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PHOSPHATE FERTILIZERS EFFECTS ON THE GROWTH AND YIELD TRAITS OF FABA BEAN (*VICIA FABA* L.)

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SUMMARY

The present aimed to study the effects of phosphate (P) fertilizer levels (0, 40, and 80 kg P ha^{-1}) on the growth and productivity of the Spanish and Turkish faba bean (*Vicia faba* L.) cultivars, carried out in 2021–2022 at the Kirkuk, Iraq. The results showed that 80 kg P ha^{-1} significantly influenced the growth and yield traits of faba bean, i.e., branches plant^{-1}, pod length, pods plant^{-1}, seeds plant^{-1}, seeds' weight pod^{-1}, one-seed weight, 100-seed weight, seed yield plant^{-1}, and seed yield ha^{-1}. The Turkish faba bean cultivar performed better than the Spanish cultivar for yield-related traits. Interaction between phosphorus fertilizer levels and cultivars influenced all studied traits substantially, except days to 50% flowering and plant height. Correlation analysis showed that seed yield was significantly and positively correlated with branches plant^{-1}, pod length, pods plant^{-1}, seeds pod^{-1}, seeds plant^{-1}, seed weight pod^{-1}, one-seed weight, 100-seed weight, and seed yield plant^{-1}. Regression analysis indicated a strong relationship between seed yield and its components under phosphorus fertilizer levels. Turkish cultivar responded better to phosphorus fertilizer and performed superbly compared to Spanish cultivar. Therefore, the faba bean Turkish cultivar with 80 kg P ha^{-1} fertilization could be recommendable for getting higher faba-bean seed yield.

Keywords: Faba bean (*Vicia faba* L.), cultivars, phosphate fertilizer, growth and yield-related traits, correlation coefficient, regression analysis

Key findings: The Turkish cultivar of faba beans (*Vicia faba* L.) performed better for yield-related traits than the Spanish cultivar. The phosphate fertilizer at 80 kg P ha^{-1} significantly excelled over other levels and performed better for most growth and yield-related traits. However, phosphorus fertilizer levels showed nonsignificant differences for days to 50% flowering, plant height, and seeds pod^{-1}.

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INTRODUCTION

Faba bean (*Vicia faba* L.) has become a common pulse crop in Iraq and worldwide. The faba bean has an overall well-balanced amino acid profile similar to pea and soy, containing a high amount of lysine, leucine, isoleucine, threonine, histidine, and aromatic amino acids (Rafiq and Al-Jobouri, 2020; Jaafar *et al*., 2022; Hussein *et al*., 2024). Its dry seeds and green pods have widely served human consumption and animal feeding in Iraq. Annually, Iraq imports different kinds of legume seeds, especially faba bean, with insufficient local production for the country's consumption (Al-Taey *et al*., 2018a).

The total cultivated area for faba bean reached 251.25 ha, with a total productivity of 473 tons of dry seeds during 2020, where Kirkuk province in Iraq is second place for faba bean cultivation for dry seeds and first place for its higher seed yield per unit area (2,360 kg ha^{-1}). However, faba bean's cultivated areas declined compared to previous years in Iraq (Al-Tawaha *et al*., 2020; CSO, 2021). The chief reason behind this is the replacement of specified areas for faba beans with winter cereals, such as wheat and barley. Choosing a cultivar with a higher yield is key to raising crop productivity and quality in broad beans (Kandil *et al*., 2019; Ibrahim *et al.,* 2016).

Faba bean cultivars vary in morphological shape, seed size, seed nutrients, and protein content and are often attributable to the genetic characteristics of the cultivars and their response to environmental conditions where these genotypes are cultivated (Alwan *et al.,* 2019; Abd-Alqader *et al*., 2020). Saleh and Saleh (2020) found notable differences in days to 50% flowering, plant height, and seed yield characteristics among three imported faba bean genotypes (American, Spanish, and Thailand) in the field experiment conducted at the University of Tikrit, Iraq; nevertheless, the Spanish and American genotypes produced the highest seed yield when compared to the Thailand genotype of *Vicia faba* L. Significant variations were found between the genotypes of imported faba beans (Spanish, Holland, and New Zealand) for days to 50% flowering, pods $plant^{-1}$, and plant seed yield in a previous study carried out at Wasit University, Iraq; the New Zealand genotype achieved the highest rate in pods $plant^{-1}$ and seed yield.Because it is essential to nodulation, biological nitrogen fixation, and photosynthesis, phosphorus fertilizer addition frequently increases the biomass and seed output of faba beans (Etemadi *et al*., 2019). Pulses crops require the highest amount of phosphorus in their bacterial nodule formation, and phosphorus often occurs in fixed chemical forms that crops cannot immediately absorb (Al-Taey *et al*., 2018b; El-Ghamry *et al*., 2018). Therefore, despite phosphatic fertilizer application to soil, available phosphorus always remained low for crops because of its use in various chemical reactions, particularly under arid and semiarid conditions, like Iraq, where most soils are calcareous. The available phosphorus is vital in the faba bean and other crops' growth and development (Mam-Rasul, 2017; Hussain *et al*., 2021).

In the Kirkuk Governorate, Iraq, the soil is calcareous, containing a higher amount of $CaCO_3$, which has a slightly alkaline reaction and may cause a decline in phosphorus availability to crop plants. Kandil *et al*. (2019b) found that pod length, 100-seed weight, and seed yield of faba bean cultivars attain significant effects from phosphorus fertilizer application. Jasim and Algrebawi (2020) and Jasim and Al-Amiri (2020) observed noteworthy impacts of 240 kg P_2O_5 ha^{-1} compared with 120 kg P_2O_5 ha^{-1} on plant height, branches $plant^{-1}$, pods $plant^{-1}$, seeds pod^{-1}, and 100-seed weight in faba beans. Therefore, the presented study sought to determine the effects of phosphorus fertilizer levels on the imported faba bean (*Vicia faba* L.) cultivars for growth and yield-related traits under the environmental conditions of Kirkuk Governorate, North Iraq.

MATERIAL AND METHODS

Plant material and procedure

A study on the faba bean (*Vicia faba* L.) commenced during the winter growing season of 2021–2022 at the Kirkuk Governorate, Iraq (35° 28′ N latitude, 44° 19 ′E longitude). The research aimed to determine the effects of phosphatic fertilizer on the growth and productivity of two imported (Spanish and Turkish) cultivars of faba beans under the environmental conditions of Kirkuk Governorate, Iraq. The experiment used two faba bean cultivars and phosphorus fertilizer (0, 40, and 80 kg P ha^{-1}), arranged in a randomized complete block design (RCBD) with a factorial arrangement and five replications. Applying the phosphorus fertilizer occurred once at the soil harrowing stage as triple super phosphate (46% P_2O_5). Faba bean seed sowing manually in rows ensued on the third day of November, with 30 cm distances between plants and rows. Each experimental unit contains four rows, three seeds placed in each hole at 6 cm depth, then reduced into one plant for each hole after four weeks from the sowing date. Urea (46% N) application was at a rate of 120 kg N ha^{-1} in two split doses, first at sowing and the second after two months from the sowing date. Treatment of potassium fertilizer as potassium sulfate (48% K_2O) also continued once at a rate of 120 kg K_2O ha^{-1} before sowing and mixed with soil. All crop management processes transpired according to the recommendations for the faba bean crop.

Data recorded and statistical analysis

Data collection on the randomly selected plants for the following traits continued, i.e., days to 50% flowering, plant height (cm), branches plant^{-1}, pod length (cm), pods plant^{-1}, seeds pod^{-1}, seeds plant^{-1}, seed weight pod^{-1} (g) , seed weight, 100-seed weight (g), seed yield plant^{-1} (g), and seed yield (kg ha^{-1}). Statistical analyses of the data were according to RCBD using the analysis of variance technique and least significant differences ($LSD_{0.05}$) to compare and separate the mean differences. Also, correlation coefficient analysis among the studied traits, and the linear regression analysis helped determine the most effective traits for the faba bean seed yield employing the analysis software version 9.2 (SAS, 2002).

RESULTS AND DISCUSSION

Genotype impact

The Spanish and Turkish faba bean cultivars did not vary significantly for vegetative growth traits, such as days to 50% flowering, plant height, branches plant^{-1}, and pods plant^{-1} (Table 1). However, significant differences appeared between both genotypes for seed yield and its component traits. The Turkish cultivar provided significant mean values for pod length (16.13 cm), seeds pod^{-1} (4.05), seeds plant^{-1} (33.51), seed weight pod^{-1} (3.18 g), one-seed weight (1,042 mg), 100-seed weight (104.79 g), seed yield plant^{-1} (26.3 g), and seed yield ha^{-1} (2,923 kg). The increased seed yield of the Turkish cultivar may be due to an increase in its pod length, seeds pod^{-1}, and seeds plant^{-1}, which reflected positively and eventually enhanced the seed yield. According to Alharbi and Adhikari (2020), genotypes of faba beans were greatly modified by seeds plant^{-1}.Photosynthesis is one of the physiological processes influenced by genes and their surroundings, which in turn raises faba bean cultivars' seed yield indirectly. Furthermore discovered in this investigation was the genetic composition of the Turkish faba bean cultivar, which in Kirkuk, Iraq, outperformed the Spanish variety. These results mirrored those of Mohamed *et al*. (2020) and Badawy *et al*. (2020), who discovered notable differences in parameter values and seed yield across three different kinds of faba beans. Genotypes of faba beans differed in terms of seeds per pod, 100-seed weight, and yield (Manning *et al*., 2020; Sheha et *al*., 2020). Significant agronomic variations were also seen across faba bean varieties (Fakhr, 2020; Ibrahim *et al*., 2020; Katsoulieri *et al*., 2020; Janusauskaite and Razbadauskiene, 2021). In another research, faba bean genotypes differed for yield-related parameters and controlled seed-yield variability (Abbas *et al*., 2022).

Table 1. Impact of faba bean cultivars on studied traits.

Cultivars	Days to 50% flowering	Plant height (cm)	Branches plant^{-1}	Pod length (cm)	Pods plant^{-1}	Seeds pod^{-1}	Seeds plant^{-1}
Spanish	96.8	47.55	3.66	15.05	8.44	3.62	30.04
Turkish	96.5	47.80	3.87	16.13	8.25	4.05	33.51
L.S.D $_{0.05}$	N.S	N.S	N.S	0.62	N.S	0.30	1.49
C.V %	1.06	10.16	12.38	5.25	10.08	10.18	6.14

Cultivars	Seed weight pod^{-1} (g)	One-seed weight (mg)	100-seed weight (g)	Seed yield plant^{-1} (g)	Seed yield (kg ha^{-1})
Spanish	2.22	829	83.03	18.3	2035
Turkish	3.18	1042	104.79	26.3	2923
L.S.D $_{0.05}$	0.19	60	4.05	1.1	119
C.V %	9.25	8.47	5.66	6.3	6.28

Table 2. Impact of phosphorus fertilizer on studied traits of faba bean.

Phosphorus levels (kg P ha^{-1})	Days to 50% flowering	Plant height (cm)	Branches plant^{-1}	Pod length (cm)	Pods plant^{-1}	Seeds pod^{-1}	Seeds plant^{-1}
0	96.9	46.05	3.48	15.09	7.78	3.74	29.21
40	96.4	48.79	3.77	15.80	8.38	3.80	31.42
80	96.7	48.19	4.04	15.87	8.88	3.96	34.68
L.S.D $_{0.05}$	N.S	N.S	0.43	0.76	0.76	N.S	1.82
C.V %	1.06	10.16	12.38	5.25	10.08	10.18	6.14

Phosphorus levels (kg P ha^{-1})	Seed weight pod^{-1} (g)	One-seed weight (mg)	100-seed weight (g)	Seed yield plant^{-1} (g)	Seed yield (kg ha^{-1})
0	2.56	884	88.38	19.6	2178
40	2.64	945	94.62	22.0	2442
80	2.90	977	98.73	25.3	2816
L.S.D $_{0.05}$	0.23	74	4.96	1.3	145
C.V %	9.25	8.47	5.66	6.3	6.28

Phosphorus fertilizer impact

The results revealed that most studied traits of faba bean genotypes gained significant effects from the phosphorus fertilizer, and the genotypes responded positively to enhanced phosphorus fertilizer levels (Table 2). The traits days to 50% flowering, plant height, and seeds pod^{-1} showed nonsignificant variations with phosphorus fertilizer levels. However, phosphatic fertilizer (80 kg P ha^{-1}) compared with the non-phosphorus fertilizer showed a remarkable performance in branches plant^{-1} (4.04), pod length (15.87 cm), pods plant^{-1} (8.88), seed weight pod^{-1} (2.90 g), one-seed weight (977 mg), and 100-seed weight (98.73 g). Also, an increased phosphorus dose (80 kg P ha^{-1}) achieved significant values for seeds plant^{-1} (34.68), seed yield plant^{-1} (25.3 g), and seed yield ha^{-1} (2,816 kg) compared with 0.0 and 40 kg P ha^{-1}, which showed lowest mean values for the said traits. These results could be the prime factors for phosphorus to increase the branches plant^{-1} through stimulating the root system and its development, which also improves nutrient absorption from the soil (Ali *et al*., 2014).

Phosphorus also helps in cell division and enlargement, improving ova fertility and carbohydrate movement from the leaves to fruits and seeds. Previous outcomes led to increased pod-setting percentage, which reflected positively on pods plant^{-1}, pod length, and then increasing the seed yield. Such results stated the vital role of phosphorus in improving the growth and productivity of faba bean crops. The crucial effects of phosphorus on faba bean production resulted in several studies. Sarkar *et al*. (2017) found that 75 kg P_2O_5 ha^{-1} produced the highest average of branches plant^{-1}, pod length, 100-seed weight, and seed yield in *Vicia faba* L. In addition, Fouda (2017) obtained the highest average of pods plant^{-1}, seed index, and seed yield in *Vicia* *faba* by applying 75% P_2O_5 fed^{-1} from the recommended dose.

Effect of phosphorus fertilizer on the genotype

The faba bean varieties imported from Spain and Turkey substantially interacted with different phosphorus fertilizer amounts (Figure 1). The traits, days to 50% flowering, and plant height had nonsignificant effects from the interaction between the above-studied factors (Figure 1A, B); however, the interaction between Spanish faba bean cultivars and the 80 kg P ha^{-1} achieved the highest mean values for branches $plant^{-1}$ (4.08) and pods $plant^{-1}$

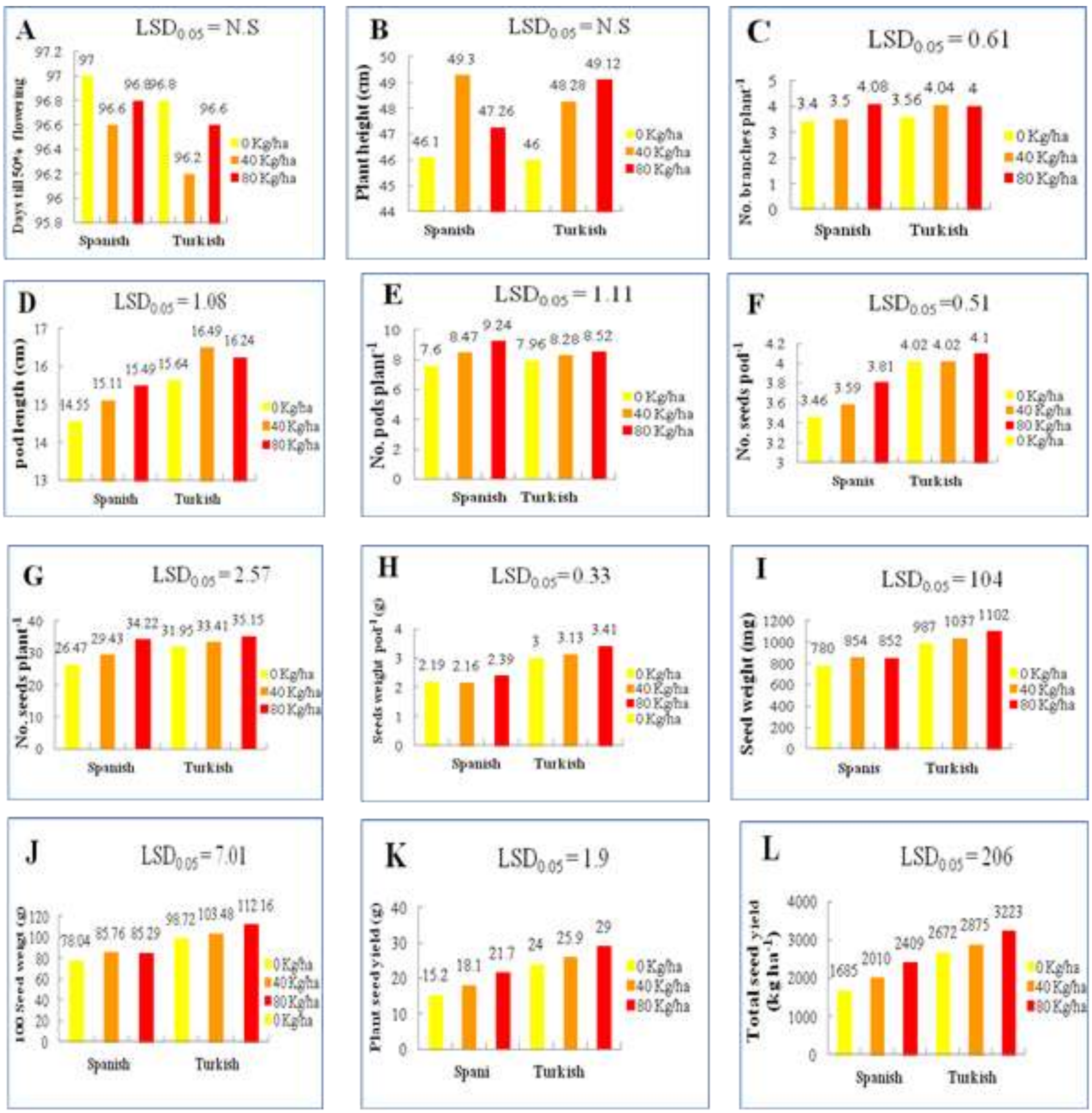

Figure 1. Interaction impact between two imported faba bean cultivars and three phosphorus fertilizer levels on Days to 50% flowering (A), Plant height (B), No. of branches $plant^{-1}$ (C), Pod length (D), No. of pods $plant^{-1}$ (E), No. of seeds pod^{-1} (F), No. of seeds $plant^{-1}$ (G), Seed weight pod^{-1} (H), One-seed weight (I), 100-seed weight (J), Seed yield $plant^{-1}$ (K), and Seed yield (L).

(9.24) (Figure 1C, E). A notably increased pod length (16.49 cm) was evident with the interaction between the Turkish cultivar and the 40 kg P ha^{-1} (Figure 1D). The Turkish cultivar with 80 kg P ha^{-1} significantly influenced seeds pod^{-1} (4.10), seeds plant^{-1} (35.15), seed weight pod^{-1} (3.41 g), one-seed weight (1,102 mg), 100-seed weight (112.16 g), seed yield plant^{-1} (29.0 g plant^{-1}), and seed yield ha^{-1} (3,223 kg) (Figure 1F-L).

However, the interaction of the Spanish faba bean cultivar and the 0 kg P ha^{-1} emerged with the lowest mean values for all the studied traits (Figure 1C-L). These results indicate that the Turkish faba bean cultivar better responded to phosphorus fertilizer than the Spanish cultivar, especially for the productivity traits under the environmental conditions of Kirkuk Governorate, Iraq. These findings also agreed with the findings of Kandil *et al*. (2019b), who observed the significant impact of faba bean cultivars in interaction with phosphorus fertilizer for the pod length, 100-seed weight, and seed yield.

Correlation analysis

The correlation coefficient analysis is a commonly accepted way to measure the ratio among independent variables, such as crop agronomic traits in faba bean genotypes (Awadalla *et al*., 2018). The results of the correlation analysis among the faba bean growth and productivity traits under the influence of cultivars and phosphorus fertilizer levels are in Table 3. Seed yield showed a significant positive correlation with branches plant^{-1}, pod length, seeds pod^{-1}, seeds plant^{-1}, seed weight pod^{-1}, one-seed weight, 100-seed weight, and seed yield plant^{-1} with correlation values (r) of 0.423, 0.694, 0.518, 0.823, 0.893, 0.814, 0.905, and 0.995, respectively.

Obtaining a high seed yield can come from increasing all the productivity traits by sowing modern cultivars characterized by a high yield under proper phosphorus fertilizer applications, and it may explain the direct correlation between yield productivity traits and seed yield (Table 3). These findings were analogous to the findings of Awadalla *et al*. (2018), Emam and Semida (2020), and Papastylianou *et al*. (2021), who also found a significant positive correlation between faba bean seed yield and its components.

Regression analysis

The regression analysis between the studied traits of faba bean and phosphorus fertilizer levels materialized (Table 4). Regression equations showed that phosphorus fertilizer enhanced levels positively impacted plant height, branches plant^{-1}, pod length, pods plant^{-1}, seeds plant^{-1}, seeds weight pod^{-1}, one-

Table 3. Correlation relationship among Faba bean traits under cultivars and phosphorus fertilizer levels impact.

Traits	DF	PH	No. bp	PL	No. PP	No. sp	No.Se.PSP		SWP	100SW	SYP
PH	-0.185										
BP	0.062	0.363*									
PL	-0.375*	0.388*	0.477**								
PP	-0.269	0.197	0.524**	0.352							
SP	-0.058	0.244	0.362*	0.574**	0.096						
Se.P	-0.195	0.240	0.628**	0.720**	0.484**	0.544**					
SP	-0.103	0.005	0.272	0.670**	-0.049	0.559**	0.669**				
SWP	-0.272	0.048	0.098	0.635**	-0.081	0.394*	0.567**	0.868**			
100 SW	-0.170	0.203	0.275	0.663**	0.012	0.488**	0.689**	0.889**	0.880**		
SYP	-0.185	0.105	0.425*	0.697**	0.222	0.572**	0.827**	0.896**	0.816**	0.907**	
SY	-0.183	0.103	0.423*	0.694**	0.218	0.518**	0.823**	0.893**	0.814**	0.905**	0.995**

*: significant at prob. of 0.05 and **: significant at prob. of 0.01. DF= Days to 50% flowering, PH= Plant height, BP= Branches plant^{-1}, PL= Pod length, PP= Pods plant^{-1}, SP= Seeds pod^{-1}, Se. P= Seeds plant-1, SP= Seeds pod^{-1} weight, SWP = Seed weight pod^{-1}, 100 SW= 100-seed weight, SYP = Seed yield plant^{-1}, SY= Seed yield.

Table 4. Regression equations for relationship between faba bean traits (Y) and phosphorus levels (X) with coefficient of determination (R^2) values.

Traits	Regression equations: Y = a + b X	R^2
Days to 50% flowering	Y = 96.767 - 0.0025 X1	0.158
Plant height	Y = 46.607 + 0.0268 X2	0.552
Branches plant^{-1}	Y = 3.483 + 0.0070 X3	0.999
Pod length	Y = 15.197 + 0.0098 X4	0.817
Pods plant^{-1}	Y = 7.797 + 0.0138 X5	0.997
Seeds pod^{-1}	Y = 3.753 + 0.0020 X6	0.495
Seeds plant^{-1}	Y = 29.035 + 0.0684 X7	0.988
Seeds weight pod^{-1}	Y = 2.530 + 0.0043 X8	0.915
One-seed weight	Y = 888.833 + 1.1625 X9	0.967
100-seed weight	Y = 88.735 + 0.129 X10	0.986
Seed yield plant^{-1}	Y = 19.450 + 0.0713 X11	0.999
Seed yield ha^{-1}	Y = 2159.667 + 7.975 X12	0.990

Table 5. Regression equations for relationship between seed yield (Y) and faba bean traits (X) under phosphorus levels with coefficient of determination (R^2) values.

Traits	Regression equations: Y = a + b X	R^2
Days to 50% flowering	Y = 97.259 - 0.0002 X1	0.093
Plant height	Y= 40.182 + 0.0030 X2	0.453
Branches plant^{-1}	Y = 1.613 + 0.0009 X3	0.986
Pod length	Y = 12.723 + 0.0012 X4	0.734
Pods plant^{-1}	Y = 4.137 + 0.0017 X5	0.977
Seeds pod^{-1}	Y = 3.159 + 0.0003 X6	0.594
Seeds plant^{-1}	Y = 10.496 + 0.0086 X7	0.999
Seeds weight pod^{-1}	Y = 1.352 + 0.0005 X8	0.962
One-seed weight	Y = 583.980 + 0.1418 X9	0.925
100-seed weight	Y = 54.565 + 0.0159 X10	0.953
Seed yield plant^{-1}	Y = 0.173 + 0.0089 X11	0.999

seed weight, 100-seed weight, seed yield plant^{-1}, and seed yield ha^{-1} (0.0268, 0.0070, 0.0098, 0.0138, 0.684, 0.0043, 1.1625, 0.129, 0.0713, and 7.975, respectively), with coefficient of determination (R^2) values equal to 55.2%, 99.9%, 81.7%, 99.7%, 98.8%, 91.5%, 96.7%, 98.6%, 99.9%, and 99%, respectively. However, the coefficient of determination (R^2) for days to 50% flowering and seeds pod^{-1} was less than 50%. The regression equations and coefficient of determination (R^2) help explain the relationship between the seed yield of faba bean cultivars with studied traits under phosphorus fertilizer levels and their interaction (Tables 5 and 6). The regression equations revealed that seed yield had growth and productivity traits determining it, with coefficient of determination (R^2) values for these equations at 98.6%, 73.4%, 97.7%, 59.4%, 99.9%, 96.2%, 92.5%, 95.3%, and 99.9% for the traits, branches plant^{-1}, pod length, pods plant^{-1}, seeds pod^{-1}, seeds plant^{-1}, seed weight pod^{-1}, one-seed weight, 100-seed weight, and seed yield plant^{-1}, respectively (Table 5).

Days to 50% flowering and plant height gave less than 50% values of the coefficient of determination (R^2); hence, they were inconsiderable. The regression equations for faba bean seed yield, determined by pod length, seeds pod^{-1}, seeds plant^{-1}, seed weight pod^{-1}, one-seed weight, 100-seed weight, and seed yield plant^{-1} had a coefficient of determination (R^2), 88.8%, 84.4%, 80.7%, 90.3%, 92.7%, 92.5%, and 99.8%, respectively (Table 6). The coefficient of determination (R^2) showed no significant influence for days to 50% flowering, plant height, branches plant^{-1}, and pods plant^{-1}.

Table 6. Regression equations for relationship between seed yield (Y) and faba bean traits (X) under interaction between cultivars and phosphorus levels with coefficient of determination (R^2) values.

Traits	Regression equations: Y = a + b X	R^2
Days to 50% flowering	Y = 97.365 + 0.0003 X1	0.341
Plant height	Y = 45.102 +0.0010 X2	0.171
Branches plant^{-1}	Y = - 175.513 + 0.0992 X3	0.118
Pod length	Y = 12.637 + 0.0012 X4	0.888
Pods plant^{-1}	Y = 7.571 + 0.0003 X5	0.101
Seeds pod^{-1}	Y = 2.784 + 0.0004 X6	0.844
Seeds plant^{-1}	Y = 18.884 + 0.0052 X7	0.807
Seeds weight pod^{-1}	Y = 0.492 + 0.0009 X8	0.903
One-seed weight	Y = 407.109 + 0.2131 X9	0.927
100-seed weight	Y = 39.279 + 0.0220 X10	0.925
Seed yield plant^{-1}	Y = 0.065 + 0.0090 X11	0.998

Generally, coefficient of determination (R^2) results showed the effect of productivity traits on faba bean seed yield under phosphorus fertilizer levels in the following order: seeds plant^{-1} and seed yield plant^{-1} (99.9%), branches plant^{-1} (98.6%), pods plant^{-1} (97.7%), seed weight pod^{-1} (96.2%), 100-seed weight (95.3%), one-seed weight (92.5%), pod length (73.4%), and seeds pod^{-1} (59.4%), as shown in Table 5. However, under the interaction between cultivars and phosphorus fertilizer levels, the arrangements were seed yield plant^{-1} (99%), one-seed weight (92.7%), 100-seed weight (92.5%), seed weight pod^{-1} (90.3%), pod length (88.8%), seeds pod^{-1} (84.41%), and seeds plant^{-1} (80.7%) (Table 6).

CONCLUSIONS

The Turkish faba bean cultivar significantly affected all production traits compared with the Spanish cultivar. Phosphorus fertilizer application proved beneficial for faba bean growth and production traits, with the 80 kg P ha^{-1} producing the remarkably highest seed yield (2,816 kg ha^{-1}). Highly significant and positive correlations emerged among faba bean production traits with seed yield. The regression analysis between seed yield and other production traits showed that seed yield plant^{-1}, seeds plant^{-1}, branches plant^{-1}, pods plant^{-1}, seed weight pod^{-1}, 100-seed weight, and one-seed weight substantially explained more than 90% variability of seed yield for each single trait under phosphorus fertilizer levels. However, seed yield plant^{-1}, one-seed weight, 100-seed weight, and seed weight pod^{-1} sequentially explained more than 90% of the seed yield variability for each trait under the interactions of faba bean cultivars and phosphorus fertilizer levels. In conclusion, it could be a proposal that the faba bean Turkish cultivar better responds to phosphatic fertilizer (80 kg P ha^{-1}) to produce the highest seed yield of faba bean in the Kirkuk Governorate, Iraq.

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