Andalasian International Journal of Agricultural and Natural Sciences (AIJANS)
ISSN: 2745-7885 (Online)
Available in : https://aijans.lppm.unand.ac.id/index.php/aijans



Article

Response of Two Cultivars of Faba Bean (*Vicia Faba L.*) to Different Levels of Phosphorus Fertilizer

Aznor Nazim Saleh[1], Saja Baker Hassan[2], Ibrahim Ali Ameen[3]
[1,2,3]*Department of Medicinal and Industrial Plants, College of Medicinal and Industrial Plants, University of Kirkuk, Iraq.*

DOI: https://doi.org/10.25077/aijans.v6.i01.44-49.2025

Submission Track

Received: June 10, 2025
Final Revision: July 25, 2025
Accepted: July 27, 2025
Available Online: July 30, 2025

Keywords

Cultivars, faba bean (*Vicia faba L.*), phosphorus fertilizer, yield plant

Correspondence

*E-mail: aznoor.salih@uokirkuk.edu.iq

ABSTRACT

A field experiment was conducted during the winter season (2023–2024) in a private field located in Kirkuk Governorate. The study was implemented as a factorial experiment using a Randomized Complete Block Design (RCBD) with three replications. The results and differences among means were analyzed using Duncan's Multiple Range Test (DMRT) at a 5% probability level. The experiment aimed to evaluate the response of two faba bean (Vicia faba L.) cultivars (Spanish and local) to five phosphorus fertilizer levels (0, 25, 50, 75, and 100 kg ha^{-1}), applied in two splits. The results showed that the fifth phosphorus level (P_5) significantly improved plant height (58.667 cm $plant^{-1}$), number of branches (6.833 branches $plant^{-1}$), number of leaflets (40.89 leaflets $plant^{-1}$), number of flowers (30.33 flowers $plant^{-1}$), number of pods (27.33 pods $plant^{-1}$), and single plant yield (188.83 g $plant^{-1}$). The fourth phosphorus level (P_4) also led to significant improvement in all studied traits, with values of plant height (58.667 cm $plant^{-1}$), number of branches (6.166 branches $plant^{-1}$), number of leaflets (41.071 leaflets $plant^{-1}$), number of flowers (31.33 flowers $plant^{-1}$), number of pods (28.33 pods $plant^{-1}$), and single plant yield (190.00 g $plant^{-1}$). No significant differences were observed between the two cultivars. However, significant interactions were found, particularly for the combination A_1P_5 (Spanish cultivar × fifth phosphorus level), which excelled in plant height (63.00 cm $plant^{-1}$), number of branches (7.000 branches $plant^{-1}$), and number of leaflets (42.35 leaflets $plant^{-1}$). Additionally, the interaction A_2P_4 (local cultivar × fourth phosphorus level) showed superiority in number of flowers (31.33 flowers $plant^{-1}$), number of pods (28.66 pods $plant^{-1}$), and single plant yield (193.67 g $plant^{-1}$). Meanwhile, the interaction A_2P_3 (local cultivar × third phosphorus level) was superior in total yield (30.00 kg 1000 m^{-2}).

INTRODUCTION

Faba bean (*Vicia faba* L.) is among the most important legumes and have been widely used in traditional medicine since ancient times. Today, they are a vital source of food and medicine in many countries around the world, primarily due to their rich nutritional value, which provides significant amounts of 56% carbohydrates [1], 20-36% proteins [2] , 1.24% fats [3], minerals, and vitamins, in addition to their seeds, which contain a wide range of bioactive compounds with important medicinal and pharmaceutical properties[4]. Faba beans also play a pivotal role in crop rotations by forming root nodules that fix atmospheric nitrogen, thus enhancing soil fertility [5].

Faba bean cultivars display substantial variability in their genetic and physiological traits,

This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License

exhibiting differences in growth parameters such as leaf size, pod length, and seed weight, which in turn have a direct impact on their production performance under diverse agricultural conditions [6]. These differences represent a critical factor in selecting cultivars that are well-adapted to diverse agricultural environments, thereby enabling improved productivity and more efficient utilization of natural resources.

Phosphorus is one of the essential nutrients required by faba bean plants to support various vital processes. It plays a central role in the synthesis of nucleic acids (DNA and RNA) and in energy production through the formation of adenosine triphosphate (ATP), while also enhancing enzymatic activities within plant cells. A deficiency of phosphorus in the soil leads to stunted growth, impaired root development, and a reduction in both flowering and fruiting, which ultimately results in a significant decline in overall yield [7]. In soils exhibiting alkaline traits and containing reactive minerals, phosphorus amendments undergo both adsorption and precipitation processes that reduce its availability to plants. Consequently, determining the optimal level of phosphorus fertilizer is essential to ensure a favorable plant response [8], [9].

This study aims to evaluate the responses of two faba bean cultivars to varying levels of phosphorus fertilizer, as part of research designed to investigate the interactions between cultivar type and fertilization level and their combined effects on the crop's growth and yield traits.

MATERIALS AND METHODS:

A field experiment was conducted during the winter season of 2023–2024 in a private field located in Kirkuk Governorate. The experiment was laid out in a randomized complete block design (RCBD) with a factorial arrangement involving two faba bean (Vicia faba L.) cultivars: the Spanish cultivar and the local one. Five levels of di-ammonium phosphate (DAP) fertilizer were applied at the rates of 0, 25, 50, 75, and 100 kg ha^{-1} in a single dose after sowing. Treatments were replicated three times, resulting in a total of 30 experimental units.

The seeds were sown in pots at a rate of three seeds per pot. Regarding fertilization recommendations, nitrogen fertilizer was applied in two equal splits and thoroughly mixed with the soil. The first dose was applied at sowing and the second at the branching stage, using urea (40% N) at a rate of 225 kg ha^{-1}. Potassium was added at sowing in the form of potassium sulfate (K_2SO_4, 41.5% K) at a rate of 120 kg ha^{-1} for all treatments.

Factor A represented the faba bean cultivars: A_1 (Spanish cultivar) and A_2 (Local cultivar). Factor P represented phosphorus fertilizer levels as follows: P_1 (0 kg ha^{-1}), P_2 (25 kg ha^{-1}), P_3 (50 kg ha^{-1}), P_4 (75 kg ha^{-1}), and P_5 (100 kg ha^{-1}).

Phosphorus fertilizer quantities were measured using a precision balance, and weeds were manually controlled. Data were statistically analyzed using Duncan's multiple range test at a 5% level of probability [10].

Traits studied: All potted plants were selected for measuring shoot mass, yield, and plant components. The following traits were studied:

1. Plant height (cm $plant^{-1}$): The height of each plant was measured from the base of the soil to its top using a measuring tape. The mean height of each plant was then calculated.
2. Number of branches (branch $plant^{-1}$): This was measured by counting the number of lateral branches.
3. Number of leaves (leaf $plant^{-1}$): This trait was measured by counting the total number of fully developed green leaves on the main stem and branches of each plant at the flowering stage.
4. Number of flowers (flower $plant^{-1}$)

5. Number of pods (pod plant^{-1}): This was measured by calculating the mean number of pods per plant in the experimental unit.
6. Singel Yield per plant (g plant^{-1})
7. Total yield (kg dunum^{-1})

RESULTS AND DISCUSSION

1. Plant Height:

Table (1) shows that there were significant differences due to the phosphorus fertilizer levels. The fourth (P4) and fifth (P5) levels recorded the highest plant heights, both reaching 58.66 cm plant^{-1}, compared to the control treatment which recorded 17.50 cm plant^{-1}. Regarding the cultivars, there were no significant differences between the Spanish and local varieties.

As for the interaction between cultivars and phosphorus levels, the combinations A1P4, A1P5, A2P4, and A2P5 showed significantly higher plant heights of 60.66, 63.00, 56.66, and 54.33 cm plant^{-1}, respectively, compared to the control interaction (A1P1) which recorded 17.00 cm plant^{-1}.

The noticeable increase in plant height at higher phosphorus levels can be attributed to phosphorus's vital role in promoting plant growth, particularly by enhancing cell division and elongation, which in turn increases plant height. These findings are consistent with those reported by [4], [11], [12].

Table 1. Effect of cultivar, phosphorus fertilizer levels, and their interaction on plant height (cm plant^{-1})

Cultivars	P1 (0 kg ha^{-1})	P2 (25 kg ha^{-1})	P3 (50 kg ha^{-1})	P4 (75 kg ha^{-1})	P5 (100 kg ha^{-1})	Mean
Spanish (A1)	17.00 b	21.00 b	25.00 b	60.66 a	63.00 a	37.33 a
Local (A2)	18.00 b	21.66 b	24.00 b	56.66 a	54.33 a	34.93 a
Mean	17.50 b	21.33 b	24.50 b	58.66 a	58.66 a	

2. Number of Branches (branches plant^{-1})

According to Table (2), phosphorus fertilizer levels significantly influenced the number of branches. Treatments P4 and P5 resulted in the highest branch numbers (6.16 and 6.83 branches plant^{-1}, respectively), compared to the control treatment (1.83 branches plant^{-1}). No significant differences were observed between the two cultivars regarding this trait.

Regarding the interaction between cultivars and phosphorus levels, the Spanish cultivar (A1) at P4 and P5 produced 6.00 and 7.00 branches plant^{-1}, respectively, while the local cultivar (A2) at the same levels recorded 6.33 and 6.66 branches plant^{-1}, respectively.

The superior performance at higher phosphorus levels may be attributed to phosphorus's role in forming cellular membranes (plasma membrane, mitochondria, chloroplast, and vacuolar membrane), strengthening the root system, and enhancing vegetative growth. These effects improve photosynthetic efficiency, which translates into increased branching. These results align with the findings of [13; 14], who reported increased branching in faba bean plants with increasing phosphorus application.

Table (2): Effect of cultivar, phosphorus fertilizer levels, and their interaction on number of branches (branches plant^{-1})

Cultivars	P1 (0 kg ha^{-1})	P2 (25 kg ha^{-1})	**P3 (50 kg ha^{-1})**	**P4 (75 kg ha^{-1})**	**P5 (100 kg ha^{-1})**	**Mean**
Spanish (A1)	2.00 **c**	2.66 **bc**	3.33 **b**	6.00 **a**	7.00 **a**	4.20 **a**
Local (A2)	1.66 **c**	2.66 **bc**	3.33 **b**	6.33 **a**	6.66 **a**	4.13 **a**
Mean	1.83 **c**	2.66 **b**	3.33 **b**	6.16 **a**	6.83 **a**	

3. Number of Leaves (leaves plant^{-1})

Table 3 indicates that phosphorus fertilizer levels had a significant effect on the number of leaves. Treatments P4 and P5 recorded the highest leaf counts, reaching 41.07 and 40.89 leaves plant^{-1}, respectively, compared to the control treatment which recorded 17.37 leaves plant^{-1}. No significant differences were observed between the two cultivars in this trait.

Regarding the interaction between cultivars and phosphorus levels, the combinations A1P4, A1P5, A2P4, and A2P5 showed significantly higher values of 42.27, 42.35, 39.87, and 39.44 leaves plant^{-1}, respectively.

The superiority of higher phosphorus levels may be due to their role in strengthening the plant root system and enhancing vegetative growth, which improves photosynthetic efficiency. This leads to an increase in branching and, consequently, a greater number of leaves. These findings align with those reported by [11] ,[12], 14].

Table. Effect of cultivar, phosphorus fertilizer levels, and their interaction on number of leaves (leaf plant^{-1})

Cultivars	P1 (0 kg ha^{-1})	P2 (25 kg ha^{-1})	P3 (50 kg ha^{-1})	P4 (75 kg ha^{-1})	P5 (100 kg ha^{-1})	Mean
Spanish (A1)	17.51 b	21.54 b	23.54 b	42.27 a	42.35 a	29.44 a
Local (A2)	17.23 b	20.79 b	22.87 b	39.87 a	39.44 a	28.04 a
Mean	17.37 c	21.16 bc	23.20 b	41.07 a	40.89 a	

4. Number of Flowers (flowers plant^{-1})

Table 5 shows significant differences between phosphorus fertilizer levels regarding the number of flowers. The P4 and P5 levels recorded the highest flower counts of 31.33 and 30.33 flowers plant^{-1}, respectively, compared to the control treatment (20.83 flowers plant^{-1}). No significant differences were detected between the two cultivars.

Regarding the interaction between phosphorus levels and cultivars, the combinations A1P4, A1P5, A2P4, and A2P5 recorded the highest number of flowers with values of 31.33, 31.00, 31.33, and 29.66 flowers plant^{-1}, respectively, compared to the control (A1P1) with 20.66 flowers plant^{-1}.

The increase in flower number at higher phosphorus levels may be attributed to phosphorus's essential role in stimulating cell division and accelerating plant growth, which helps plants reach the flowering stage faster. These findings are consistent with those reported by [4], [14], [15].

Table. Effect of cultivar, phosphorus fertilizer levels, and their interaction on number of flowers (flowers plant^{-1})

Cultivars	P1 (0 kg ha^{-1})	P2 (25 kg ha^{-1})	P3 (50 kg ha^{-1})	P4 (75 kg ha^{-1})	P5 (100 kg ha^{-1})	Mean
Spanish(A1)	20.66 d	26.00 bc	26.33 b	31.33 a	31.00 a	27.06a
Local (A2)	21.00 d	23.33 cd	24.66 bc	31.33 a	29.66 a	26.00a
Mean	20.83 c	24.66 b	25.50 b	31.33 a	30.33 a	

5. Number of Pods (pods plant^{-1})

As shown in Table 5, significant differences were observed among phosphorus fertilizer levels in terms of number of pods per plant. Treatments P4 and P5 significantly outperformed the control, recording 28.33 and 27.66 pods plant^{-1}, respectively, compared to 17.16 pods plant^{-1} in the control (P1). However, no significant differences were detected between the two cultivars.

In terms of interaction between cultivars and phosphorus levels, the Spanish cultivar (A1) showed significant increases at P4 and P5, averaging 28.00 and 28.33 pods plant^{-1}, respectively. Similarly, the local cultivar (A2) also recorded the highest values at P4 and P5, with means of 28.66 and 27.00 pods plant^{-1}, respectively. These findings are in agreement with [16].

The increase in number of pods with higher phosphorus levels is likely due to phosphorus's role in promoting plant height, branching, and leaf area development, all of which support better nutrient translocation and increase pod-setting potential. A strong positive correlation was observed between pod number and phosphorus application. These findings are consistent with [12], [15], [16].

Table. Effect of cultivar, phosphorus fertilizer levels, and their interaction on number of pods (pods plant^{-1})

Cultivars	P1 (0 kg ha^{-1})	P2 (25 kg ha^{-1})	P3 (50 kg ha^{-1})	P4 (75 kg ha^{-1})	P5 (100 kg ha^{-1})	Mean
Spanish(A1)	17.00 e	21.66 bc	22.66 b	28.00 a	28.33 a	23.53a
Local (A2)	17.33 de	19.66 cd	21.00 bc	28.66 a	27.00 a	22.73a
Mean	17.16 c	20.66 b	21.83 b	28.33 a	27.66 a	

6. Yield per Plant (g plant^{-1})

Table 6 indicates that phosphorus levels had a significant effect on yield per plant. P4 and P5 recorded the highest average yields, 190.00 and 188.83 g plant^{-1}, respectively, significantly surpassing the control (56.33 g plant^{-1}). No significant differences were observed between cultivars.

Regarding the interaction effect, the treatments A1P4, A1P5, A2P4, and A2P5 resulted in the highest yields of 186.33, 187.67, 193.67, and 190.00 g plant^{-1}, respectively, compared to 54.67 g plant^{-1} in the control treatment (A1P1), as confirmed by [16].

The improvement in yield at higher phosphorus levels is attributed to enhanced physiological functions such as cell division, root development, and flowering, which consequently increase pod and seed production. These results agree with [12]

Table 6. Effect of cultivar, phosphorus fertilizer levels, and their interaction on yield per plant (g plant^{-1})

Cultivars	P1 (0 kg ha^{-1})	P2 (25 kg ha^{-1})	P3 (50 kg ha^{-1})	P4 (75 kg ha^{-1})	P5 (100 kg ha^{-1})	Mean
Spanish(A1)	54.67 d	74.67 bcd	97.33 bc	186.33 a	187.67 a	120.13a
Local (A2)	58.00 cd	84.00 bcd	100.00 b	193.67 a	190.00 a	125.13a
Mean	56.33 c	79.33 bc	98.67 b	190.00 a	188.83 a	

CONCLUSION

The results of this study indicate that phosphorus fertilization, particularly at rates of 75 and 100 kg ha^{-1}, significantly improved most of the vegetative, floral, and reproductive traits in both studied faba bean cultivars. This improvement is attributed to phosphorus's essential physiological role in promoting growth, flowering, and fruit set. It is therefore recommended to adopt higher phosphorus fertilization levels within this range to optimize growth and yield of faba bean under similar growing conditions.

REFERENCES

[1] Kadhim, J. J., Altai, D. S. K., Alsaedi, N. Z. M., and Seadh, S. E. (2024). Effect of foliar spraying with nano-zinc on growth and productivity some faba bean varieties. *Anbar Journal of Agricultural Sciences, 22*(2): 1094-1109.

[2] Al-Obaidi, S. I. Y., Aziz, M. M., & Shaker, A. T. (2021). Effect of different levels of algren twin and humic acid on characters of bean crop (*Vicia faba* L.). *Kirkuk University Journal for Agricultural Sciences (KUJAS)*, *12*(1).

[3] Salem, S., & Ahmed, L. (2024). Growth Characteristics Influence of Beans by spraying with Salicylic acid and zinc. *Journal of Medicinal and Industrial Plant Sciences*, *2*(4), 13-22. https://doi.org/10.32894/MEDIP.24.4.2

[4] Al-Saqal, D. S. F & Al-Badrani, W. A. A (2023). The effect of phosphate and sulfur fertilization on the growth and yield of the bean plant (*Vicia Faba*. L). *Syrian Journal of Agricultural Research, 10(5), 263-281.*

[5] Allito, B. B., Ewusi-Mensah, N., & Logah, V. (2020). Legume-Rhizobium Strain Specificity Enhances Nutrition and Nitrogen Fixation in Faba Bean (*Vicia faba* L.). *Agronomy*, *10*(6), 826. https://doi.org/10.3390/agronomy10060826

[6] Wondaferew, D., Mullualem, D., Bitewlgn, W., Kassa, Z., Abebaw, Y., Ali, H., ... & Astatkie, T. (2024). Cultivating sustainable futures: multi-environment evaluation and seed yield stability of faba bean (*Vicia faba* L.) genotypes by using different stability parameters in Ethiopia. *BMC Plant Biology*, *24*(1), 1-18.

[7] Yasmin, W., Paul, S. K., & Anwar, M. P. (2020). Growth, yield and quality of faba bean (*Vicia faba* L.) in response to sowing date and phosphorus fertilization. *Archives of Agriculture and Environmental Science*, *5*(1), 11-17.

[8] Abdl-Rahmaan, A. J., Ahmed, T. S., Altememe, J. Y., & Hasbullah, R. M. (2023). Effect of Spraying Humic Acid and Sea Algae Extracts on Growth and Chemical Content of Cress Plants (Lepidium Sativum L.). *Journal of Medicinal and Industrial Plant Sciences*, 1(1), 26-36. https://doi.org/10.32894/MEDIP.23.1.3

[9] Hanyabui, E., Apori, S. O., Frimpong, K. A., Atiah, K., Abindaw, T., Byalebeka, J., ... & Asiamah, J. Y. (2020). Phosphorus sorption in tropical soils. *AIMS Agriculture and Food, 5(4): 599–616.* DOI: 10.3934/agrfood.2020.4.599

[10] Al-Zubaidy, K. M. D., & Al-Jubory, K. K. A. (2016). Design And Analysis of Genetically Experiments. Dar Alwadah For Kingdom-Amman Library, Printing, And Distribution. The Republic of Iraq. (In Arabic).

[11] Papakaloudis, P., & Dordas, C. (2023). Phosphorus Fertilization Affects Morphological, Physiological and Agronomic Characteristics of Faba Bean Cultivars. *Sustainability*, *15*(17), 13172. https://doi.org/10.3390/su151713172.

[12] Raheem, A. H., Taha, A. A., & Ashraa Kalee, H. H. H. (2024). Phosphate fertilizers effects on the growth and yield traits of faba bean (*Vicia faba* L.). *Sabrao Journal of Breeding and Genetics*, *56*(3), 1324-1333.

[13] Alshummary, A. M., Alfreeh, L. M., & Mohssen, K. H. (2021). Response of faba bean cultivars (*Vicia faba* L.) to phosphorus application. *Int. J. Agricult. Stat. Sci. Vol*, *17*(1), 329-333.

[14] El-Gedwy, E. S. M., & Ibrahim, A. (2021). Performance of some faba bean varieties in relation to phosphorus fertilization and some microelements spraying. *Annals of Agricultural Science, Moshtohor*, *59*(2), 383-398.

[15] Sarhan, I. A. (2022). Effect of Phosphate Fertilization on the Growth and Yield of Three Genotypes of Faba Bean (*Vicia faba* L.). *Iraqi Journal of Desert Studies*, *12*(1), 29-37. (In Arabic).

[16] Ibraheem, F., Marwah. M. H., Asmaa. M. S. (2021). Response of three varieties of broad bean (*vicia faba* L.) to np mineral fertilizer. *Mesopotamia Journal of Agriculture*, *49*(2), 190.

[17] Algraishi, A. H. A., & Alogaidi, F. F. M. (2022). Evaluation of the performance of some cultivars of Faba Bean *Vicia faba* L. under different levels of phosphorus. *Journal of Kerbala for Agricultural Sciences*, *9*(4), 227-238.