Al-Furat Journal of Innovations in Agricultural Sciences (FJIAS)
https://doi.org/10.46649/fjias.v2i2.001

Effect of phosphorus levels and planting dates in yield and quality of two faba bean varieties (*Vicia faba* L.)

Asawir Abbas Imran[1*], Ahmed Mohamed Lehmood[1]
[1]Department of plant production , AL- Musaib Technical college, AL- Furat AL-Awsat University
Corresponding auther E-mail: asawir.abaas.tcm77@student.atu.edu.iq

Received (12/01/2026), Received in revised form (18/03/2026)
Accepted (22/05/2026), Available online (29/06/2026)

FJIAS 2026, 2(2): 1-11

Abstract

A research experiment was selected during the 2025-2026 winter season in the Al-Mahawil area, north of Babil Governorate (32°N, 44°E), to investigate the effect of cultivation, variety, and phosphorus levels in the growth and yield of broad bean. Three factors were present: first, three cultivation variables (D1, D2, D3), second, a specific broad bean variety (V1, V2), and third, three phosphorus levels (P1, P2, P3). The experiment was conducted using a arrangement (split- split plots) with a randomized complete block design (RCBD) and three replicases. The experiment concluded in April 1, 2026, and the results were analyzed using Genstat software. The Least Significant Difference (LSD) was selected at a p-value of 0.05. The product length is characterized as follows: The results showed the superiority of the Egyptian variety over the Spanish variety in the characteristics of (pod length (cm), number of pods (pods/plant^{-1}), number of seeds per pod (seed/pod^{-1}), weight of 100 seeds (g), and percentage of protein%), while the Spanish variety was superior in the characteristic of (harvest index%). The second planting date was also superior to the other dates, as was the third level of phosphorus (240 kg phosphorus / hectare) in most of the studied characteristics.

***Keywords:* Broad beans, Phosphate fertilization, Planting dates.**

1. INTRODUCTION

Broad beans (*Vicia faba* L.) are a widely distributed and important plant in the legume family (Fabaceae). They are a major source of protein in Africa and Asia and have the highest productivity values compared to all other legume crops [1]. They are cultivated for their dry and soft seeds, which contribute to a balanced diet due to their high content of plant protein and amino acids, offering numerous scientifically proven health benefits [2]; [3]. Broad bean seeds are high in dietary fiber, carbohydrates (30–45%), iron, zinc, antioxidants, saponins, and some phenolic compounds [4]. Given the increasing world population and the lack of a corresponding increase in food production, especially vegetables, researchers have been driven to develop high-yielding varieties [5]. These varieties require nutrient availability in the soil, and fertilization is one of the most important crop management practices that leads to increased production because it regulates physiological processes within the plant, especially when fertilizing with macro- and micronutrients [6]. Phosphorus is an essential nutrient for plant growth and development. It promotes branching, root proliferation, and accelerates plant maturation, while also improving crop quality [7].It plays a pivotal role in most processes occurring within plant cells. It is involved in carbohydrate metabolism to release energy needed to fuel vital plant processes. A phosphorus deficiency reduces the rate of carbohydrate formation, such as starch synthesis, as well as sugar formation and cellulose production. Phosphorus also contributes to cell formation and division, and its absence affects the formation of amino acids and proteins, which are essential building blocks of plant cells [8].

2. MATERIALS AND METHODS

A field trial was conducted for the year 2025-2026 in the fields of a farmer in Al-Mahawil district (20 km north of the center of Babylon Governorate) with the aim of determining the best concentration of phosphate fertilizer (80, 160, 240) kg phosphorus/hectare, the best planting date (September 15, September 30, October 15), and the best variety (Egyptian and Spanish). The land was plowed perpendicularly using a moldboard plow to a depth of (30 cm), then the soil was smoothed and leveled. After that, the land was divided into three main blocks, each blocks containing (18) experimental units, with an area of (9 m²) with dimensions of (3 x 3 m). Each experimental unit contained five rows, with a distance between the rows of (50 cm) and between the holes of (25 cm). Three seeds were placed in each hole and thinned to one plant after the plant reached a height of (15-20 cm). The total number of experimental units was (54) experimental units. The experiment ended in 1/4/2026 The following measurements were taken:

(Pod length, number of pods, number of seeds per pod, weight of 100 seeds, harvest index, percentage of protein).

3. RESULTS AND DISCUSSION

Pod Length (cm)

The results in Table (1) show significant differences between planting dates in the pod length (cm) of the plant. The second planting date achieved the highest average length of 20.70 cm, while the first planting date achieved the lowest average length of 18.66 cm , resulting in the superior pod length of the second planting date. The results also showed significant differences between varieties. Variety (V2) achieved the highest average length of 20.36 cm, while variety (V1) achieved the lowest average length of 19.59 cm. The superiority of variety (V2) is attributed to its genetic makeup, which was clearly reflected in its response to environmental conditions. The results in the table also showed significant differences between the phosphorus levels, as the third level, p3, achieved the highest average of 21.22 cm compared to the first level, p1, which achieved the lowest average of 18.78 cm. Perhaps the reason for this is the effect of phosphorus on the vital processes, resulting in good crop growth and thus an increase in the length of the pod. This result is consistent with what [9] concluded. The same table showed a significant effect of the interaction between planting dates and varieties. The interaction between the second planting date and the Egyptian variety resulted in the highest average length of 21.08 cm, while the interaction between the first planting date and the Spanish variety resulted in the lowest average length of 17.96 cm. Regarding the interaction effect between planting dates and phosphorus, it was significant in the pod length (cm) of the plant. The interaction (D2 x P3) got the highest average length of

22.53 cm, while the interaction (D1 x P1) got the lowest average length of 17.78 cm. As for the interaction between varieties and phosphorus, the interaction (P3 x V2) got the highest average length of 21.93 cm, while the interaction (P1 x V1) got the lowest average length of 18.44 cm. Finally, the The Trible interaction between planting dates, varieties, and phosphorus resulted in the interaction (D2 x V2 x P3) achieving the highest average length of 23.73 cm, while the interaction (D1 x V1 x P1) got the lowest average length of 17.03 cm.

Table (1): Effect of planting dates, varieties, phosphorus fertilizer levels, and their interactions in pod length (cm).

Varieties	Phosphorus Levels	Planting dates			P * V
		D1	D2	D3	
V1	P1	17.03	19.17	19.13	18.44
	P2	17.87	20.47	21.13	19.82
	P3	18.97	21.33	21.23	20.51
V2	P1	18.53	19.27	19.53	19.11
	P2	19.67	20.23	20.23	20.04
	P3	19.90	23.73	22.17	21.93
L.S.D (0.05)		1.984			0.861
		D * V			V
V1		17.96	20.32	20.50	19.59
V2		19.37	21.08	20.64	20.36
L.S.D (0.05)		1.713			0.443
		D * P			P
P1		17.78	19.22	19.33	18.78
P2		18.77	20.35	20.68	19.93
P3		19.43	22.53	21.70	21.22
L.S.D (0.05)		1.766			0.680
Planting dates		18.66	20.70	20.57	
L.S.D (0.05)		1.746			

Number of Pods (Pod per Plant^{-1})

The results in Table (2) show significant differences between planting dates in the number of pods per plant. The second planting date achieved the highest average of 19.50, while the first planting date achieved the lowest average of 13.17. This may be attributed to the favorable climatic conditions and temperatures, which led to successful pollination of the flowers and consequently an increase in the number of pods per plant. This result is consistent with the findings of [10].The results also showed significant differences between varieties. Variety (V2) achieved the highest average of 17.13, while variety (V1) achieved the lowest average of 15.19. The superiority of variety (V2) is attributed to its genetic makeup, which was clearly reflected in its response to environmental conditions. The table also revealed significant differences in phosphorus levels. Level 3 (P3) achieved the highest average at 19.50, compared to level 1 (P1), which achieved the lowest average at 12.47. This may be attributed to the role of phosphorus in improving growth, flowering, fruit set, nutrient transport, and dry matter accumulation. This results in increased plant efficiency in converting nutrients formed at the source (chlorophyll-containing parts) and accumulating them at the destination (the fruiting part, represented by the pods). The same table also showed a significant effect of the interaction between planting dates and varieties. The interaction between the second planting date and the Egyptian variety resulted in the highest average at 20.89, while the interaction between the first planting date and the Spanish variety resulted in the lowest average at 12.00. Regarding the interaction between planting dates and phosphorus, the effect was significant. The interaction (D2 x P3) got the highest mean value of 23.17, while the interaction (D1 x P1) got the lowest mean value of 11.00. As for the interaction between varieties and phosphorus, the interaction (P3 x V2) got the highest mean value of 20.56, while the interaction (P1 x V1) got the lowest mean value of 11.44. Finally, the Trible interaction between planting dates, varieties, and phosphorus resulted in the interaction (D2 x V2 x P3) achieving the highest mean value of 25.33, while the interaction (D1 x V1 x P1) got the lowest mean value of 10.00.

Table (2): Effect of planting dates, varieties, phosphorus fertilizer levels, and their interactions in number of pods (pods plant^{-1})

Varieties	Phosphorus Levels	Planting dates			P * V
		D1	D2	D3	
V1	P1	10.00	14.00	10.33	11.44
	P2	10.67	19.33	17.00	15.67
	P3	15.33	21.00	19.00	18.44
V2	P1	12.00	16.00	12.50	13.50
	P2	14.67	21.33	16.00	17.33
	P3	16.33	25.33	20.00	20.56
L.S.D (0.05)		3.347			2.051
		D * V			V
V1		12.00	18.11	15.44	15.19
V2		14.33	20.89	16.17	17.13
L.S.D (0.05)		1.714			1.327
		D * P			P

Al-Furat Journal of Innovations in Agricultural Sciences (FJIAS)
https://doi.org/10.46649/fjias.v2i2.001

P1	15.00	11.42	12.47	12.47
P2	20.33	16.50	16.50	16.50
P3	23.17	19.50	19.50	19.50
L.S.D (0.05)	2.242			1.506
Planting dates	13.17	19.50	15.81	
L.S.D (0.05)	1.008			

Number of seeds per pod (1⁻ seed per pod)

The results of the statistical analysis in Table (3) showed no significant differences in the number of seeds per pod in broad beans based on planting dates, varieties, and their interaction. The results also showed no significant differences between the averages of the different varieties .The table also revealed significant differences in phosphorus levels. Level 3 (p3) achieved the highest average at 5.73, compared to level 1 (p1), which achieved the lowest average at 4.70. This may be attributed to the effect of phosphorus on physiological processes. This results in the availability of the necessary materials for increased fertilization in a single pod. These findings are consistent with. The results are consistent with those of [11]. The same table shows no significant effect of the interaction between planting dates and varieties. However, the interaction between planting dates and phosphorus was significant. The interaction (D2 x P3) got the highest mean value of 5.96, while the interaction (D3 x P1) got the lowest mean value of 4.31. As for the interaction between varieties and phosphorus, the interaction (P3 x V1) got the highest mean value of 5.80, while the interaction (P1 x V2) got the lowest mean value of 4.65. Finally, the Trible interaction between planting dates, varieties, and phosphorus resulted in the combination (D2 x V1 x P3) achieving the highest mean value of 6.20, while the interaction (D3 x V2 x P1) got the lowest mean value of 4.13.

Table (3): Effect of planting dates, varieties, phosphorus fertilizer levels, and their interactions in number of seeds per pod (seeds pod⁻¹).

Varieties	Phosphorus Levels	Planting dates			P * V
		D1	D2	D3	
V1	P1	4.667	5.067	4.500	4.744
	P2	4.967	5.233	5.267	5.156
	P3	5.733	6.200	5.467	5.800
V2	P1	4.633	5.200	4.133	4.656
	P2	5.133	5.733	5.300	5.389
	P3	5.567	5.733	5.733	5.678
L.S.D (0.05)		0.7913			0.4279
		D * V			V
V1		5.122	5.500	5.078	5.233
V2		5.111	5.556	5.056	5.241
L.S.D (0.05)		NS			NS
		D * P			P

P1	4.650	5.133	4.317	4.700
P2	5.050	5.483	5.283	5.272
P3	5.650	5.967	5.600	5.739
L.S.D (0.05)	0.6254			0.2906
Planting dates	5.117	5.528	5.067	
L.S.D (0.05)	NS			

Weight of 100 seeds (g)

Table(4) shows significant differences in the 100-seed weight trait between planting dates. Variety D2 achieved the highest average weight of 139.61 g, while variety D1 achieved the lowest average weight of 134 g. This result is consistent with the findings of [12] and [13].The results also indicate significant differences between varieties. Variety V2 achieved the highest average weight of 143.92 g, while variety V1 achieved the lowest average weight of 131.13 g. The superiority of variety V2 is attributed to its genetic makeup, which was clearly reflected in its response to environmental conditions. The table also shows significant differences. Among the phosphorus levels, level 3 (p3) achieved the highest average at 142.50, compared to level 1 (p1), which achieved the lowest average at 132.29. This may be attributed to the role of phosphorus in increasing the upstream capacity (the fruiting parts) to receive nutrients from the source, as well as increasing the source's capacity to produce dry matter and enhance grain filling .The results in the same table showed a significant effect of the interaction between planting dates and varieties. The interaction between D2 x V2 achieved the highest average at 146.59, while the interaction between D1 x V1 achieved the lowest average at 128.49.As for the effect of the interaction between planting dates and phosphorus, it was also significant. The interaction between D2 x P3 got the highest average at 144.93, while the interaction between D1 x P1 got the lowest average at 129.89. Regarding the interaction between varieties and phosphorus, the combination (P3 x V2) got the highest average at 150.02, while the combination (P1 x V1) got the lowest average at 127.14. As for the Trible interaction between planting dates, varieties, and phosphorus, the combination (D2 x V2 x P3) achieved the highest average at 152.01, while the combination (D1 x V1 x P1) got the lowest average at 124.31.

Table (4): Effect of planting dates, varieties, phosphorus fertilizer levels, and their interactions in 100-seed weight (g).

Varieties	Phosphorus Levels	Planting dates			P * V
		D1	D2	D3	
V1	P1	124.31	127.47	129.65	127.14
	P2	128.71	132.57	132.50	131.26
	P3	132.44	137.84	134.66	134.98
V2	P1	135.48	139.68	137.14	137.43
	P2	140.67	148.07	144.22	144.32
	P3	147.14	152.01	150.91	150.02
L.S.D (0.05)		5.502			3.043

	D * V			V
V1	128.49	132.63	132.27	131.13
V2	141.10	146.59	144.09	143.92
L.S.D (0.05)	4.143			2.288
	D * P			P
P1	129.89	133.57	133.39	132.29
P2	134.69	140.32	138.36	137.79
P3	139.79	144.93	142.78	142.50
L.S.D (0.05)	4.269			2.037
Planting dates	134.79	139.61	138.18	
L.S.D (0.05)	3.915			

Harvest index (%)

The results presented in Table (5) showed significant differences among phosphorus levels. The third level (P3) recorded the highest mean (47.77%), compared with the first level (P1), which gave the lowest mean (43.71%). This increase may be attributed to the role of phosphorus in enhancing plant growth through its influence on vital physiological processes, increasing cell division and root development, which improves nutrient uptake efficiency, as well as enhancing photosynthetic capacity. This, in turn, leads to increased vegetative growth. These findings are in agreement with those reported by [14].The same table also indicated a significant effect of the interaction between planting dates and varieties. The interaction (D2 × V1) recorded the highest mean (48.92%), whereas the interaction (D1 × V1) gave the lowest mean (41.74%).Regarding the interaction between planting dates and phosphorus levels, it was significant. The interaction (D1 × P1) produced the highest mean (70.83%), while the interaction (D2 × P2) recorded the lowest mean (61.36%).As for the interaction between varieties and phosphorus levels, it was also significant. The interaction (V1 × P3) recorded the highest mean (48.33%), whereas the interaction (V2 × P2) gave the lowest mean (42.39%).The Trible interaction among planting dates, varieties, and phosphorus levels was significant as well. The combination (D1 × V2 × P3) achieved the highest mean (50.48%), while the interaction (D1 × V1 × P1) recorded the lowest mean (35.99%).

Table (5): Effect of planting dates, varieties, phosphorus fertilizer levels, and their interactions in harvest index (%)

Varieties	Phosphorus Levels	Planting dates			P * V
		D1	D2	D3	
V1	P1	35.99	49.07	44.99	43.35
	P2	41.49	47.72	47.25	45.48
	P3	47.37	49.99	47.26	48.33
V2	P1	43.90	41.96	46.32	44.06
	P2	47.75	40.41	39.02	42.39

	P3	50.48	45.69	45.45	47.21
L.S.D (0.05)		37.07			NS
		D * V			V
V1		41.74	48.92	46.50	45.72
V2		47.38	42.69	43.60	44.56
L.S.D (0.05)		NS			NS
		D * P			P
P1		70.83	63.58	64.13	43.71
P2		68.08	61.36	70.05	43.94
P3		65.79	61.62	67.31	47.77
L.S.D (0.05)		7.252			3.461
Planting dates		44.56	45.81	45.05	
L.S.D (0.05)		NS			

Protein percentage (%)

The results presented in Table (6) showed significant differences among planting dates in protein percentage. The planting date D2 recorded the highest mean (27.97%), whereas D1 gave the lowest mean (24.99%). The results also indicated no significant differences among varieties. The table further showed significant differences among phosphorus levels. The third level (P3) recorded the highest mean (27.56%), compared with the first level (P1), which gave the lowest mean (24.76%). This may be attributed to the role of phosphorus in the formation of certain compounds such as ATP and RNA, which are essential for protein synthesis. In addition, phosphorus contributes to the formation of root nodules that aid in atmospheric nitrogen fixation and its absorption by the plant. These findings are consistent with those reported by [19].The same table also indicated a significant effect of the interaction between planting dates and varieties. The interaction (D2 × V2) recorded the highest mean (28.11%), whereas the interaction (D1 × V1) gave the lowest mean (24.87%).Regarding the interaction between planting dates and phosphorus levels, it was significant. The interaction (D2 × P3) produced the highest mean (28.96%), while the interaction (D1 × P1) recorded the lowest mean (23.30%).As for the interaction between varieties and phosphorus levels, the combination (P3 × V2) recorded the highest mean (27.43%), whereas the

Table (6): Effect of planting dates, varieties, phosphorus fertilizer levels, and their interactions in protein percentage (%).

Varieties	Phosphorus Levels	Planting dates			P * V
		D1	D2	D3	
V1	P1	22.81	26.36	24.27	24.48
	P2	25.20	28.48	26.74	26.80
	P3	26.60	28.65	27.79	27.68
V2	P1	23.80	26.61	24.70	25.04

	P2	25.33	28.43	26.43	26.73
	P3	26.23	29.28	26.80	27.43
L.S.D (0.05)		1.554			0.863
		D * V			V
V1		24.87	27.83	26.26	26.32
V2		25.12	28.11	25.98	26.40
L.S.D (0.05)		1.146			0.637
		D * P			P
P1		23.30	26.48	24.48	24.76
P2		25.27	28.45	26.58	26.77
P3		26.41	28.96	27.29	27.56
L.S.D (0.05)		1.197			0.586
Planting dates		24.99	27.97	26.12	
L.S.D (0.05)		1.080			

combination (P1 × V1) gave the lowest mean (24.48%).The Trible interaction among planting dates, varieties, and phosphorus levels was also significant. The interaction (D2 × V2 × P3) achieved the highest mean (29.28%), while the interaction (D1 × V1 × P1) recorded the lowest mean (22.81%).

4. CONCLUSIONS

The results showed that the cultivar had a significant effect due to genetic differences among cultivars. Phosphorus also played a positive role in improving yield traits, as it increased the efficiency of seed formation and enhanced protein concentration in the seeds, which was directly reflected in improved productivity traits. Additionally, appropriate planting dates had a clear effect on enhancing plant performance and increasing seed yield.

ACKNOWLEDGEMENT

This research did not receive any specific financial support from any funding agency, whether governmental, commercial, or non-profit.

DECLARATION OF COMPETING INTEREST

None

REFERENCES

[1] Mekky R.H., Thabet M.M., Rodríguez-Pérez C., Elnaggar D.M.Y., Mahrous E.A., SeguraCarretero A., Abdel-Sattar E. .(2020). Comparative metabolite profiling and antioxidant potentials of seeds and sprouts of three Egyptian cultivars of Vicia faba L. Food Research International, 136,109537 .

[2] Khazaei, H., Purves, R. W., Hughes, J., Link, W., O'Sullivan, D. M.,Schulman, A. H., Björnsdotter, E., Geu-Flores, F., Nadzieja, M.,Andersen, S. U., Stougaard, J., Vandenberg, A., & Stoddard, F. L.(2019). Eliminating vicine and convicine, the main anti-nutritional fac- tors restricting faba bean usage.Trends in Food Science & Technology,91, 549–556.

[3] Liu, C., Pei, R., & Heinonen, M. (2022). Faba bean protein: A promisingplant based emulsifier for improving physical and oxidative stabilitiesof oil-in-water emulsions.Food Chemistry,369, 130879.

[4] Labba,I.C.M., Frokier ,H.,Sandberg, A. S. (2021). Nutritional and antinutritional composition of fava bean (Vicia faba L.),var. minor cultivars. Food Research International, 140,110038.

[5] Cieslarova.J.; M. Hybli; M. Griga and p. Smykal. (2012). Molecular analysis of temporal genetic structuring in pea (pisum sativum sativum L.) cultivars breed in the Czech Republic and in former Czechoslovakia since the mid-20th century. Czec. Genet. Plant Breed. 48(2): 61-73.

[6] Abu Dhahi, Yusuf Muhammad. (1989). Feeding Practical Intentions. Ministry of Higher Education and Scientific Research - University of Baghdad - House of Wisdom. p. 41.

[7] Kolodiazhnyi , O. I. (2021). Phosphorus compounds of natural origin: Prebiotic ، stereochemistry, application. Symmetry, 13(5): 889.

[8] Al-Nuaimi, Saadallah Najm Abdullah. (1999). Fertilizers and Soil Fertility. College of Agriculture, University of Mosul. Dar Al-Kutub for Printing and Publishing, Mosul.

[9] Abdul-Hussein, Ali Hussein Alwan. (2022). Studying Some Genetic Parameters of Several Genetic Compositions of Broad Bean (Vicia faba L.) and Evaluating Their Morphological Performance Under Different Phosphorus Levels. Master's Thesis, College of Science, Agricultural Engineering, University of Baghdad.

[10] Al-Sabahi, Walid Abdul-Ridha Jubail. (2012). Path Coefficient Analysis in Broad Bean (Vicia faba L.) Crops Planted at Different Dates in Two Locations. College of Education, Al-Qurna University, Basra.

[11] Abdul Qader, Omar Abdul Mawjoud, Saleh Mohammed Ibrahim Al-Jubouri and Laith Mazen Hadi Butros. (2020). The effect of nitrogen nano-hydroxyapatite fertilizer and urea on the growth and yield of two varieties of broad beans (Vicia faba L.). Euphrates Journal of Agricultural Sciences - Volume (12). Issue (2): 202-227.

[12] Tawfik, M. M., Bakhoum, G. S., Kabesh, M. O., and Thalooth, A. T. . (2018) Comparative study on some Faba bean cultivars under water limitation conditions and different sowing dates. Middle East J. of Agric. Res, (4)7, 1431-.3441 .

[13] Al-Bawi, Amjad Shaker Hamoud. (2016). The Effect of Planting Dates and Foliar Feeding with Humic Acid and Chelated Iron on the Growth and Yield of Broad Bean (Vicia faba L.). Master's Thesis, College of Education for Pure Sciences - Department of Life Sciences.

[14] Fakhr, S.K.M., Fotouhi, F., Khaniani, B.H., Sadeghi, M., Zadeh, S.A.F. (2020). Effect of Planting Date and Density on Yield and Yield Components of Bean Genotypes (Vicia faba L.). Legume Research, 43(5): 672-677.

[15] Mostafa, S. M., Zaid, G. G. A., and Mohamed, A. M. . (2021). Effect of Sowing date on chocolate spot and rust foliar diseases reaction, Yield components and Seed quality in faba bean (Vicia faba L.). Menoufia j. of plant prod., 6(2), 83-100.