significant effect on fertilization percentage. However, plant spacing showed a significant influence. The 25 cm spacing recorded the highest fertilization rate of 10.42%, while the 15, 20, and 30 cm spacings resulted in lower values of 7.27%, 7.06%, and 7.47%, respectively. This increase in fertilization

percentage at the 25 cm spacing could be due to enhanced plant growth, which led to more efficient flower development and pod setting. Reduced interplant competition for essential growth elements like light, nutrients, and moisture may have contributed to this outcome [14]. These results are in agreement with previous findings [11]. The interaction between row and plant spacing had no significant effect on fertilization rate.

Table.4 Impact of Line and Plant Distances and Their Interaction on Fertilization Percentage (%)

Distance between lines A (cm)	Distance between plants B (cm)				Average Distance between lines A
	15	20	25	30	
55	6.66	6.68	10.06	7.52	7.73
65	7.39	8.38	11.13	7.66	8.64
75	7.77	6.11	10.08	8.04	8.00
Average Distance between plants B	7.27	7.06	10.42	7.74	
L.S.D(0.05)	Distance between lines		Distance between plant		Interaction
	N.S		1.55		N.S

4. Total Seed Yield (tons ha⁻¹):

As shown in Table (5), there was a significant effect of narrower row spacing, where the 55 cm spacing recorded the highest mean yield of 4.64 tons ha⁻¹. This value was not significantly different from the 65 cm spacing, which yielded an average of 3.89 tons ha⁻¹, whereas the 75 cm spacing resulted in the lowest mean yield of 2.96 tons ha⁻¹. The superiority of the narrower spacing between rows may be attributed to the higher number of plants per unit area (increased plant density), which compensated for the reduction in yield components at the individual plant level, ultimately leading to an increase in the total seed yield. These findings are consistent with those reported by [13, 14].

Similarly, when considering different plant spacings within the row, the 25 cm spacing produced the highest mean yield of

4.97 tons ha⁻¹, which was significantly higher than the yields obtained from the 15, 20, and 30 cm spacings (3.92, 4.10, and 2.34 tons ha⁻¹, respectively). The increase in seed yield at the 25 cm spacing could be attributed to a higher fertilization rate (Table 4), which positively influenced the number of pods per plant—a key yield component—thereby enhancing total seed yield. These results differ from those of [15], who reported that closer plant spacing results in the highest mean yields. Regarding the interaction between the two factors, the combination of 55 cm row spacing and 25 cm plant spacing yielded the highest mean value for this trait, reaching 5.91 tons ha⁻¹. In contrast, the combination of 75 cm row spacing with 30 cm plant spacing resulted in the lowest mean yield of 1.45 tons ha⁻¹. This could be due to the combined superiority of both individual factors when applied together for this trait.

Table.5 Effect of row spacing, plant spacing, and their interaction on total seed yield (tons ha⁻¹)

Distance between lines A (cm)	Distance between plants B (cm)				Average Distance between lines A
	15	20	25	30	
55	5.80	4.68	5.91	2.16	4.64
65	2.78	4.02	5.37	3.40	3.89
75	3.18	3.59	3.63	1.45	2.96
Average Distance between plants B	3.92	4.10	4.97	2.34	
L.S.D(0.05)	Distance between lines		Distance between plant		Interaction
	1.18		0.63		1.33

5. Biological Yield (tons ha⁻¹):

The results in Table (6) revealed a significant increase in biological yield with narrower row spacing, where the 55 cm spacing produced the highest mean value of 22.13 tons ha⁻¹. This was significantly higher than the yields obtained at the 65 cm and 75 cm spacings, which recorded the lowest means of 16.99 and 16.87 tons ha⁻¹, respectively. This increase may be attributed to the superiority of this spacing in total seed yield (Table 5), which in turn led to an increase in biological yield. These findings differ from

those reported by [16, 17], who indicated in their experiments that wider row spacing increases biological yield. Similarly, plant spacing had a significant effect on this trait, where the 15 cm spacing recorded the highest mean value of 25.09 tons ha⁻¹. This was significantly higher than the yields obtained at the 20, 25, and 30 cm spacings, which recorded lower means of 19.10, 17.01, and 13.46 tons ha⁻¹, respectively. The increase at the 15 cm spacing may be attributed to its superiority in total seed yield (Table 5), which consequently led to a higher biological yield. These results are consistent with those of [18,

19], who reported that narrower plant spacing increases biological yield.

In contrast, the interaction between the two factors had no statistically significant effect on this trait.

Table.6 Effect of row spacing, plant spacing, and their interaction on biological yield (tons ha⁻¹)

Distance between lines A (cm)	Distance between plants B (cm)				Average Distance between lines A
	15	20	25	30	
55	27.17	25.75	21.10	14.51	22.13
65	24.47	16.67	13.22	13.58	16.99
75	23.61	14.89	16.71	12.28	16.87
Average Distance between plants B	25.09	19.10	17.01	13.46	
L.S.D(0.05)	Distance between lines		Distance between plant		Interaction
	4.22		2.97		N.S

6. Protein percentage (%):

spacings, plant spacings, or their interaction on the protein percentage.

The results in Table (7) indicated that there was no significant effect of different row

Table.7 Effect of row spacing, plant spacing, and their interaction on protein percentage (%).

Distance between lines A (cm)	Distance between plants B (cm)				Average Distance between lines A
	15	20	25	30	
55	25.46	23.55	23.21	24.80	24.26
65	24.47	24.08	22.02	24.50	23.77
75	22.41	23.97	22.18	22.80	22.84
Average Distance between plants B	24.11	23.87	22.47	24.03	
L.S.D(0.05)	Distance between lines		Distance between plant		Interaction
	N.S		N.S		N.S

References

- 1- El-Bassiony, A. M., Fawzy, Z. F., & Bakry, B. A. (2021). Effect of organic and mineral fertilization on growth, yield and quality of faba bean (*Vicia faba* L.). *Journal of Plant Production*, 12(2), 141–148.
- 2- Mahmoud, A. R., El-Gayar, S. H., & Khalil, M. S. (2025). Interactive effects of temperature variation and sowing depth on germination and early growth of faba bean (*Vicia faba* L.). *Environmental and Experimental Botany*, 205, 105234.
- 3- Al-Ani, L. J., & Abdulhameed, Z. A. (2017). Response of several faba bean genotypes to planting densities. *Al-Anbar Journal of Agricultural Sciences*, 15(1), 83–94.
- 4- Al-Dulaimi, N. A. H. (2024). The effect of plant spacing on the growth and yield of introduced field pistachio genotypes (Master's thesis, University of Anbar, Iraq).

- 5- Lahmoud, Ahmed Mohamed , Wafaa M Laftta.(2022). Effect of planting distances and phosphate fertilization on two cultivars of broad bean (Vicia faba L .) . International Journal of Aquatic Science , 13(1):379-393.
- 6- Payne, R. W., Murray, D. A., Harding, S. A., Baird, D. B., & Soutar, D. M. (2024). GenStat for Windows (21st Edition).
- 7- Al-Rubaie, Q. M., Salman, R. A., & Naser, H. T. (2025). The role of plant spacing in reducing flower drop and improving yield components of faba bean (Vicia faba L.). Journal of Crop Science and Biotechnology, 28(4), 301–308.
- 8- Central Statistical Organization. (2023). Crop and vegetable production report for 2023. Ministry of Planning, Iraq.
- 9- Hassanein, A. M., Al-Hawary, M. A., & Saafan, S. F. (2021). Principles of field crop production. Faculty of Agriculture, Al-Azhar University.
- 10- Masa , Maguje , Tamado Tana Abdulatif .(2017) . Effect of Plant Spacing on Yield and Yield Related Traits of Common Bean (Phaseolus vulgaris L.) Varieties at Areka, Southern Ethiopia . Plant Biol Soil Health , 4(2);1-13 .
- 11- Gasim, S., & Abdelmula, A. (2018). Impact of bee pollination on yield of faba bean (Vicia faba L.) grown under semi-arid conditions. Agricultural Sciences, 9(6), 729–740 .
- 12- Wali, A. M. A. (2016). Improved methods for predicting leaf area in faba bean (Vicia faba L.). Tikrit Journal of Pure Sciences, 21(4), 1–5.
- 13-] Zhang, Y., El-Mehy, D. A., & Hassan, M. M. (2025). Impact of environmental stress on flowering and pod development in faba bean (Vicia faba L.). Legume Research, 48(3), 215–222. Zhang, Y., El-Mehy, D. A., & Hassan, M. M. (2025). Impact of environmental stress on flowering and pod development in faba bean (Vicia faba L.). Legume Research, 48(3), 215–222.
- 14- Alatawi, M. J., Alhajoj, Y. A. A., & Abdullah, R. M. (2024). Evaluation of the performance of several cultivars of bean (Vicia faba L.) for yield and its components under three different cultivation distances. Tikrit Journal for Agricultural Sciences, 24(3), 256–266.
- 15- Hussein, R. A., Al-Janabi, S. M., & Abbas, A. H. (2025). Response of faba bean (Vicia faba L.) cultivars to planting dates under changing climatic conditions. Plant Production Science, 28(2), 134–142.
- 16- Omar, S. K., Al-Khafaji, E. A., & Jasim, H. A. (2025). Evaluating the performance of faba bean (Vicia faba L.) under different irrigation regimes in southern Iraq. Iraqi Journal of Agricultural Sciences, 56(1), 89–98. Omar, S. K., Al-Khafaji, E. A., & Jasim, H. A. (2025). Evaluating the performance of faba bean (Vicia faba

L.) under different irrigation regimes in southern Iraq. *Iraqi Journal of Agricultural Sciences*, 56(1), 89–98.

- 17-** Joan, K. F., Alshieli, S. S., & Manshoud, M. A. (2019). Effect of distances and dates of cultivation on growth and yield of fenugreek (*Trigonella foenum-graecum* L.). *Muthanna Journal of Agricultural Sciences*, 7(2), 133–140.
- 18-** Tadesse, G., Mekonnen, T., & Abebe, Z. (2025). Effect of nitrogen and biofertilizer application on growth and yield of faba bean (*Vicia faba* L.) in highland areas of Ethiopia. *Heliyon*, 11(5), e21567
- 19-** Alhasany, A. R., Leiby, H. R., & Noaema, A. H. (2021). Effectiveness of spraying nano-fertilizers of iron and potassium on the growth and yield of faba bean crop (*Vicia faba* L.). *Int. J. Agricult. Stat. Sci*, 17(1), 341-345.